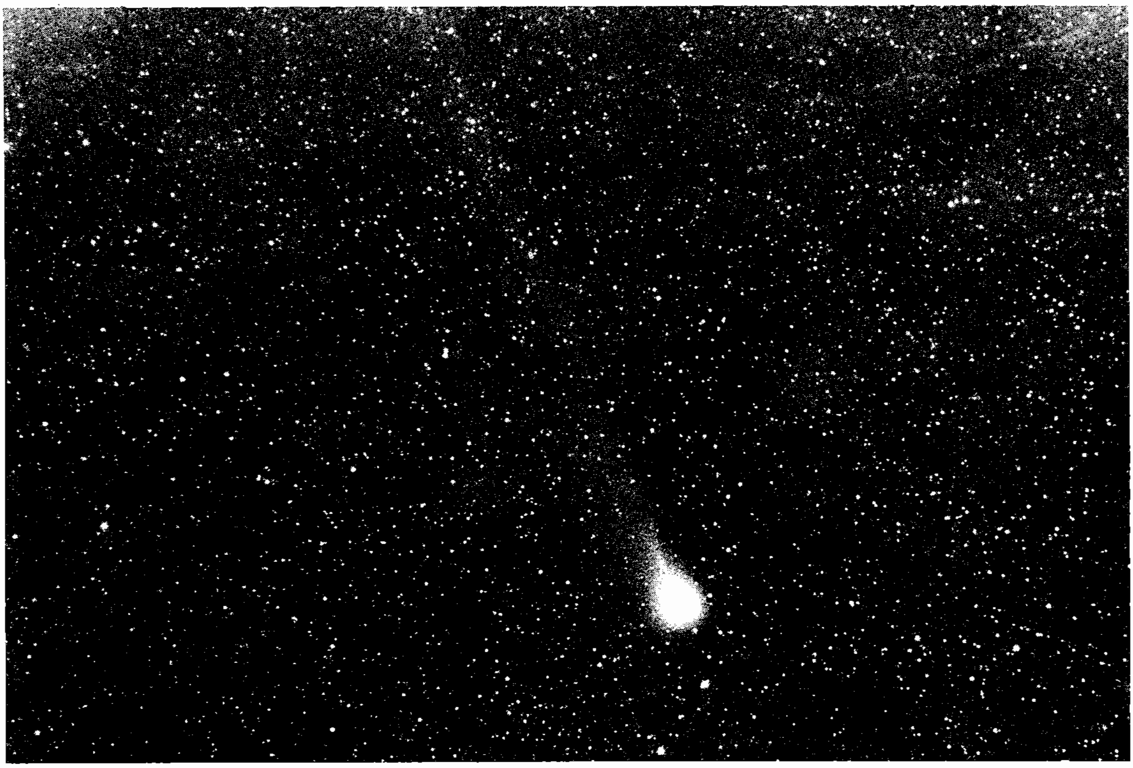
ISSN 0039-2502

# The Journal Of The Association Of Lunar And Planetary Observers

## *The Strolling Astronomer*

Volume 34, Number 4 Published November, 1990



Comet Levy 1990c, discovered by A.L.P.O. Assistant Meteors Recorder David H. Levy, here photographed by Jean Dragesco and P. Tosi on 1990 July 31 at 01h 35m U.T. Comet Levy was then still approaching the Sun and the Earth. This photograph was taken with a 20-cm. aperture f/1.5 Schmidt camera, using a 6-minute exposure on hypered Kodak TP2415 Film. South is at the top; note the faint tail extending to the upper left (southwest). See also "Comet Corner" on pp. 180-181.

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ASSOCIATION OF LUNAR & PLANETARY OBSERVERS
ALPO
Founded in 1947

## IN THIS ISSUE



### SPECIAL LAST-MINUTE NOTICE

We have just received notification from the U.S. Internal Revenue Service that the Association of Lunar and Planetary Observers has been determined to be exempt from Federal Income Tax as a publicly-supported organization as described in section 501(c) (3). This means that, for American members, the portion of their annual dues to the A.L.P.O. that exceeds $11 per year may be considered as a contribution to a tax-exempt organization. This deduction becomes significant for Sustaining Members and Sponsors. Also, the entire amount of any donation to our Foreign Membership Fund is such a contribution. In the next issue we will describe another charitable effort of the A.L.P.O.—a fund to supply deserving foreign members with astronomical literature, supplies, and equipment.

A.L.P.O. Board and staff members may be able to deduct their personal expenses involved with conducting the business of the A.L.P.O. and its Sections, and we have mailed a more detailed notice to these persons.

You should be able to deduct contributions to the A.L.P.O. beginning in calendar year 1990. Please note that keeping records of contributions, and determining if they are deductible, remains the contributor's responsibility. If you are at all uncertain, you should question a tax consultant.

# MAPPING LUNA INCOGNITA

By: John E. Westfall, A.L.P.O. Lunar Recorder, Luna Incognita Project

ABSTRACT

*Luna Incognita* is the portion of the Moon, near the south and southwest limbs, that was poorly photographed by the space missions of the 1960's and which thus remained inadequately mapped. This report describes the A.L.P.O. Lunar Section project that studied this region between 1972 and 1990; an effort that involved 58 A.L.P.O. and other observers, who submitted 384 drawings and 1509 photographs done particularly for the project. Other sources were Lunar Orbiter-IV and -V, and Zond-8 photography; pre-project earthbased drawings, photographs, and maps; radar maps and images; and charts of the Moon's limb profile. These were consulted in compiling the shaded-relief topographic map presented here, which is on the Transverse Mercator Projection, based on 821 positions measured from Lunar Orbiter and earthbased photographs. The map was prepared with a computer "paint " (shading) program at an original scale of 1:2,500,000, reproduced here at approximately 1:3,500,000.

## GOAL OF PROJECT

This cartographic project involved compiling, drafting, and publishing a relief map of that portion of the Moon that was not adequately mapped in the past. The map includes the 270,000-sq km area that suffered from a low Sun angle when the Lunar Orbiter-IV and -V Missions photographed most of the remainder of the Moon in 1967.

The region was named *Luna Incognita* because it was the largest unmapped zone remaining on the Moon. It includes the south and southwest lunar limb areas, as seen from the Earth. (We here use the International Astronomical Union system of directions, with, e.g., Bailly near the south*west* limb.) Most of this region is occasionally visible from Earth, given suitable conditions of lighting and libration. However, outside of the A.L.P.O. project, there are no current plans to map this region, or indeed any part of the Moon, at a scale larger than 1:5,000,000 (Planetary Cartography Working Group, 1984). Thus, earthbased observations were used to fill in many of the blank spaces on lunar maps of the region. The final product is a 1:2,500,000-scale shaded-relief topographic map of Luna Incognita and its environs, reduced here to a scale of approximately 1:3,500,000 (about 35 km/cm or 55 mi/in).

## THE A.L.P.O. OBSERVING PROGRAM

This mapping project began in 1972 when it was clear that there would be no more lunar missions for the foreseeable future and that the missions to date had failed to complete the mapping of the Moon (Westfall, 1972). The emphasis during 1972-87 was an observing project conducted by the Association of Lunar and Planetary Observers (A.L.P.O.). By the time the last observations were received (in 1990), some 58 amateur and professional astronomers had submitted some 384 telescopic drawings and 1509 photographs of the region. The majority of the drawings were made on standard outline forms prepared by the writer, who also provided annual visibility predictions for 1972-87 (Westfall, 1972, 1972a, 1974, 1974a, 1976, 1977, 1977a, 1977b, 1978, 1980, 1981, 1982, 1982a, 1983, 1984, 1984a, 1986, 1986a, 1987).

Successful observation of this portion of the Moon's southern limb requires a strong southerly libration, preferably combined with a southerly selenocentric declination of the Sun. Conditions are more restrictive for the southwest limb, where both southerly and westerly librations are needed, preferably with a low- or medium sun angle The last set of conditions follows a 5.997-year visibility cycle, which ultimately depends on the "beat" between the draconic month (27.2122 days, the period of the latitude libration) and the anomalistic month (27.5546 days, the period of the longitude libration). An indication of this cycle is given in *Table 1*, below, which shows the number of days for each year in 1977-1987 when three latitude zones in *Luna Incognita* could be successfully observed.

**Table 1. Visibility of *Luna Incognita* by Latitude Zone, 1977-1987.**

| | Number of Days Visible | | | |
|---|---|---|---|---|
| | Any | Latitude Range | | |
| Year | Portion | 80°-90°S | 65°-80°S | 50°-65°S |
| 1977 | 96 | 68 | 61 | 0 |
| 1978 | 105 | 69 | 69 | 7 |
| 1979 | 110 | 70 | 74 | 33 |
| 1980 | 122 | 81 | 83 | 36 |
| 1981 | 119 | 86 | 79 | 7 |
| 1982 | 113 | 74 | 77 | 0 |
| 1983 | 110 | 73 | 75 | 0 |
| 1984 | 103 | 66 | 68 | 22 |
| 1985 | 109 | 77 | 67 | 35 |
| 1986 | 112 | 79 | 73 | 21 |
| 1987 | 113 | 76 | 75 | 1 |

We here thank the observers who generously contributed their time, drawings, and photographs to our project. They consisted of both members and non-members of the A.L.P.O. and were both amateur and professional astronomers. *Table* 2 (p. 150) lists these individuals, with the aperture (in cm.) and type (M =reflector, L = refractor) of telescope used, and the number of drawings (D) or photographs (P) that they contributed.

**Table 2. Participants in the *Luna Incognita* Observing Project.**

| | | |
|---|---|---|
| Abbott, Patrick (32M) | 15D | - |
| Abineri, K.W. (20M) | 7D | - |
| Aerts, Leo (15L) | 4D | 23P |
| Aloy, Jordi (20M, 31M) | 6D | - |
| Barbero, Pier (20M) | 1D | - |
| Caruso, Joseph (32M, 51L) | 7D | 19P |
| Childers, D.P. (30M) | - | 3P |
| Cruz Conejo, Manuel (20M) | 3D | - |
| Cyrus, Charles (32M) | 12D | - |
| Fox, James H. (25M, 51M) | 2D | 3P |
| Garcia, Joaquim (6L, 41M) | 2D | 15P |
| Gardner, Bruce (20L, 30M) | - | 12P |
| Genebriera, Joan (26M, 36M) | - | 17P |
| Goodrich, R.W. (20M) | - | 19P |
| Gorski, L. (20M) | 1D | 2P |
| Graham, Francis* | 143D | 821P |
| Herman, Lester C. (15L, 30M) | - | 2P |
| Hill, Harold (20M) | 3D | - |
| Hill, Michael (25M) | - | 1P |
| Hitchcock, R. (20M) | 1D | - |
| Hladluk, Don (30M) | - | 6P |
| Johnson, Gus (15M) | - | 1P |
| Kemble, Fr. Lucian (28M) | - | 4P |
| Korintus, John S. (20M, 32M) | - | 61P |
| Legrand, Michel (20M, 21M, 60M) | 9D | 24P |
| Libert, Claude (12L) | - | 1P |
| Loblaw, R. (28M) | - | 3P |
| McDavid, David (36M) | 1D | 4P |
| Mallama, Anthony (25M) | 2D | - |
| Marcisz, Richard (33M) | 1D | 14P |
| Mazzanti, Ferran (35M, 41M) | 2D | - |
| Mettig, Hans-Joerg (15L) | 3D | - |
| Oehlert, Ronald (15M) | 77D | 28P |
| Oliver, Richard (61L) | - | 17P |
| Palulis, Charles (15L, 20L, 32M) | - | 12P |
| Parish, Roy (not known) | - | 1P |
| Parizek, A.K. (29M) | - | 50P |
| Patton, C. (15M) | 5D | - |
| Pola, Salvador (40M) | 1D | - |
| Porter, Alain C. (10L, 15M) | 2D | 2P |
| Rhea, Kermit (20M) | - | 109P |
| Roginski, T. (30M, 38L) | - | 9P |
| Romano, Tallone (20M) | - | 10P |
| Sabia, John (10L, 24L, 24M) | 13P | 8P |
| Sanford, John (30M) | - | 7P |
| Soldevilla, Josep (10L, 16M, 26M, 30M, 35M) | 11D | 1P |
| Sweetman, Michael (25M) | - | 8P |
| Tackaes, C. & Horn, T. (15L) | - | 1P |
| Tobal, Christofol (10L, 16M, 26M) | 25D | - |
| Troiani, D. (25M) | 3D | 7P |
| Van Loo, Francois (25M) | 4D | 3P |
| Venne, Roger (20M) | - | 1P |
| Ventre, John (41M) | - | 28P |
| Viscardy, Georges (52M) | - | 8P |
| Waffen, G. (20M) | 2D | - |
| Webb, Robert & Palmer, Kirk (31L) | - | 26P |
| Wessling, Richard (32M) | 1D | 7P |
| Westfall, John (10M, 36M, 51L) | 15D | 111P |
| Total (58 principal observers) | 384D | 1509P |

*Francis Graham observed with a 6L, 7.6L, 10M, 15M, 18L, 20M, 25L, 25M, 33L, 33M, 76M, 79M, 102L, and 209M. He conducted joint observations with the following colleagues: M. Benson, P. Callas, K. Good, C. Graham, K. Graham, T. Guzik, W. Hall, C. Havey, C. Hughes, B. Levenson, S. Lubay, R. McGinty, E. Onder, T. Palmer, D. Potemra, D. Ramey, E. Santorini, G. Walsh, and R. Wamsley.

It is interesting to note that photographs constituted 80 percent of the 1893 observations submitted. The participants used a wide range of apertures, from 5 to 209 cm. Weighted by observers, rather than by the number of observations, the median aperture was 24.7 cm, the mean was 30.5 cm, and the most frequently used aperture was 20 cm.

## OTHER SOURCES

Other earthbased data included about 170 observatory photographs; that part of the A.L.P.O. collection of about 3000 such photographs that showed *Luna Incognita* (Catalina Observatory, Lick Observatory, Lowell Observatory, Mount Wilson Observatory, Pic du Midi Observatory; U.S. Naval Observatory—Flagstaff). The major other "historical" sources consisted of published lunar atlases (Fauth, 1964; Kuiper, 1960; Kuiper *et al.*, 1967; Lohrmann, 1878; Miyamoto & Hattori, 1964; Pickering, 1903; Rükl, 1972; Schmidt, 1963; Shirao & Sato, 1987; Viscardy, 1985; Whitaker *et al.*, 1963; Wilkins & Moore, 1955); reports of the A.L.P.O. and the British Astronomical Association (Abineri, 1952, 1956; Arthur & Abineri, 1951; Cattermole, 1964; Hare, 1953; Lenham & Abineri, 1955; Rackham, 1955; Stone, *no date.*; Westfall, 1954; Whitaker, 1954, 1956, 1956a; Wilkins, 1950, 1952, n.d.); *Communications* of the Lunar and Planetary Laboratory (Tucson; Herring, 1964, 1965); and radar imagery and atlases (Zisk, 1970?, 1974). Space-Mission data included American Lunar Orbiter-IV and -V views (Bowker & Hughes, 1971; Lunar Orbiter-IV; Lunar Orbiter-V), U.S. Geological Survey maps made primarily from Orbiter imagery (Scott *et al.*, 1977; U.S. Geological Survey, 1978, 1981, 1981a; Wilhelms, 1979); and Soviet space imagery, particularly from Zond-8 (Lipskiy *et al.*, 1969; U.S.S.R. Academy of Science, 1975; U.S.S.R. Univ. of Moscow, Sternberg State Astron. Inst., 1979; Zond-8). Most of the references used were in the writer's personal library or the A.L.P.O. lunar photograph collection, although the writer also used the collections of the U.S. Geological Survey (Menlo Park), U.S. Naval Observatory (Washington, DC) and the Lunar and Planetary Laboratory (Tucson, AZ).

The study area was particularly lacking in positional control. There were few earthbased positions for the map region, and those that existed were largely selenographic measures, which assumed that the Moon was spherical and thus were subject to considerable errors near the limb (Arthur, 1962). Only approximate positions were available from American and Soviet lunar missions; the entire area was far south of Apollo orbital photography tracks. Probably the most useful previous positional information came from the Watts limb profiles (Watts, 1963: see also Chugunov, 1979; Scott, 1988; Van Flandern, 1970).

For the present project, earthbased photographs were used to determine a 52-feature primary net of selenodetic (3-dimensional) coordinates (Westfall, 1984). This served as the basis for measures from the Orbiter photographs, consisting of 769 secondary positions (based on 2078 measures), 318 crater diameters, and 851 relative elevations; the last found from shadow-length measures. All measurements were done with a digitizing tablet and an Apple-II computer, using software written by the writer to convert photographic coordinates to lunar latitude and longitude; and, in the case of the selenodetic positions, also to radius vector. Similar programs computed crater diameters or relative elevations. Selenocentric spacecraft coordinates were also necessary for the reduction (Moyers, 1969, 1969a).

Positional accuracy is unsatisfactory in this region because of the difficulty of extending the earthbased system of measured points to the lunar farside across the poorly-photographed zone of *Luna Incognita*. The writer's primary and secondary nets had 43 points in common, with a mean disagreement of ±5.6 km between the two systems. The formal statistical mean error of the secondary system itself was ±6.2 km. As a further check, the system of measures that has been used for the U.S. Geological Survey series of maps (U.S. NASA, 1975; U.S. Geological Survey, 1978, 1981, 1981a) contains 11 points that fall in or near *Luna Incognita* and correspond with points measured by the writer. The mean positional difference between those points and the writer's was ±17.1 km, while the root-mean-square difference was ±19.8 km. Note that the U.S. Geological Survey maps themselves state, "Positional discrepancies as large as 25 km at map scale exist in the mosaic base." (U.S. Geological Survey, 1981a)

## MAP COMPILATION

These measurements above allowed features to be plotted on base maps of the study area, using the Transverse Mercator Projection at 1:2,500,000 scale, assuming that the Moon is a sphere with a radius of 1738.0 km. Coverage extends southward along the 105°W meridian from 50° S across the South Pole and along the 75°E meridian to about 75°S. The 105°W/75°E meridian is the transformed equator of the projection, and is located 7 cm. above the bottom margin of each map section (at original scale). The nominal scale is correct along that meridian; but the scale is increased by 4.17 percent at the top of the map, and by 0.51 percent at the bottom. Areas are thus exaggerated slightly, but the projection is conformal in that the shapes of small features are essentially correct.

The map is intended to be oriented with the earthside hemisphere to the top and the farside to the bottom. This places lunar north to the left and the south polar region on the righthand portion of the map (in Section 4 as reproduced here).

Feature outlines were traced from Lunar Orbiter and Zond-8 photographs which had been enlarged to map scale. These were approximately rectified by enlargement onto a tilting easel upon which was placed a base map that contained pre-plotted positions.

At this point, *Luna Incognita* was divided into eight octants so that each octant could be stored as a computer file that could be viewed as a whole. The outline maps were scanned, making "PICT"-format graphic files suitable for use with a Macintosh II computer. In terms of resolution, the screen pixel size was 1/72 inch square (0.353 mm or 882 meters at scale). Each octant measured 16.5 by 13.5 cm, or 468 by 383 pixels. The complete map covers an area of 1.11 million sq km, or about 2.9 percent of the Moon's entire surface.

These scanned files, showing feature positions and outlines to scale, were accessed with a commercial "paint" program (PixelPaint ©). It had been decided previously that topography would be shown by the shaded-relief ("plastic relief") method (Imhof, 1982). in this method, the imaginary light source is assumed to be above the top margin of the map, and features are so illuminated that slopes facing toward the light are lighter than the background, while those facing away are darker. The background shade, representing a level surface, is a 50-percent medium grey. The intensity of light or dark for a sloping surface is proportional to its estimates gradient and to the cosine of the difference in azimuth between the slope normal and the illumination direction. Slopes "shade" only themselves and do not cast shadows upon other features.

The use of a "paint" program allowed the outline base to be drawn over in a manner analogous to air brushing; except that corrections could be made at any time, and 256 levels of grey could be used. Features were drawn in roughly with a screen image at 2 times the final scale, while details were added at a 4-times enlargement.

Because detailed elevation information was lacking, standard methods of relief shading that require the use of contour lines could not be used. Rather, the technique pioneered by Patricia Bridges and her colleagues was employed; first visualizing a three-dimensional feature and then rendering it under set lighting conditions (Batson, 1978; Inge and Bridges, 1976; for background see Arthur, 1960 and Kopal & Carder, 1974). Thus, using all the sources mentioned above, the writer then rendered shaded-relief topographic detail upon the base maps. This was done with plausible "interpretation"; when a feature was visible only in part, its unseen portions were assumed to also exist and thus were drawn in. Such details are evidenced by their simplified, schematic appearance.

After the preliminary version of the shaded-relief map was completed, it was reviewed and edited. A latitude/longitude grid, along with feature names, was prepared with a "drawing" program (Adobe Illustrator ©). Hard copies of the eight octants of the *Luna Incognita* map were then printed on a LaserWriter for rough copies, and on a Linotronics © printer when better quality was needed, such as for the version reproduced in this paper as *Figure 1* (pp. 155-159).

Mapping this region at the scale used made it clear that the place-name density was quite low. The writer has added to the map in parentheses ten new names commemorating polar explorers (Nobile, Shackleton) and professional and amateur astronomers (Ashbrook, Bartlett, Chappe, Gant, Hare, Hedervári, and La Paz). The tenth name, *Mare Parvum*, is descriptive of a small *mare* unit in the map area. The names *Hare* and *Mare Parvum* were used on the Wilkins map (Wilkins and Moore, 1955) but have not been approved by the International Astronomical Union (I.A.U.). These ten names will be submitted to the I.A.U. and are provisional until approved by that body. Existing nomenclature conforms to the *NASA Catalog of Lunar Nomenclature* (Andersson and Whitaker, 1982; see also Arthur *et al.*, 1965, 1966).

## PLANS AND DISCUSSION

The map reproduced here will also be published separately as a single sheet. A longer-range plan is to use the shaded-relief map as a base in order to plot the 21 absolute, and 851 relative, elevations that have been measured. At least in the vicinity of the Moon's South Pole, where solar lighting assumes a wide range of azimuths, these measured points should allow an actual contour map to be drawn.

The sources were of variable quality, but often were complementary. Lunar Orbiter-IV and -V views provided by far the highest resolution, but suffered from low Sun angles and extensive underexposed and shadowed areas. Soviet Zond-8 photography was a useful supplement for areas north of approximate latitude 80° S. Earthbased visibility, on the other hand, was poorest in those most northerly areas of the map. However, almost all the south polar region was visible for earthbased observers when lighting and libration were suitable. The Zisk radar maps helped greatly in the southerly zones where the Sun angle is always low. Finally, the Watts limb profiles helped at least to approximately fix positions of positive relief features throughout the region.

The present map provides the largest-scale and most detailed cartographic coverage yet prepared for this portion of the Moon. Besides *Luna Incognita* proper, it encompasses portions of the earthside hemisphere that are adjacent to the limb in order to aid in orientation for earthbased observers. It includes the lunar south polar zone; a region where water ice may be preserved in ever-shaded depressions, which would be important for any future lunar base. There are a number of noteworthy features in this region, including ejecta from the impact sites of Zeeman and Mare Orientale, several of the Moon's tallest mountains and deepest craters, and portions of several large impact basins. Indeed, several arcuate features may represent rings of previously-unrecongnized basins or ancient craters.

Although the new map contains significant detail that was not shown on the best previous maps, which were at 1:5,000,000 scale, considerable areas remain blank or are only partially mapped. Such zones are obvious on the map and represent areas that are either always invisible from the Earth, are never sunlit, or both. Their more complete mapping will probably have to wait for a lunar polar orbiter imaging mission.

Likewise, horizontal and vertical positional absolute control is essentially no better than in the early 1970's, with uncertainties on the order of 20 km, and again may have to await a polar orbiting mission to be improved significantly (Rükl, 1968).

Also, the writer believes that the map is a significant contribution to lunar cartographic techniques because it has been innovative in using a computer paint program in making a shaded-relief map. Such mapping usually employs an air-brush; a difficult technique which is practiced by only a few highly trained and talented planetary cartographers.


## ACKNOWLEDGEMENTS

I particularly wish to thank the many observers, amateur and professional, who provided the lunar drawings and photographs that constituted the observational phase of this project. Particularly helpful were three individuals: Francis G. Graham who supplied observations, organized other observers, and helped with interpretation throughout the project; Don E. Wilhelms, who drew my attention to an invaluable collection of earthbased lunar photography; and Donald Davis (Davis, 1986, 1986a), who also pointed out important sources and supplied his own independent renderings of the region's topography. Finally, San Francisco State University, and its Department of Geography, provided the writer with Sabbatical Leave with pay for one semester, which allowed the final map to be completed.


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Lunar Orbiter-IV (Space Mission). *Medium-resolution frames:* 5, 6, 8, 44, 58, 70, 82, 94, 106, 118, 130, 154, 166, 179, 193. *High-resolution frames:* 5-1, 6-1, 8-2, 44-1, 58-1, 70-1, 82-1, 94-1, 106-1, 118-1, 130-1, 154-1, 166-1, 166-2, 166-3, 179-1, 179-2, 179-3, 193-1, 193-2, 193-3.

Lunar Orbiter-V (Space Mission). *Medium-resolution frames:* 21, 22. *High-resolution frames:* 21-1, 21-2, 22-3.

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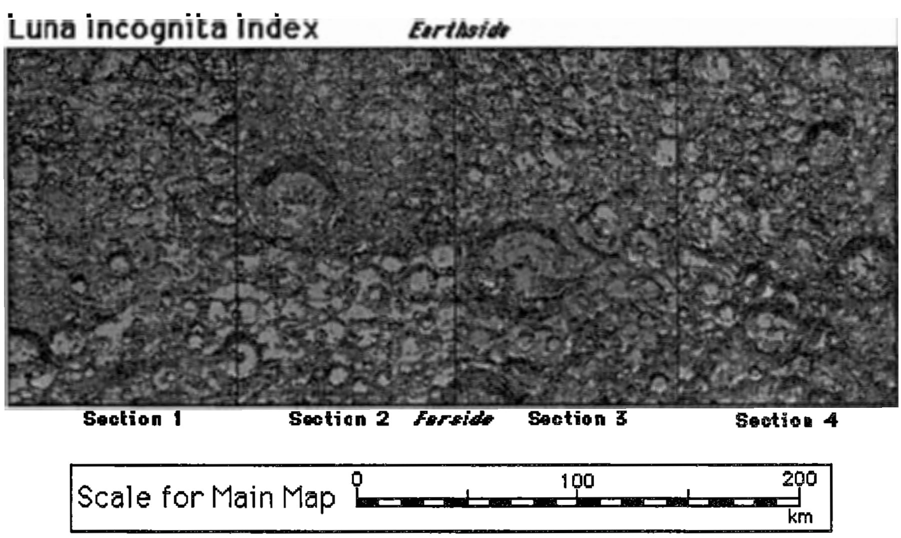


Figure 1.0. Index map and scale bar for the four sections of the map of *Luna Incognita* that follow (Fig. 1.1-1.4, pp. 156-159). See text on pp. 149-152 for further information.


Figure 1.1. Section One (northern) of the four sections of the map of *Luna Incognita*.

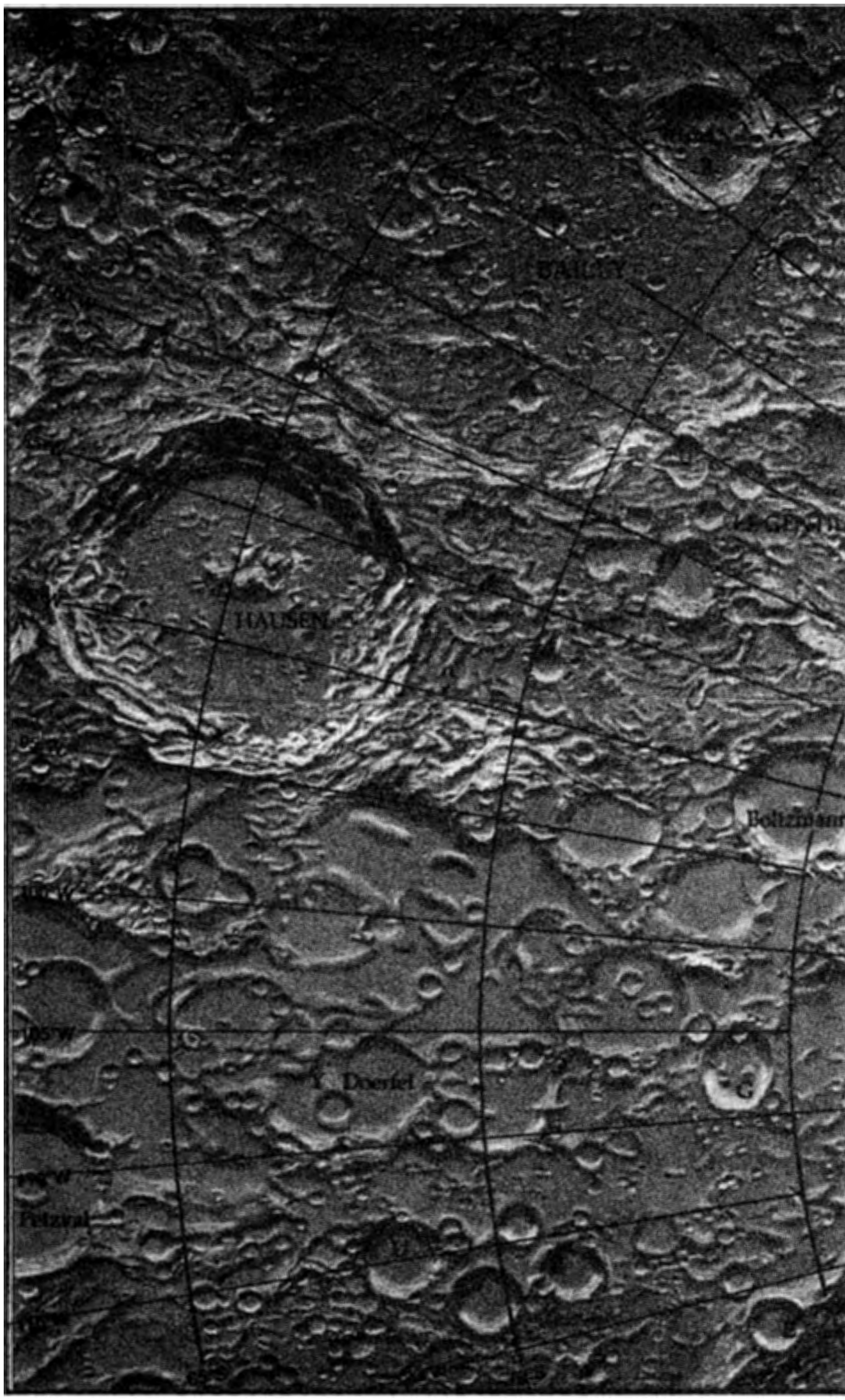


Figure 1.2. Section Two (north central) of the four sections of the map of *Luna Incognita*.


Figure 1.3. Section Three (south central) of the four sections of the map of *Luna Incognita*.


Figure 1.4. Section Four (southern) of the four sections of the map of *Luna Incognita.*

# THE 1988-89 APPARITION OF SATURN: VISUAL AND PHOTOGRAPHIC OBSERVATIONS

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


## ABSTRACT

Visual and photographic studies of the planet Saturn and its Ring System were done by 17 A.L.P.O. Saturn Section observers between 1989 FEB 20 and DEC 03 with instruments from 15.2 to 40.6 cm in aperture. Saturn showed no significant increase in atmospheric activity, compared with the 1987-88 observing season. The number of observers and observations submitted had decreased slightly since the last apparition. Several persons conducted central-meridian transit timings of atmospheric detail on Saturn, although none of the features timed lasted long enough for confirmation or for reliable rotation periods to be found. The inclination of the Rings to our line of sight, **B**, reached a maximum of +26°.13 during 1988-89, exposing the Northern Hemisphere of the Globe and the north face of the Rings to our view. This report is accompanied by references, drawings, a photograph, graphs, and tables.


## INTRODUCTION

A great variety of visual and photographic observations of the planet Saturn and its Rings was contributed throughout the 1988-89 Apparition, constituting the basis of this analytical report. The observing season covered by these data was from 1989 FEB 20 to DEC 03; and the observer participation, as well as the number of observations, was slightly less in 1988-89 than it had been in the 1987-88 Apparition. Selected drawings and a photograph accompany this report in order to enhance the reader's understanding of the text and tables. [Note that all dates and times in this report are in Universal Time, or "U.T."]

*Table 1*, below, gives pertinent geocentric data for the 1988-89 Apparition of Saturn. Note that the saturnicentric latitude of the Earth, **B**, referred to the ring plane and positive when north, ranged from +24°.69 on 1989 APR 22 to +26°.13 on 1989 SEP 19, while the saturnicentric latitude of the Sun, **B'**, ranged from +25°.99 on 1989 FEB 20 down to +24°.70 on 1989 DEC 03. [4]

**Table 1. Geocentric Phenomena for Saturn in the 1988-89 Apparition. [4]**

| | |
|---|---|
| Conjunction | 1988 DEC 26, $12^h$ |
| Opposition | 1989 JUL 02, 13 |
| Conjunction | 1990 JAN 06, 21 |

*Opposition Data:*

| | |
|---|---|
| Visual Magnitude | +0.0 |
| **B** | +25°.40 |
| **B'** | +25°.47 |
| Declination of Saturn | -22°.40 |
| Globe Diameter: Equatorial | 18".34 |
| Polar | 16".73 |
| Rings: Major Axis | 41".61 |
| Minor Axis | 17".83 |

*Table 2*, to the right, lists the 17 persons who submitted a total of 170 observations to the A.L.P.O. Saturn Section for the 1988-89 Apparition, together with their observing sites, number dates of observation, and descriptions of their telescopes.

**Table 2. Contributing Observers, 1988-89 Apparition of Saturn.**

| Observer & Location | No. of Dates | Telescope Data* |
|---|---|---|
| Julius L. Benton, Jr. Wilmington Island, GA | 12 | 15.2cm (6.0in) REFR |
| Matthew Boulton Redditch, Worcs., UK | 2 | 15.7cm (6.2in) NEW |
| Dan Boyar Boynton Beach, FL | 7 | 25.4cm(10.0in) NEW |
| David Fisher Kemsley, Kent, UK | 3 | 21.5cm (8.5in) NEW |
| Marc A. Gelinas Quebec, Canada | 4 | 15.2cm (6.0 in) REFR |
| David L. Graham Richmond, N. Yorks., UK | 13 | 15.2cm (6.0in) REFR |
| Francis G. Graham East Pittsburgh, PA | 1 | 40.6cm (16.0in) NEW |
| Walter H. Haas Las Cruces, NM | 27<br>8 | 31.8cm (12.5in) NEW;<br>20.3cm (8.0in) NEW |
| Charles B. Haun Morristown, TN | 36 | 33.0cm (13.0in) NEW |
| Daniel Louderback South Bend, WA | 6 | 20.3cm (8.0in) NEW |
| Clinton Lower Port Deposit, MD | 2<br>1 | 25.4cm (10.0in) NEW<br>20.3cm (8.0in) NEW |
| Lee MacDonald Newbury, Berks., UK | 1 | 22.2cm (8.7in) NEW |
| Frank J. Melillo North Valley Stream, NY | 6 | 20.3cm (8.0in) S-C |
| Thomas Mohney East Pittsburgh, PA | 1 | 40.6cm (16.0in) NEW |
| Gary T. Nowak Essex Junction, VT | 6 | 20.3cm (8.0in) NEW |
| Richard W. Schmude College Station, TX | 1 | 35.6cm (14.0in) S-C |
| Michael E. Sweetman Tucson, AZ | 33 | 15.2cm (6.0in) REFR |

*Total Observations 170*

*Total Observers 17*

*** Notes: CASS= Cassegrain; NEW = Newtonian; REFR = Refractor; S-C = Schmidt-Cassegrain.**

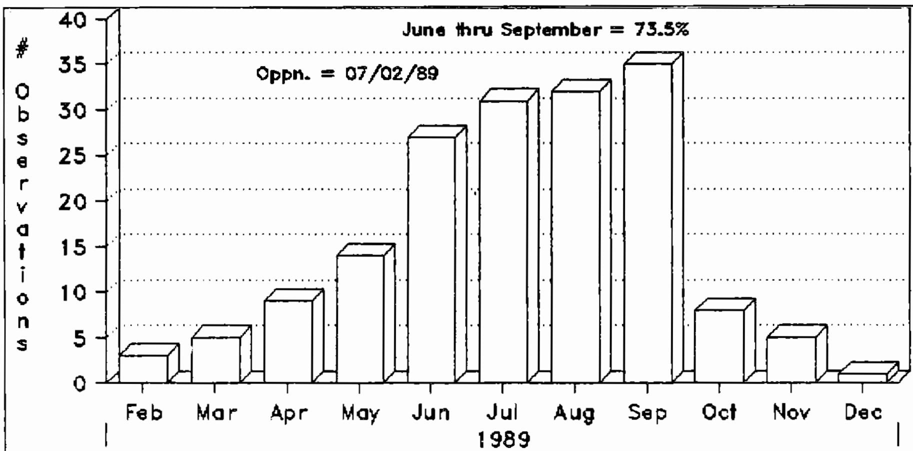


Figure 2. Distribution of observations of Saturn by month during the 1988-89 Apparition (170 observations total).

*Figure 2*, above, gives the distribution of observations by month in 1989, showing that 73.5 percent of the observations were for the months of June through September, 1989, with a perceptible decline in frequency on either side of this peak. Also, 35.9 percent of the observations were made before opposition, 1.8 percent on the date of opposition (1989 JUL 02), and 62.4 percent after that date. It is usual that the maximum observational coverage of Saturn falls near, or slightly after, opposition, as in 1988-89. This of course creates observational bias; and we encourage all observers to try to maintain a consistent surveillance of Saturn, starting as early in each apparition as possible, and continuing until Saturn nears the time of conjunction with the Sun.

*Figure 3*, below, depicts our observations in terms of nation of observation; usually also nation of residence. Slightly over one-quarter of our observers were located outside the United States, in Europe and Canada, which demonstrates the continuing international scope of our work. The observations themselves show a somewhat stronger bias towards the United States, which supplied 86 percent of the observations.

Finally, *Figure 4* (lower right) graphs the 1988-89 observations by type of instrument. Telescopes of classical design predominate as in other recent apparitions, due chiefly to their overall proven performance, soundness of design, and consistent favorable image contrast and resolution; all desirable for planetary work. All of the observations were made with instruments of 15 cm. (6 in.) aperture or greater, and over half with instruments larger than 25 cm. (10 in.)8

During the 1987-89 Apparition, seeing conditions averaged about 5.9 on the A.L.P.O. Seeing Scale, which ranges from 0.0 for the worst possible seeing to 10.0 for perfect conditions. Atmospheric transparency, expressed as the magnitude of the faintest star visible to the unaided dark-adapted eye near the object being observed, averaged about +4.1 during the same period.

The writer expresses his warmest gratitude to all the dedicated colleagues mentioned in *Table 2* who carried out their observations as part of the A.L.P.O. Saturn Section. We are continuing to encourage and coordinate more intense and comprehensive coverage of Saturn in coming apparitions. The cooperation of the A.L.P.O. with such groups as the British Astronomical Association (BAA) and the Royal Astronomical Society of Canada (RASC) continues, along with the potential of

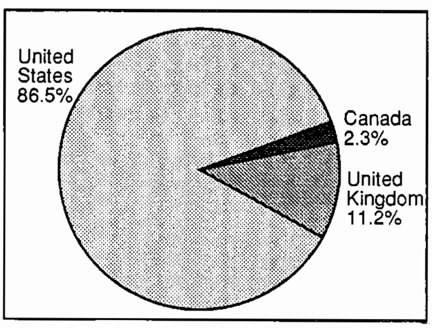


Figure 3. Distribution of Saturn observations by nation of observing site for the 1988-89 Apparition.

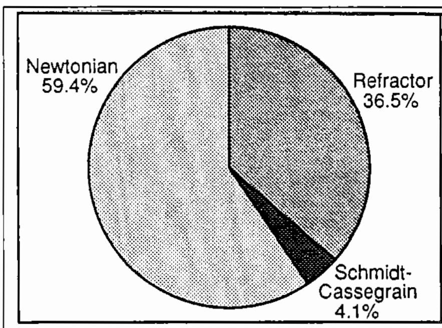


Figure 4. Distribution of observations of Saturn by type of instrument for the 1988-89 Apparition.

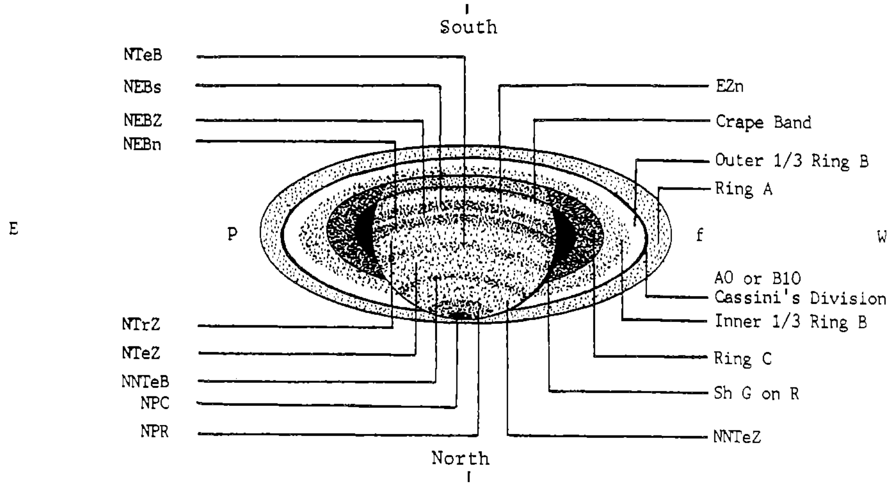


Figure 5. The general appearance of Saturn near opposition (1989 JUL 02), with nomenclature of the major Globe and Ring features that were easily detected with moderate apertures in good seeing. South is at the top; and global features move across the planet from right to left in this normal inverted view (i.e., as seen in an astronomical telescope near culmination in the Earth's Northern Hemisphere without a prismatic diagonal or other device that would reverse the image). East (E) and West (W) are shown in the International Astronomical Union (IAU) convention; in the celestial convention, East would be to the right. The numerical value of **B** is +25°.5. The text discusses the Globe and Ring features shown here. Some minor features that are not depicted include the: North Polar Belt (NPB), encircling the NPR; North North North Temperate Belt (NNNTeB), immediately north of the NNTeZ; Shadow of the Rings on the Globe (Sh R on G); Terby White Spot (TWS), adjacent to the shadow of the Globe on the Rings (Sh G on R); Encke's Division (A5), when detected midway between Cassini's Division (A0 or B10) and the outer edge of Ring A; and any intensity minima in several Ring components, as mentioned in the text. The easternmost and westernmost extensions of the Rings are called the *ansae*. "p" stands for preceding and "f" for following. **[1, 2]**

enlisting regular exchange of data between the A.L.P.O. and groups in Belgium, Germany, Spain, Hungary, and Australia. The writer was especially pleased to receive observations this apparition from members of the Junior Astronomical Society in Great Britain. We are attempting to establish and maintain a growing worldwide observer base in the coming years by using standardized and comparable methods of data acquisition. We heartily invite interested observers to join us, regardless of experience or nationality.

## THE GLOBE OF SATURN

The descriptions that follow have been derived from an analysis of the reports contributed to the A.L.P.O. Saturn Section throughout the 1988-89 Apparition. For the purpose of brevity, except when the identity of an individual is judged to be pertinent to the discussion, the names of observers are not given in the text. Numerical tables, graphs, drawings, and a photograph accompany the text; and readers should refer to them while reading this report. Features on the Globe are discussed in north-to-south order and can be identified by the nomenclature diagram in *Figure 5*. (at right). Southern Hemisphere features are not described because most of that portion of the Globe was hidden from view by the Ring System and was tilted away from the Earth in 1988-89. Also, several individuals made central-meridian (CM) timings of atmospheric detail on Saturn, although none of the features persisted long enough for confirmation or for reliable rotation rates to be derived.

**Northern Portions of the Globe.**—The Northern Hemisphere of Saturn showed limited and sporadic activity during the 1988-89 Apparition, and there was nearly the same frequency of recurrent local phenomena when compared with the immediately preceding observing season. The detail recorded in the Northern Hemisphere of Saturn was mostly ill-defined in 1988-89, but there were a few instances when discrete features could be seen fairly easily in such regions as the NTeB (North Temperate Belt), NTrZ (North Tropical Zone), NEB (North Equatorial Belt), NEB Z (North Equatorial Belt Zone), and EZ (Equatorial Zone).

The following summary of the Northern Hemisphere atmospheric features compares data between apparitions, as in prior Saturn observing reports, in order to help the reader to appreciate the subtle but recognizable variations that may be underway, both seasonally and long-term. **[3]** It is often thought that the varying tilts of Saturn's rotational axis with respect to the Sun and the Earth play a rather significant role in any recorded changes in belt and zone intensities, such as are given in *Table 3* (p. 164). The intensity scale used here is the A.L.P.O. Standard Numerical Relative Intensity Scale, where 0.0 is total black and

10.0 is the brightest possible condition; this scale is normalized by setting the outer third of Ring B at a standard brightness of 8.0. The sign of an intensity change is found by subtracting a feature's 1987-88 intensity from its 1988-89 intensity.

With the possible exception of the EB (Equatorial Belt), all of the belts observed in 1988-89 showed very little change in appearance and intensity since 1987-88. Most of Saturn's zones remained at about the same intensity between the two observing seasons, although the NNTeZ (North North Temperate Zone) and NEB Z (North Equatorial Belt Zone) showed slight brightness increases (by +0.5 and +1.3 mean intensity points respectively). Also, the NTeZ (North Temperate Zone) was slightly darker in 1988-89 than it had been in 1987-88 (by -1.0 mean intensity points). Note that a change of only ±0.1 mean intensity points is considered to be of no significance. As a matter of fact, a change is not likely to be significant unless it is greater than about 3 times its standard deviation.

**North Polar Region (NPR).**—The brightness of the diffuse, greyish NPR remained essentially the same between 1987-88 and 1988-89. The intensity of the NPR was always uniform. The diffuse greyish NPC (North Polar Cap) was detected on a few occasions in the extreme north. The NPB (North Polar Belt), sometimes seen encircling the NPR, was not reported in 1988-89.

**North North North Temperate Belt (NNNTeB).**—This elusive feature was seen only rarely in 1988-89, and then as a somewhat fragmented linear, greyish belt. No activity was reported in the NNNTeB during this apparition.

**North North Temperate Zone (NNTeZ).**– The NNTeZ was sighted only once in 1988-89; as a light yellowish-white region, quite diffuse, and uniform in intensity from limb to limb. If a single observation is of any value, the NNTeZ was second only to the EZ in being the brightest zone on Saturn in 1988-89.

**North North Temperate Belt (NNTeB).**— During 1988-89, the NNTeB was described as a very thin, continuous linear feature, yellowish-grey in hue, and devoid of detail or intensity variations. It was very slightly lighter in 1988-89 than in 1987-88; by +0.2 mean intensity points.

**North Temperate Zone (NTeZ).**—When seen during 1988-89, the yellowish-grey NTeZ showed occasional intensity differences, but these were always poorly defined. The NTeZ was equal to the NEB Z in intensity throughout the apparition, and it showed a decrease in overall brightness (-1.0 mean intensity points) from 1987-88 to 1988-89.

**North Temperate Belt (NTeB).**—This belt was frequently reported as narrow, usually uniform, very dusky yellow to yellowish-grey, and extending from one limb to the other. The NTeB was essentially the same intensity during 1988-89 as it had been in 1987-88.

**North Tropical Zone (NTrZ).**—The NTrZ in 1988-89 exhibited little if any change in brightness compared with 1987-88 (+0.1 mean intensity points). Observers assigned a yellowish-white color to this zone in 1988-89, and it was usually constant in intensity from limb to limb throughout the observing season.

**North Equatorial Belt (NEB).**—The greyish-brown NEB was sometimes seen in 1988-89 as differentiated into the NEBn and NEBs, where **n** refers to the North Component and **s** to the South Component, separated by the NEB Z (North Equatorial Belt Zone). This aspect was slightly less common in 1988-89 than it had been in 1987-88; the NEB was most often seen as a single feature in 1988-89. As a whole, the NEB was the same intensity in 1988-89 as it had been in 1987-88, and was actually the darkest belt on the Globe during the 1988-89 Apparition.

The dark greyish-brown NEBn showed no change in mean brightness from 1987-88 to 1988-89. Observers detected several discrete features within the NEBn, but none lasted long enough for usable CM transit timings.

The greyish-brown NEBs was the darkest belt on the Globe of Saturn in 1988-89, which had been the case in 1987-88 and for several other recent apparitions. The NEBs showed a very slight increase in overall intensity since 1987-88 (by +0.2 mean intensity points). This belt component showed a mainly uniform overall intensity across the Globe for much of the 1988-89 observing season, but there were some short-lived and ill-defined features reported in the NEBs by a few observers in 1988-89.

The NEB Z was yellowish-grey during most of 1988-89, showing a mean intensity increase of +1.3 since 1987-88. As in the immediately previous apparition, the NEB Z, like the NTeZ, was one of the darkest zones on Saturn in 1988-89. While these factors might suggest that the NEB Z would be troublesome to see in contrast with its environment, particularly as the Globe north of the NEB was the same average intensity as the NEB Z, the location of this zone between the darker NEBn and NEBs made it possible to distinguish the feature. The NEB Z showed little or no activity during the 1988-89 Apparition, and remained uniform in intensity throughout the observing season.

**Equatorial Zone (EZ).**—Unless otherwise specified, this report concentrates on the EZn, which was pale yellowish-white in 1988-89, and showed a very slight brightness decrease of -0.3 mean intensity points as compared with 1987-88. The EZn remained the brightest global feature on Saturn in 1988-89, and indeed was brighter than any portion of the Rings other than Ring B and the Terby White Spot (TWS). A few discrete phenomena were sighted in the EZ during 1988-89, but these vague whitish spots and wispy festoons faded rapidly. The intensity of the EZn thus remained fairly constant during the entire 1988-89 observing season, although Haas reported a subtle brightening trend in the EZ from May to October, 1989.

**Table 3. Visual Numerical Intensity Estimates and Colors: Saturn, 1988-89.**

| Globe/Ring Feature | Relative Intensity (1988-89) Number of Estimates | Mean and Standard Deviation | Change Since 1987-88 | "Mean" Derived Hue (1988-89) |
|---|---|---|---|---|
| *ZONES:* | | | | |
| NPC | 5 | 3.7 ±1.06 | -- | Diffuse greyish |
| NPR | 78 | 4.1 ±0.66 | 0.0 | Greyish |
| NNTeZ | 1 | 6.5 ------- | +0.5 | Light yellowish-white |
| NTeZ | 6 | 5.3 ±0.61 | -1.0 | Dusky yellowish-grey |
| NTrZ | 54 | 6.0 ±0.76 | +0.1 | Yellowish-white |
| NEB Z | 9 | 5.3 ±0.88 | +1.3 | Yellowish-grey |
| EZn | 82 | 6.9 ±0.46 | -0.3 | Pale yellowish-white |
| Globe North of NEB | 67 | 5.3 ±0.48 | 0.0 | Dusky yellowish-grey |
| *BELTS:* | | | | |
| NNNTeB | 1 | 4.0 ------- | -- | Greyish |
| NNTeB | 4 | 4.5 ±0.94 | +0.2 | Yellowish-grey |
| NTeB | 33 | 4.0 ±0.30 | -0.1 | Yellowish-grey |
| NEB (entire) | 67 | 3.4 ±0.50 | 0.0 | Greyish-brown |
| NEBn | 19 | 3.4 ±0.27 | 0.0 | Greyish-brown |
| NEBs | 16 | 3.3 ±0.29 | +0.2 | Greyish-brown |
| EB | 2 | 3.8 ------- | -0.6 | Yellowish-grey |
| *RINGS:* | | | | |
| Ring A (entire) | 68 | 5.9 ±0.84 | 0.0 | Dull white |
| Ring A (outer half) | 5 | 6.8 ±0.00 | 0.0 | Dusky white |
| Encke's Division (A5; ansae) | 1 | 3.8 ------- | -0.2 | Dark grey |
| Ring A (inner half) | 5 | 6.6 ±0.00 | +0.1 | Dusky white |
| Cassini's Division (A0 /B10; ansae) | 36 | 0.9 ±0.58 | 0.0 | Greyish-black |
| Ring B | | | | |
| Ring B (outer third) | 94 | 8.0 **[Standard]** | | White. |
| Ring B (inner two-thirds) | 43 | 7.2 ±0.52 | 0.0 | Yellowish-white |
| Intensity Min. (B1; ansae) | 12 | 2.8 ±0.20 | -0.1 | Dark grey |
| Ring C (ansae) | 66 | 1.0 ±0.59 | +0.1 | Greyish-black |
| Crape Band | 38 | 3.2 ±0.48 | +0.5 | Very dark grey |
| Sh G on R | 35 | 0.5 ±0.31 | -0.1 | Greyish-black |
| TWS | 20 | 7.7 ±0.08 | +0.3 | White |

*Notes:* For nomenclature see text and *Figure 5* (p.162). A letter with a digit (e.g., A5) refers to a location on the Ring specified in terms of units of tenths of the distance from the inner edge to the outer edge. Visual numerical relative intensity estimates (visual surface photometry) are based upon the A.L.P.O. Intensity Scale, where 0.0 denotes complete black (shadow) and 10.0 refers to the most brilliant condition (very brightest Solar System objects). The adopted scale for Saturn uses a reference standard of 8.0 for the outer third of Ring B, which appears to remain stable in intensity for most Ring inclinations. All other features on the Globe or in the Rings are compared systematically using this scale, described in the *Saturn Handbook*, which is issued by the A.L.P.O. Saturn Section. [2] The "Change Since 1987-88" is in the sense of the 1987-88 value subtracted from the 1988-89 value, "+" denoting an increase in brightness and "-" indicating a decrease (darkening). When the apparent change is less than about 3 times the standard deviation, it is probably not statistically significant.

The Equatorial Band (EB) was rarely detected during the 1988-89 Apparition; and when seen well, the EB was dull yellowish-grey in hue, very narrow, linear, and discontinuous along its extent across the Globe. It was slightly darker in overall mean intensity as compared with 1987-88 (by -0.6 intensity points).

**Shadow of the Rings on the Globe (SH R on G).**—The Shadow of the Rings on the Globe of Saturn was not described by any of the observers who submitted data to the A.L.P.O. Saturn Section in 1988-89. [Due to the relative values of **B** and **B'**, it should have overlapped the Crape Band at some times in the 1988-89 Apparition. Ed.]

**Table 4. Latitudes of the Belts of Saturn in the 1988-89 Apparition.**

| Saturnian Belt | Form of Latitude (All are North; change from 1987-88 in parentheses) | | | | | |
|---|---|---|---|---|---|---|
| | Planetocentric | | Eccentric | | Planetographic | |
| | ° | ° | ° | ° | ° | ° |
| South edge NPR | 75.3±2.9 | (-2.1) | 76.8±2.7 | (-1.9) | 78.2±2.4 | (-1.7) |
| Center NTeB | 35.4±1.9 | (+1.2) | 38.5±2.0 | (+1.3) | 41.7±2.0 | (+1.5) |
| North edge NEB | 21.4±1.2 | (-1.0) | 23.7±1.2 | (-1.1) | 26.2±1.3 | (-1.1) |
| South edge NEB | 16.0±1.4 | (-0.9) | 17.8±1.5 | (-1.0) | 19.8±1.6 | (-1.1) |

*Notes:* For nomenclature see *Figure 5* (p. 162). The latitude calculations assume a tilt, **B**, of +25°.7±0°.4 (while the tilt with respect to the Sun, **B'**, was +25°.3±0°.6. Planetocentric latitude is the angle between the equator and the feature as seen from the center of the planet. Planetographic latitude is the angle between the surface normal and the equatorial plane. Eccentric, or "Mean," latitude is the arc-tangent of the geometric mean of the tangents of the other two latitudes. The change is the result of subtracting the 1987-88 latitude value from the 1988-89 latitude value.

**Shadow of the Globe on the Rings (SH G on R).**—The shadow of the Globe on the Rings was seen as a greyish-black feature in 1988-89, regular in form. Any deviation from the true black condition (intensity 0.0) can be attributed to poor seeing and the possible scattering of light in our atmosphere, the telescope, and even the observer's eye.

## LATITUDES OF SATURN'S BELTS

Using the visual method developed by Haas many years ago, several observers in 1988-89 estimated the fraction of the polar semidiameter of the planet's disk that was subtended on the central meridian (CM) between the limb and the features whose latitude was sought. [Note that this method was complicated by the fact that Saturn's south limb was hidden by the Rings in 1988-89. Ed.] This method is easy to use, and its results compare well with similar values obtained by filar-micrometer measurements. After mathematical reduction, the resulting latitudes appear in *Table 4* (above). It must be remembered, however, that it is often risky to place too much confidence on data from only a few observers; but Haas particularly has been using this technique for a number of years with good, usually reliable results. Use of this method is slowly catching on among observers; and others are strongly urged to employ this simple procedure whenever it is possible, even if a filar micrometer might be available. This advice is given because data from both methods would be useful for comparison. A full discussion of this visual technique can be found in the *Saturn Handbook.* [2]

## THE RINGS OF SATURN

This section covers the analysis of the observations of Saturn's Ring System that were submitted throughout the 1988-89 Apparition, together with a continuing comparative study of the mean intensity data as has been done for previous apparitions. As noted in the Introduction, the northern face of the Rings was very well presented to our view during the 1988-89 observing season

**Ring A.**—Taken as a whole, Ring A was dull white throughout the 1988-89 Apparition, maintaining the same mean intensity as in 1987-88. There were only a few sightings of Encke's Division (A5) made during the apparition, at the Ring ansae in favorable seeing, and there were no other intensity minima recorded in Ring A in 1988-89. On 1989 JUL 30, at 02h 30m U.T., using a 20.3-cm (8.0-in.) Newtonian telescope at 150× with good seeing, Nowak glimpsed a whitish spot of intensity 7.0 on the east ansa (E in the Saturnian or IAU sense; i.e., preceding) of Ring A; but there were no confirming reports by other individuals.

On fairly infrequent occasions, Ring A was described as having distinct outer and inner halves in terms of intensity. In 1988-89, the outer half of Ring A was pale dusky white and was +0.2 mean intensity points lighter than the dusky white inner half. Compared with the 1987-88 Apparition, the outer half of Ring A showed no significant change in brightness, while the inner half remained virtually stable in intensity throughout the apparition.

**Ring B.**—The outer third of Ring B is the adopted standard of reference for the A.L.P.O. Saturn Intensity Scale, with an assigned value of 8.0. Throughout 1988-89, this portion of Ring B appeared white, stable in intensity, and the brightest feature on either Saturn's Globe or its Rings.

The inner two-thirds of Ring B, chiefly yellow-white in hue, was of the same mean intensity in 1988-89 as it had been in the immediately preceding apparition. It was also mostly uniform in intensity throughout 1988-89. An intensity minimum at B1 (i.e., located at about 0.1 of the distance from the inner to the outer edge of Ring B) was sighted on several occasions in 1988-89, and was described as dark greyish and perceptible only at the ansae. Also, there were extremely rare sightings of intensity minima at B5 and B7 during the apparition. Such features are not permanent, as was shown by the Voyager Missions.

On 1989 JUN 16, at 07h 40m U.T., using a 15.2-cm. (6.0-in.) refractor at 290× and with good seeing, Sweetman sighted what he described as "two dark fans" of intensity 4.5 extending halfway out in Ring B at the W ansa (W in the Saturnian or IAU sense; following). No other individuals reported similar phenomena on the Rings; neither on the same evening nor at any other time during the 1988-89 Apparition.

**Cassini's Division (A0 or B10).**—This feature was usually easily visible at the ansae in 1988-89, and it was often seen all the way around the Rings in optimum seeing. It had a grayish-black appearance in 1988-89, equal in intensity to its 1987-88 appearance. [As with the Sh G on R, the deviation from a true black appearance is due to scattered light. Ed.] Observers with even the smallest apertures had little difficulty in finding this feature during the observing season.

**Ring C.**—In 1988-89, individuals reported Ring C as fairly easy to see at the ansae, very dark grayish-black in color, and largely unchanged in appearance when compared with 1987-88. Here, it should be noted that faint or narrow Ring features are usually easier to perceive, and look darker, when the Rings are open to the extent that they were in 1988-89.

The Crape Band, or Ring C as projected onto the Globe, was +0.5 mean intensity points brighter in 1988-89 than in the immediately preceding apparition. In the more recent apparition, observers described this feature as uniform in intensity and dark grey in color. During the past several apparitions, the Saturnicentric latitudes of the Sun and Earth have conspired to bring about the partial coincidence of the Crape Band with the Shadow of Ring C on the Globe.

**Ring Components Other Than A, B, or C.**—Neither Ring D (inside Ring C) or Ring E (outside Ring A) was reported in 1988-89. Of course, these Ring components are exceedingly difficult to observe except under the best conditions and using large apertures.

**Terby White Spot (TWS).**—The TWS is an occasionally-reported brightening of the Rings adjacent to the Sh G on R. Several observers during 1988-89 recorded a bright, pale yellowish-white TWS. However, as in 1987-88, this feature did not show the dazzling appearance characteristic of much earlier apparitions. Nonetheless, it was the brightest object in Saturn's Rings except for the outer third of Ring B. The TWS is probably a contrast phenomenon and is not usually considered to be an important, or intrinsic, Saturnian feature. Even so, it would be interesting to investigate any correlation that may exist between the brilliance of the TWS and varying Ring tilt, as well as its prominence or appearance in colored filters.

**Bicolored Aspect of the Rings.**—This phrase refers to reported differences in color between the two ansae of the Rings. Several persons attempted to observe this phenomenon in 1988-89, and variations were seen in the brightness of the east and west ansae (IAU system) when compared with W47 (Wratten 47) or W80A blue filters and W25 or W23A red filters. On 30 separate evenings, observers reported suspected differences in brightness between the E and W ansae when compared in blue and red light. *Table 5* (p. 167) lists the circumstances of these observations. The reader should note that the directions in *Table 5* refer to Saturnian or IAU directions, where west is to the right in a normally-inverted telescopic image which has south at the top; also see *Figure 5* (p. 162) for the proper orientation.

This Recorder cannot stress too strongly the critical need for observers to participate in a simultaneous observing program which emphasizes, among other projects when viewing Saturn, a meaningful study of the bicolored aspect of the Rings. Increased observer participation in this program during 1988-89 was most encouraging. The greater the number of persons taking part in this effort, making systematic visual and photographic filter estimates, the greater the chance of shedding some new light on this intriguing and yet-to-be-understood phenomenon.

## SATURN'S SATELLITES

A very small fraction of the contributors to our observing programs in 1988-89 submitted visual studies of Saturn's satellites. No truly systematic program of visual magnitude estimates was undertaken, nor any other investigations of the satellites. We encourage observers to pursue satellite studies as outlined in the *Saturn Handbook*. [2]

## SIMULTANEOUS OBSERVATIONS

There happened to be several simultaneous observations in the 1988-89 Saturn Apparition; where persons independently observed at the same date and time. If more individuals carried out all of the routine programs discussed in this report, there would be a greater chance for observers, for example, to make drawings, intensity estimates, or central-meridian transits at the same time.

Simultaneous observations during 1988-89 provided limited confirmation of the appearance of Saturn. This is encouraging, and we invite readers who are interested in helping bring about more confirming reports to write to the A.L.P.O. Saturn Section for guidance and instructions.

## OCCULTATION OF 28 SAGITTARII

On 1989 JUL 03, an exceedingly rare occultation of a naked-eye star by Saturn, its Rings, and its satellite Titan, took place. The star was 28 Sagittarii, at visual magnitude +5.4, and of spectral type K4. Due to the wealth of data that was submitted for this spectacular event, a separate report is being prepared for publication in a future issue of this *Journal* .

## CONCLUSIONS

Members of the A.L.P.O. Saturn Section

**Table 5. Observations of the Bicolored Aspect of Saturn's Rings in 1988-89.**

Notes: Telescope types are as in *Table 2* (p. 160). Seeing is on the 0-10 A.L.P.O. scale (see p. 161). Transparency is the limiting visual magnitude in the vicinity of Saturn. Under "Filter," **B** refers to the blue W47 or W80A filters, **IL** to integrated light (no filter), and **R** to the red W25 or W23A filters. **E** means that the E ansa was brighter than the W, **W** that the W ansa was brighter, and = means that the two ansae were equally bright.

| Observer | 1989 U.T. Date and Time | | Telescope Type and Aperture | Magnification | Seeing | Transparancy | Filter B | IL | R |
|---|---|---|---|---|---|---|---|---|---|
| Haas | MAY 09 | 09:47-10:37 | NEW 31.8cm (12.5in) | 366× | 3.5 | 3.5 | E | = | = |
| Haas | MAY 20 | 08:56-10:11 | NEW 31.8cm (12.5in) | 366× | 4.0 | 4.5 | E | = | = |
| Haas | JUN 05 | 08:58-09:45 | NEW 20.3cm (8.0in) | 231× | 4.0 | 4.5 | E | = | = |
| Haas | JUN 18 | 06:41-07:00 | NEW 20.3cm (8.0in) | 231× | 3.5 | 4.0 | E | = | = |
| Lower | JUN 19 | 04:50-05:15 | NEW 20.3cm (8.0in) | 348× | 4.0 | 6.0 | E | = | E |
| Haas | JUN 24 | 05:40-06:57 | NEW 31.8cm (12.5in) | 366× | 4.0 | 2.5 | E | = | = |
| Haas | JUN 26 | 06:20-07:09 | NEW 31.8cm (12.5in) | 366× | 4.0 | 3.5 | E | = | = |
| Haas | JUN 29 | 05:28-05:55 | NEW 31.8cm (12.5in) | 366× | 3.5 | 3.5 | E | = | = |
| Lower | JUL 01 | 06:00-06:30 | NEW 25.4cm (10.0in) | 362× | 7.0 | 6.0 | E | = | = |
| Haas | JUL 01 | 07:29-08:19 | NEW 31.8cm (12.5in) | 366× | 5.5 | 3.5 | E | = | = |
| Haas | JUL 02 | 04:35-05:28 | NEW 20.3cm (8.0in) | 231× | 3.5 | 3.5 | E | = | = |
| Haas | JUL 11 | 03:42-05:30 | NEW 20.3cm (8.0in) | 231× | 4.0 | 4.0 | E | = | = |
| Boyar | JUL 22 | 03:00-03:30 | NEW 25.4cm (10.0in) | 408× | 5.5 | 4.0 | E | = | = |
| Boyar | AUG 02 | 01:20-01:35 | NEW 25.4cm (10.0in) | 272× | 7.0 | 4.5 | = | W | W |
| Haas | AUG 03 | 04:25-04:59 | NEW 31.8cm (12.5in) | 321× | 4.0 | 3.0 | E | = | = |
| Haas | AUG 09 | 03:11-05:14 | NEW 31.8cm (12.5in) | 366× | 4.0 | 4.0 | W | = | = |
| Haas | AUG 11 | 02:54-03:48 | NEW 31.8cm (12.5in) | 303× | 3.5 | 4.0 | E | = | = |
| Haas | AUG 22 | 03:00-04:55 | NEW 31.8cm (12.5in) | 366× | 4.0 | 3.5 | E | = | = |
| Haas | SEP 02 | 02:37-04:18 | NEW 20.3cm (8.0in) | 406× | 3.5 | 2.0 | E | = | = |
| Haas | SEP 10 | 02:27-03:32 | NEW 31.8cm (12.5in) | 366× | 3.5 | 4.5 | E | = | = |
| Haas | SEP 11 | 03:07-03:49 | NEW 31.8cm (12.5in) | 321× | 3.5 | 4.5 | E | = | = |
| Haas | SEP 16 | 03:01-03:12 | NEW 20.3cm (8.0in) | 271× | 4.5 | 3.5 | E | = | = |
| Haas | SEP 27 | 01:22-02:42 | NEW 31.8cm (12.5in) | 428× | 4.5 | 3.5 | E | = | = |
| Haas | SEP 29 | 02:02-02:42 | NEW 31.8cm (12.5in) | 366× | 3.0 | 4.0 | E | = | = |
| Haas | OCT 13 | 01:21-02:23 | NEW 31.8cm (12.5in) | 366× | 3.5 | 4.0 | E | = | = |
| Haas | OCT 17 | 01:16-01:47 | NEW 31.8cm (12.5in) | 321× | 3.0 | 4.0 | E | = | = |
| Haas | OCT 23 | 01:26-02:27 | NEW 31.8cm (12.5in) | 321× | 3.5 | 4.0 | E | = | = |
| Haas | NOV 05 | 00:49-00:58 | NEW 31.8cm (12.5in) | 321× | 3.0 | 4.0 | E | = | = |
| Haas | NOV 25 | 00:47-00:55 | NEW 31.8cm (12.5in) | 321× | 2.0 | 3.5 | E | = | = |
| Haas | DEC 03 | 00:35-00:53 | NEW 31.8cm (12.5in) | 321× | 2.0 | 3.0 | E | = | = |

contributed very meaningful observations of the planet during 1988-89, as in other recent years, which has been very gratifying. Our goal of improving observational coverage during each apparition is being achieved, along with a spread of emphasis throughout all Saturn observing programs, which increases the opportunity for simultaneous observations. Furthermore, the international observational cooperation has been very good, and we hope that these trends will continue in coming observing seasons.

Once again, this Recorder expresses his gratitude to everyone mentioned in this report for their lasting dedication. New observers of Saturn are always needed and are most welcome. We urge interested readers to contact the A.L.P.O. Saturn Section to find out how their teamwork can bring worthwhile scientific results and increase our knowledge about the planet Saturn.

## REFERENCES

1. Alexander, A.F. O'D. *The Planet Saturn.* London: Faber and Faber, 1962.

2. Benton, J.L., Jr. *Visual Observations of the Planet Saturn: Theory and Methods (the Saturn Handbook).* Savannah, GA: Review Publishing Company, 1988. (5th revised edition).

3. ________. "The 1987-88 Apparition of Saturn: Visual and Photographic Observations." *J.A.L.P.O., 34,* No. 2 (April, 1990), pp. 49-59.

4. United States Naval Observatory. *The Astronomical Almanac.* Washington: U.S. Government Printing Office. (Annual publication; the 1988 and 1989 editions were used for this report, which were published in 1987 and 1988, respectively.)

*Note:* For the drawings and photograph in *Figures 6-13*, unless otherwise stated, seeing is on the 0-10 A.L.P.O. Scale and transparency is in terms of the limiting naked-eye visual magnitude in the vicinity of Saturn. South is at the top of these views. CM(I) is the longitude of the central meridian in rotational System I; CM(II), in rotational System II. [System I applies to the NEBs, EZ, and SEBn, with a period of 844°.3 per day; System II applies to the rest of the Ball, with a period of 812°.0 per day.]

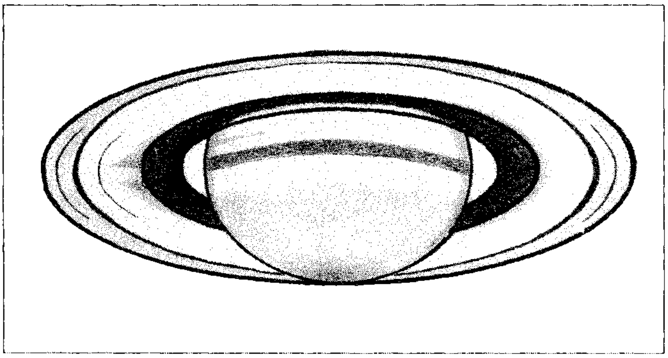

Figure 6. Drawing by Michael E. Sweetman. 1989 JUN 16, 07h40m-08h18m U.T. 15.2-cm. (6.0-in.) refractor, 290×; diagonal used (laterally reversed image) No filter. Seeing 7-8; transparency +4.0. CM(I) = 177-199°; CM(II) = 249-271°. B = +25°.1; B' = +25°.5. Note "spokes" on inner following ansa of Ring B.

Figure 7. Photograph by Frank J. Melillo. 1989 JUL 01, 05h00m U.T. 20.3-cm. (8.0-in.) Schmidt-Cassegrain, f/140; 8 Sec. on Kodak 2415 Film. Seeing 9; transparency +4.5. CM(I) = 149°; CM(II) =101°. B = +25°.4; B' = +25°.5.

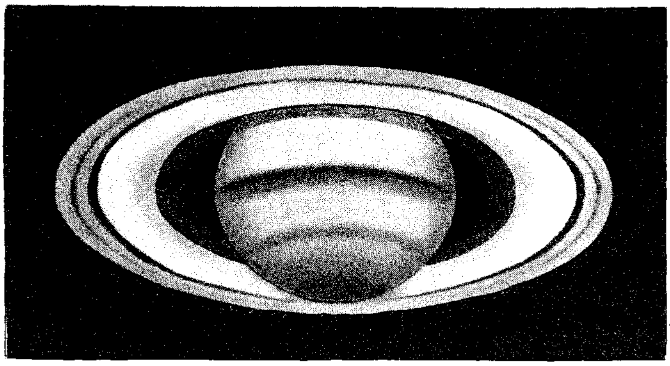

Figure 8. Drawing by David L. Graham. 1989 JUL 03, 23h20m-23h35m U.T. 15.2-cm. (6.0-in.) refractor, 286×. Seeing II-III on the Antoniadi Scale (good-moderate). CM(I) = 323-332°; CM(II) = 185-194°. B = +25°.4; B' = +25°.5. Note Encke Division in Ring A.

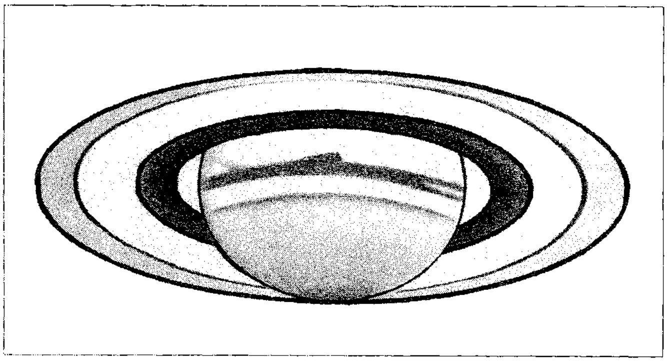

Figure 9. Drawing by Michael E. Sweetman. 1989 JUL 13, 07h10m-07h41m U.T. 15.2-cm. (6.0-in.) refractor, 182-280×; diagonal used (laterally reversed image). No filter. Seeing 5-7; transparency +5.0. CM(I) = 278-296°; CM(II) = 199-216°. B = +25°.6; B' = +25°.4. Note NEB projection into EZ near CM.

*Note:* For the drawings and photograph in *Figures 6-13*, unless otherwise stated, seeing is on the 0-10 A.L.P.O. Scale and transparency is in terms of the limiting naked-eye visual magnitude in the vicinity of Saturn. South is at the top of these simply-inverted views. CM(I) is the longitude of the central meridian in rotational System I; CM(II), in rotational System II.

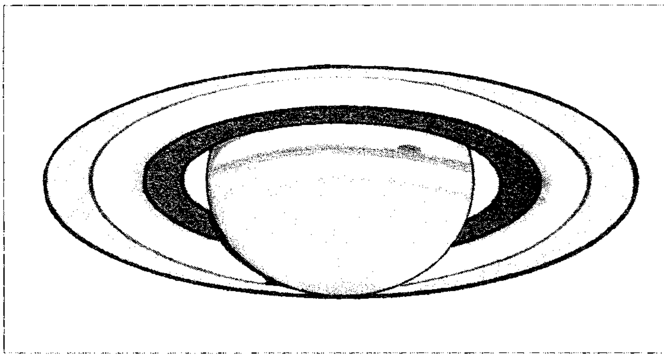

Figure 10.Drawing by Michael E. Sweetman. 1989 AUG 14, 05h15m-06h02m U.T. 15.2-cm. (6.0-in.) refractor, 435×; diagonal used (laterally reversed image). No filter. Seeing 7. CM(I) = 229-256°; CM(II) = 199-225°. B = +25°.9; B' = +25°.3. Note dark condensation in northern EZ and light oval near following limb in NTrZ.

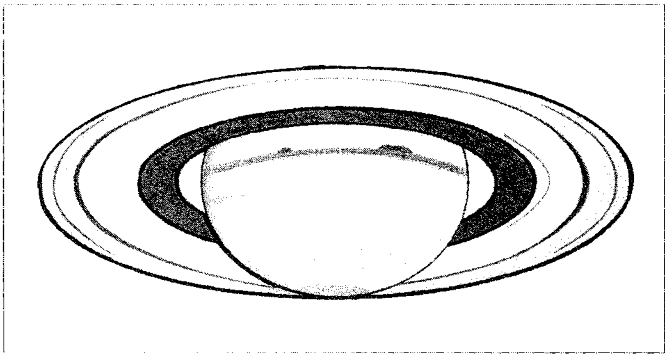

Figure 11. Drawing by Michael E. Sweetman. 1989 AUG 20, 04h05m-04h38m U.T. 15.2-cm. (6.0-in.)refractor, 290-435×; diagonal used (laterally reversed image). No filter. Seeing 8; transparency +4.5. CM(I) = 213-233°; CM(II) = 351-010°. B = +26°.0; B' = +25°.2. Note Ring division near inside preceding edge of Ring B and projections on south edge of NEB.

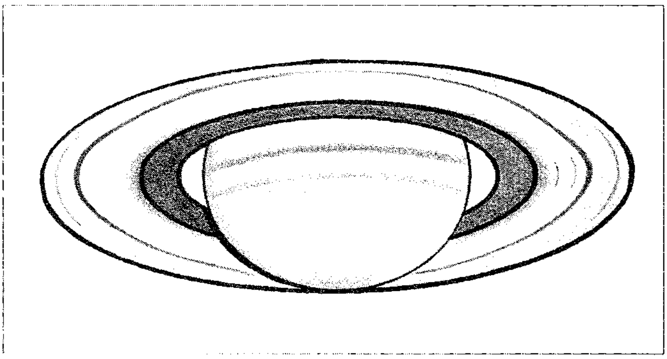

Figure 12. Drawing by Michael E. Sweetman. 1989 SEP 16, 02h20m-02h52m U.T. 15.2-cm. (6.0-in.) refractor, 435×; diagonal used (laterally reversed image). No filter. Seeing 7; twilight. CM(I) = 266-285°; CM(II) = 255-273°. B = +26°.1; B' = +25°.1. Note Encke Division in Ring A and two apparent divisions on preceding ansa of Ring B.

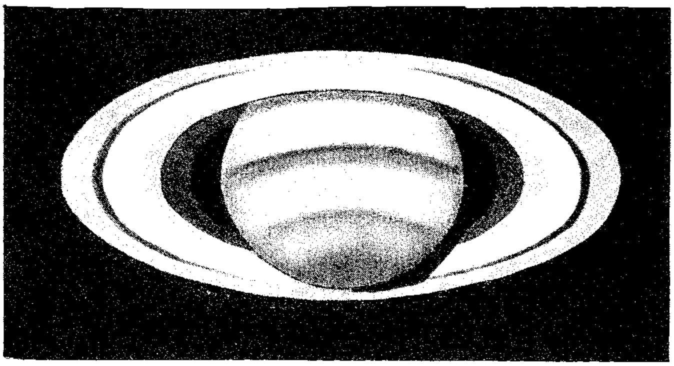

Figure 13. Drawing by David L. Graham. 1989 SEP 24, 18h53m-19h18m U.T. 15.2-cm. (6.0-in.) refractor, 222 & 286×. Seeing III on the Antoniadi Scale (moderate). CM(I) = 043-057°; CM(II) = 110-124°. B = +26°.1; B' = +25°.1.

# A.L.P.O. SOLAR SECTION OBSERVATIONS FOR ROTATIONS 1818-1823 (1989 JUL 19 TO DEC 29)

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

## ABSTRACT

This report summarizes A.L.P.O. Solar Section observations for Rotations 1818-1823 (1989 JUL 19 to DEC 29), particularly in terms of the morphology and development of sunspot groups. Twenty-four observers in five nations contributed visual drawings and integrated-light and Hydrogen-α photographs. Solar activity tended to increase in this period; the highest rotational means were slightly lower, but the lowest means were somewhat higher, than those for the previous reporting period (Rotations 1813-1817).

## INTRODUCTION

Solar activity tended to increase during this reporting period, although its highest rotational sunspot-number means fell short of the maximum during the previous reporting period (Rotations 1813-1817).

As has become usual, the Relative American Sunspot Number, **RA**, was higher than the International Number, **RI**, for most of the period, in both daily and rotational means. The activity levels for both forms of Daily Sunspot Numbers fell below 100 on only about a dozen days out of 164.

The mean rotational **RI** for this period was 164.8, with a low of 153.4 for Rotation 1820 and a high of 174.1 for Rotation 1819. The mean six-rotation **RA** was 167.2, dropping to a low of 154.3 in Rotation 1820 after a high of 179.8 in Rotation 1818. The highest daily **RI** was 296 (on 1989 SEP 09 in Rotation 1819), while the lowest was 50 (on 1989 AUG 28; Rotation 1819). Oddly, although the rotational means for **RA** were usually higher than the **RI** means, the highest daily **RA** was only 284 (on 1989 SEP 09 and 10, in Rotation 1819), while the lowest was 68 (1989 AUG 28 in Rotation 1819). *Figure 14* (p. 171) graphs the rotational means for both forms of Sunspot Number.

Most of the terms and abbreviations used in this report are explained in our Section's *Handbook for the White Light Observation of Solar Phenomena*, which can be obtained from the writer for $US 6.00; in the *A.L.P.O.S.S. Monochromatic Handbook*, available from Co-Recorder Randy Tatum (both addresses on inside back cover); or in *The New Observe and Understand the Sun*, available from the Astronomical League Book Service. References to sunspot classification are explained in "A Three-Dimensional Sunspot Classification System" (*J.A.L.P.O.*, *33*, Nos. 1-3, Jan., 1989, pp. 10-13) and the Astronomical League book mentioned above.

The times used in this report are all Universal Time (U.T.) Directions are abbreviated (e.g., N, SW) and are heliographic as are angular dimensions. The term "group" refers to white-light collections of sunspots, while "region" designates whole areas of magnetic activity in all wavelengths. In a change from previous reports, active regions will be enumerated with the prefix **AR**, and are designated as such by the Space Environmental Services Center (SESC) of the National Oceanic and Atmospheric Administration (NOAA) in Boulder, Colorado.

Twenty-four observers from five countries contributed their data to this report. This represents the largest number of observers and countries yet for our rotational reports. More and more of these participants are becoming regular observers. Due to their spacing in terrestrial longitude, we have essentially 24-hour per day coverage of the Sun!

**Table 1. Observers Contributing to This Report.**

| Observer | Telescope cm. | f/ | Type | Location |
|---|---|---|---|---|
| Bartell. W. | 6 | 16 | Refr. | B.C., Can. |
| Clement, D. | 8 | 15 | Mak. | Louisiana, USA |
| Dragesco, J. | 36 | 10 | S.-C. | France |
| Flugan, S. | 25 | 10 | S.-C. | Ohio, USA |
| Garcia, G. | 20 | 10 | S.-C. | Illinois, USA |
| Garfinkle, R. | 25 | 10 | S.-C. | California, USA |
| Gelinas, M.A. | 15.2 | 12 | Refr. | Quebec, Can. |
| Glaser, P. | 20 | 10 | S.-C. | California, USA |
| Hill, R.E. | 6 | 13 | Refr. | Arizona, USA |
| Kavanagh, O. | 20 | 10 | S.-C. | New Jersey, USA |
| Kazmer, L. | 20 | 10 | S.-C. | Illinois, USA |
| Luciuk, M. | 20 | 10 | S.-C. | New Jersey, USA |
| Maxson, P. | 15 | 6 | New. | Arizona, USA |
| Melillo, F.J. | 20 | 10 | S.-C. | New York, USA |
| Morris, R. | 5 | 30 | Refr. | Colorado, USA |
| Rousom, J. | 13 | 10 | New. | Ontario, Can. |
| Ryder, J. | 15 | ? | Refr. | Qld., Australia |
| Tao, Fan-Lin and Chang, Grace | 13 | ? | Refr. | Rep. of China |
| Tatum, R. | 18 | 15 | Refr. | Virginia, USA |
| Timerson, B. | 18 | 8 | New. | New York, USA |
| VanHoose, D. | 11 | 7.8 | New. | Indiana, USA |
| Viens, J.F. | 11.5 | 7.9 | New. | Quebec, Can. |
| Winkler, W. | 25 | 6 | New. | Texas, USA |

*Notes:*"cm." is the aperture of the telescope in centimeters; "f/" is its focal ratio; "Mak." is Maksutov; "New." is Newtonian; "Refr." is refractor; and "S.-C." is Schmidt-Cassegrain.

**Rotation 1818 [2,3]**
**(1989 JUL 19.05 to AUG 15.27 )**

| Sunspot Number | Mean | Maximum (Dates) | Minimum (Date) |
|---|---|---|---|
| **RI** | 170.6 | 227 (AUG 05) | 75 (JUL 28) |
| **RA** | 179.8 | 244 (AUG 06) | 88 (JUL 28) |

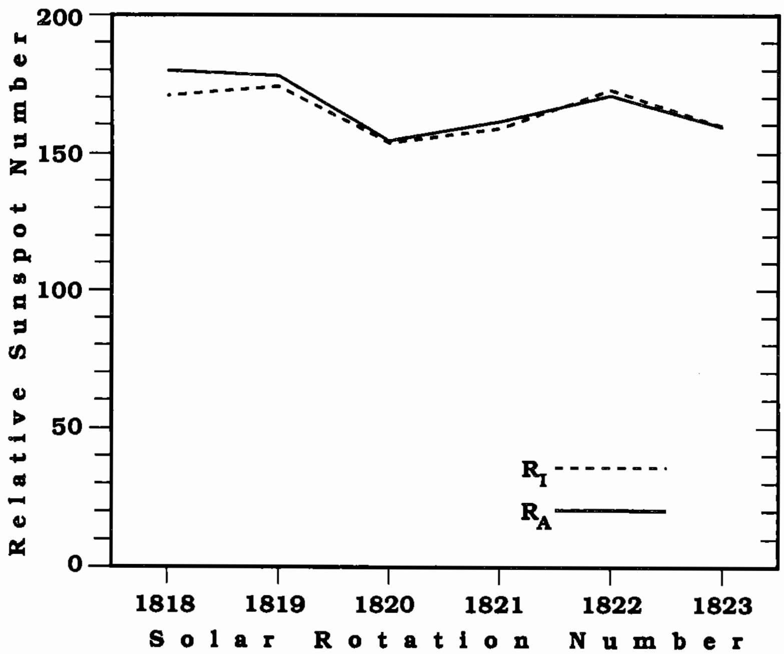


Figure 14. Graph of rotation means of **RI** (Relative International Sunspot Number) and **RA** (Relative American Sunspot Number) for Rotations 1818-1823.

There was considerable activity during this rotation, increasing toward its end. There were numerous small groups with clusters of umbral spots. Sunspot counts rose significantly from Rotation 1817, covered in the previous report **[1]**, when the mean **RI** was 144.9 and the mean **RA** was 156.6 This rise proved that Sunspot Cycle 22 had not yet peaked.

This rotation's largest region was **AR5629**, which was a naked-eye group throughout most of its time on the disk. It came into view on AUG 03 and was first recorded by Luciuk, photographically, as a large region with many faculae, spanning some 5° on the limb. It was composed of one large spot with a detached portion of penumbra containing a few umbral spots following in the facular filigree. Two days later, it was still completely surrounded by faculae. Concentric to the penumbra of the large spot and to the N was an arc of spots with rudimentary penumbrae. The main spot itself had at least a half-dozen umbrae in one penumbra with two fingers of penumbra pointing SW from the S leading edge. In the light of the H-α line, Garcia showed the region to be fairly quiet, with long radial filaments stretching off to the SE, NE, and SW.

On AUG 06, a photograph by Dragesco showed the main spot to consist of eight large umbrae in a chaotic penumbra with a number of penumbral fragments surrounding it, especially on the SE and NW. The faculae were fewer, which was to be expected as the spot moved away from the limb. In H-α, he photographed filaments, but only to the N and the SW of a quiet region.

Ryder measured the width of the region as 82 arc-seconds on AUG 07, when the umbrae were separating within the large penumbra. This was a portent because the group began breaking apart on the next day. Then, one umbra with some penumbra was separating to the SW, and a bright thin light bridge was snaking through the larger "main" spot. There were still many small umbrae with rudimentary penumbrae around them and some bits of detached penumbra. In H-α, Melillo showed the area to have a faint plage, with filaments to the N and E.

AR5629 reached the central meridian on AUG 09. By then, it had formed "wings," where umbrae had moved out to the N and S within the penumbra. The penumbral structure was less organized and possibly formed a delta [triangular] configuration. Melillo caught a small H-α flare at 15h00m U.T. There was little change on the next day, but on AUG 11 the spot to the SE again separated with penumbra. The larger remaining portion of the region consisted of two large umbrae which were formed into two parallel "S"-shaped curves, aligned roughly N-S. To the W a string of small umbrae formed a loop within some penumbral material. All the penumbrae were poorly organized on this day of maximum regional development and area.

On AUG 12, the entire W side of the region was a scrambled mixture of penumbrae and small umbral spots. The detached spot to the SE was decaying, and the umbrae in the main spot were still oriented roughly N-S. In H-α, the region was ringed by weak filaments, with

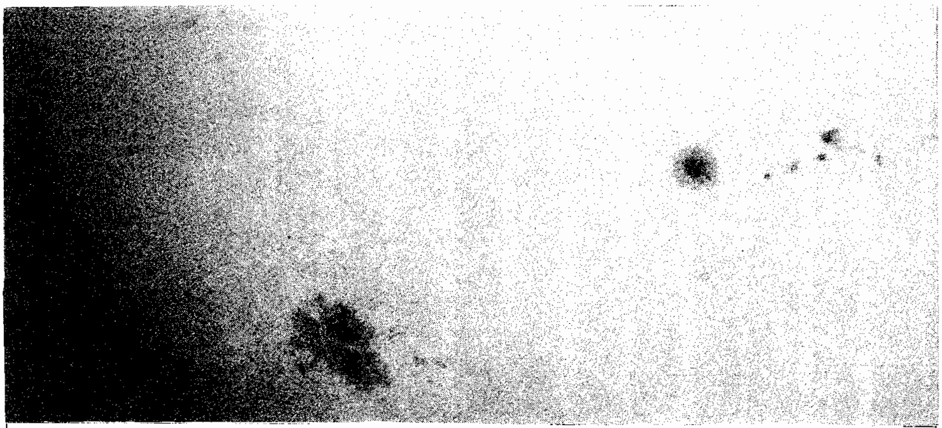

Figure 15. Group AR 5629 near the limb, photographed on 1989 AUG 13, 14h38m U.T., by Paul Maxson. 15.2-cm. (6.0-in.) reflector at f/30. Exposed 1/250 Sec.; W11 (green) Filter on Kodak 2415 Film. Seeing 1-3 arc-seconds. North at top, heliographic east to the right.

a bright arc to the N. On AUG 13, the penumbra of the large spot on the W was becoming more organized, with fewer small umbrae and only one medium-sized umbra. Its appearance on that day is shown in *Figure 15* (above). Several small spots with penumbrae had separated to the W. By then, the umbrae in the main spot had light bridges cutting through them from the E. The spot to the SE was only an umbral spot. Faculae were visible again, but by then were weak and fragmentary. In H-α, Garcia showed a bright plage leading to the E of the region. As the region neared the limb on AUG 14, it still subtended 5° along the limb. Dragesco photographed some prominences over the region on the next day as it passed behind the limb.

### Rotation 1819 [3,4]
### (1989 AUG 15.27 to SEP 11.52)

| Sunspot Number | Mean | Maximum (Dates) | Minimum (Date) |
|---|---|---|---|
| **RI** | 174.1 | 296 (SEP 09) | 50 (AUG 28) |
| **RA** | 178.0 | 284 (SEP 09 & 10) | 68 (AUG 28) |

This rotation was typified by small- to medium-sized groups, mostly of Class C or D [*C:* bipolar group with penumbra on one end of the group. *D:* bipolar group with penumbrae on spots at both ends of the group; length under 10°], with one giant group, **AR5669**. This was a naked-eye group from AUG 29 until the day before it left the disk, SEP 12. This rotation had both the highest and the lowest daily sunspot counts for both the International and the American Numbers for this reporting period.

Bartell was the first to record AR5669 in white light, on AUG 29 as a depression on the limb. Many observers reported this group on the next day, noting that it consisted of four main collections of spots. In the lead were several large umbrae in one disorganized penumbra. There were a few small umbrae to the N and S, immersed in the same penumbra but separated by light bridges. This area was followed by a mid-leader that was an irregularly shaped umbra in a rudimentary penumbra, not even organized enough to be called disorganized. Behind this was the mid-follower collection of two umbrae, oriented E-W in one penumbra. The character of this penumbra could not be determined due to its nearness to the limb. The follower was just a streak on the limb on this date.

On AUG 31, the leader and mid-leader spots were connected by a penumbral bridge. Other than this, the group's appearance was similar to that earlier. The follower could now be seen as three main umbrae, arranged N-S in a poorly organized penumbra. In H-α, Glaser observed the region to be fairly quiet, with a plage to the S, between the mid-follower and the follower. By SEP 01, this group was readily visible to the naked eye, looking like a "lumpy line" on the solar disk. On SEP 02, many of our observers noted that the first two collections of umbrae were connected by penumbra. The N-S umbrae were on the leading edge of the leader spot, followed by a large umbra. The lead spot penumbra was rather disorganized, and a small spot was separating from it to the N. The mid-follower was breaking up somewhat and now consisted of two main pieces surrounded by umbral spots with and without penumbrae and also by detached penumbral bits. Following this collection were a dozen umbrae in an irregular penumbra. Tatum, in H-α, observed that the plage was now among the mid-leader, mid-follower, and the follower spots, with filaments looping on the S from collection to collection.

On the next day, SEP 03, the N spot that had separated from the leader was shrinking and was separating more to the W. The mid-leader was essentially unchanged from before, while the following two collections were breaking up somewhat. The leader, mid-leader, and mid-follower spots were bridged by umbral spots in disorganized penumbrae on SEP 04. The spot that had separated from the

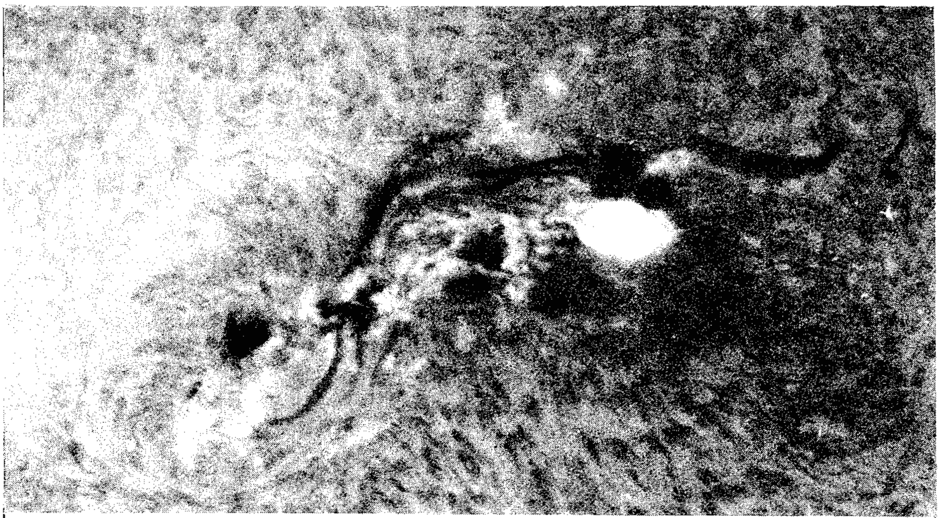

Figure 16. H-α photograph of flare in Activity Region AR 5669. Taken by Jean Dragesco on 1989 SEP 04 at 09h 00m U.T. North at top.

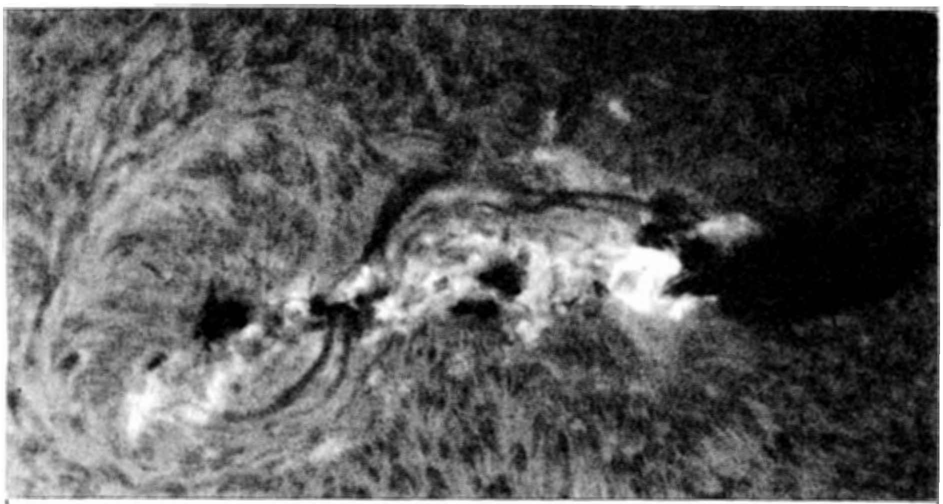

Figure 17. The same region as in Figure 16, above, photographed by Jean Dragesco only 20 minutes later. Note that, although the flare is diminished, strong prominences have been emitted, shown by the dark wisps near the left edge of the photograph. North at top.

leader was moving farther to the W and was shrinking. A sinuous E-W light bridge could be seen in the follower spot. Dragesco photographed two flares in H-α in this light bridge at 09h00m U.T., of Class 1B and 2B ["1" means an area between 100-250 millionths of the disk; "2" represents an area of 250-600 millionths; "B" means "bright." Ed.] . Then, 20 minutes later, he photographed the flare as it faded, leaving the leader in a chaotic jumble of umbrae and penumbrae. These two photographs are shown above as *Figures 16* and *17*. Following this feature, the mid-follower had penumbrae only on its following side and was reduced in area. The follower was still breaking up. Over the entire region there was a profusion of debris of umbral spots and penumbral fragments.

By SEP 07, there were only three main concentrations remaining, which could be made out with the naked eye. The leader now was a combination of the old leader and the old mid-leader. It was reported by Glaser and Bartell to be a chain of umbrae in one chaotic penumbra, led by one large umbra. The middle spot was a collection of a dozen spots in one very irregular penumbra. Following this were the remains of the old follower, consisting of about a half-dozen umbrae in a fragmentary penumbra. The region was nearing the limb on SEP 08, and the large leader umbra was now more elongated with both following spots showing dissolution. Again, Dragesco caught a surge, at 13h05m U.T. From this point on, the group continued to break up and to reduce in area.

**Rotation 1820 [4,5]**
**(1989 SEP 11.52 to OCT 08.79)**

| Sunspot Number | Mean | Maximum (Date) | Minimum (Date) |
|---|---|---|---|
| **RI** | 153.4 | 264 (SEP 12) | 80 (SEP 25) |
| **RA** | 154.3 | 272 (SEP 12) | 83 (SEP 25) |

This rotation was characterized by many C- and D-class groups (Modified Zurich Class; see p. 172), with a few larger groups. Consequently, there were few naked-eye groups reported.

The largest region of this rotation was **AR5698**, which came onto the disk on SEP 16. Maxson caught this region on the limb on that date, when it appeared as one large spot with four smaller spots with penumbrae to the N and another to the SE. Garcia did some impressive work in H-α, observing this group in the centerline of that wavelength as well as in both the blue and red wings [i.e., at very slightly shorter and longer wavelengths, respectively, than the 6562.8 Å H-α centerline]. In the centerline there was a hot spot to the SE of the large spot. This may well have been a faint subflare. The red wing showed no unusual features, but the blue wing showed a bright double-lobed small spot leading the main region by some 5-10°.

On SEP 17, the large spot was seen to be in a large disorganized penumbra. To the N a small spot had detached with penumbra. Following this, to the SE, was another small spot. There were bright faculae among all the spots of this region. In H-α, a flare was in progress during Garcia's blue-wing photograph, and had just ended in the later centerline photograph. The chromosphere was bright between the largest spot and the N spots.

Little change took place on the following day, but by SEP 19 the group had reached naked-eye visibility. The main spot was by then very complex, with one large umbra and about a dozen small umbrae in one large penumbra. To the N was a massive portion of penumbra, disorganized and fragmented, containing a scattering of small umbrae. Following this were four spots, the largest two of which were connected by a thin penumbral bridge.

By SEP 20, the large spot was followed by four smaller spots, one of which was slightly larger than the others and contained about a half-dozen umbrae. The N spots had merged into one larger spot, and the follower spots were unchanged. On SEP 21, Hill and Glaser observed that the spots following the main spot had merged into a larger spot with many penumbral extensions. The follower was now two smaller spots with several umbrae in each. Glaser further noted, in H-α, plage wings to the N and S coming from between the leader and follower spots, and then sweeping forward around the leader.

This region reached the central meridian on SEP 22, when the large spot consisted of two large umbrae and a half-dozen smaller umbrae in one penumbra. It contained penumbral extensions reaching E toward a lone follower which itself was composed of several umbrae in one rudimentary penumbra. Also, there were some pores and small umbral spots scattered about among the previous spots.

On SEP 23, a new observer, Kazmer, joined with Maxson, VanHoose, and Ryder in noting continuing dissolution of the region. In fact, the follower had lost nearly all its penumbra. The remainder of AR5698's passage across the disk was marked by fragmentation, reduction of area, and dissolution. It was last seen on SEP 27, as only a medium-sized main spot surrounded by a few umbral spots.

**Rotation 1821 [5,6]**
**(1989 OCT 08.79 to NOV 05.09)**

| Sunspot Number | Mean | Maximum (Date) | Minimum (Dates) |
|---|---|---|---|
| **RI** | 158.7 | 216 (NOV 04) | 97 (OCT 27) |
| **RA** | 161.2 | 230 (NOV 04) | 98 (OCT 26) |

Activity-level statistics rose slightly from the lows of Rotation 1820. However, for the amateur astronomer there was a marked increase in activity, particularly in H-α. As with the previous rotation, Rotation 1821 included many C- and D-class groups that caught the interest of both the professional and the amateur communities. As a result, many of the data records for this rotation are on loan, leaving some apparent gaps in coverage. While this is unfortunate for the purposes of this report, it must be kept in mind that such use of our data is the raison d'etre of our Section!

The largest region of this rotation was **AR5747**, which was first seen on OCT 13. This was one day earlier than NOAA/SESC lists its appearance, but Maxson caught it as a depression or notch on the limb on a photograph on the 13th. (Good work Paul!) The next day, a number of observers saw the region as a large spot of some four umbrae with a sprawling penumbra in a larger facular filigree. It was preceded by two small spots with penumbra in the same facular network. These preceding spots were designated **AR5744**. In H-α, a complex quasi-circular plage was seen extending from the following end of AR5744 to the leader of AR5747.

On OCT 15, the large spot had turned into three umbrae, still in a complex penumbra. One umbra had separated to the SW and a piece of umbra separated to the S. There still were a large number of faculae. The entire group, which comprised only one main spot, was "S"-shaped on the next day, with wings of penumbra spiraling off to the N and S, containing many small umbrae. In the main body, there were a half-dozen umbrae in an arc. As for the next two days, because of flare activity, the data in our files are on loan. However, by OCT 19, the penumbral wing to the S had detached and had broken up. The wing to the N was then in the process of detaching, forming a massive unit with enclosed umbrae.

Figure 18. Sunspot group AR5747, photographed by Mike Luciuk on 1989 OCT 23, 14h46m U.T. 20.3-cm. (8.0 in.) Schmidt-Cassegrain, f/30, 1/250-Sec. exposure on Kodak 2415 Film. North at top.

Morris caught a spectacular flare in H-α on OCT 19, 15h47m U.T. The entire region resembled a complex, spidery, bright plage of ribbons radiating from the center of the region. It was a 4B optical flare, classed X13 in X-Ray ["4" means an area of over 1,200 millionths of the disk; "X13" indicates an energy of $13\times10^{-4}$ watts per square meter], and the biggest since the great flare that occurred in AR5395 in March, 1989. This probably produced a white-light flare that easily could have been seen, but we received no reports of such.

OCT 20 constitutes another data gap, but on OCT 21 the spot to the N which was the detached penumbral wing was connected to the main spot only by a tendril of penumbra. The main spot itself consisted of four large umbrae in one penumbra. To the S, the small spot had detached with more pores and umbral spots around it. On OCT 22, the main spot contained one large umbra with four or five smaller detached spots to the W and S. There had been little change in the N and S spots. In H-α the fireworks continued. Garcia photographed a Class 2B flare (X2.9 X-Ray [$2.9\times10^{-4}$ watts per square meter]) in progress at 18h00m U.T. It showed a classical double-ribbon appearance.

There were three main concentrations of spots in the above groups on OCT 23, as shown in *Figure 18* (above). The leading portion showed three or four umbrae aligned N-S in one penumbra. Following this, in the middle of the group, was a small umbra in a penumbra. The following concentration contained a large umbra and a few small umbrae in one penumbra elongated N-S. All of these were connected by penumbral bridges.

The last day of this rotation for which we have data on hand for AR 5747 was OCT 24, when Luciuk and Kavanagh observed the group near the limb. All three portions had become smaller and had separated. But all was not over— Luciuk photographed yet another large flare; a Class-3B (X5.7) at 19h12m U.T.!

### Rotation 1822 [6,7]
### (1989 NOV 05.09 to DEC 02.40)

| Sunspot Number | Mean | Maximum (Dates) | Minimum (Dates) |
|---|---|---|---|
| **RI** | 172.9 | 236 (NOV 06) | 124 (NOV 16, 17, & 19) |
| **RA** | 170.7 | 230 (NOV 05) | 125 (Nov 16) |

Again, in this rotation there were many Class-C, -D, and -E groups, but they tended to be smaller than before. The largest group with good coverage is **AR5783**, reaching an area of only 1,000 millionths of the Sun's disk. While this rotation's high sunspot counts were not so high as those of Rotations 1818-1819, the lows were substantially higher, raising the mean significantly. As with the previous rotation, some data remain on loan, resulting in a few apparent gaps in coverage.

**AR5783** was first noted on NOV 05 as a group of 3 spots. The leader spot had 4-6 umbrae in a small rudimentary penumbra. Following it were two spots aligned N-S. The N follower held several umbrae in a rudimentary penumbra, and the S follower consisted of 5 umbrae in an E-W elongated penumbra. Faculae were seen between the leader and followers. Two days later, the leader and N follower appeared merged in a whole-disk drawing by Ryder. The leader held 5 umbrae in an E-W elongated penumbra. The remaining follower was to the SE, with two umbrae in an E-W elongated penumbra with umbral spots between the leader and the follower.

On NOV 09, the group reached its maximum area, on the central meridian. The leader then had a dozen smaller umbrae in the E-W elongated penumbra that reached 10° across. The follower had only 5-6 umbrae in a rudimentary penumbra. Luciuk and Maxson found the groups as some 20° long on NOV 10. By then, the leader had two umbrae, parallel and elongated N-S in one penumbra, followed by a teardrop-shaped umbra in a rudimentary penumbra, connected by a tendril of penumbra. The follower spot was now two spots, each with 3-4 umbrae in an E-W elongated rudimentary penumbra. Between these was a scattering of small spots with rudimentary penumbrae and some pieces of detached penumbra.

On NOV 11, the two umbrae in the leader had broken down into strings of smaller umbrae, but their orientation stayed the same. Following them were only 4 small spots in a row, each with 3-4 umbrae in rudimentary penumbra. An H-α photograph by Melillo showed the region as quiet. A number of observers on NOV 12 reported the group to be a leader, composed of a line of umbrae in one penumbra, but then breaking up. A small spot was detached from the leader on the following side. Following this, the 4 spots of the previous day were merging and falling back away from the leader. On NOV 13, the leader was breaking up into pieces with a disorganized penumbra on the leading side. The follower was consolidating. A most fantastic event was occurring—pieces of the leader were detaching and rapidly falling back into the follower! These pieces were probably bits of the leader on the following side of the "neutral line" that divided the magnetic polarity of the group. It is not unusual for this divider to run through one of the spots in a group. Here, the portions of the leader with the same magnetic polarity as the follower were simply detaching and joining the area of like polarity. On NOV 14, the group was showing definite signs of aging. The leader was becoming round and symmetrical, with all detached spots and penumbral pieces moving E into the follower. The follower was now larger and was condensing more with the umbrae consolidating in the penumbra. This continued as the group neared the limb, passing out of sight on NOV 16.

**Rotation 1823 [8,9]**
**(1989 DEC 02.40 to DEC 29.73)**

| Sunspot Number | Mean | Maximum (Dates) | Minimum (Date) |
|---|---|---|---|
| **$R_I$** | 159.6 | 249 (DEC 28) | 77 (DEC 15) |
| **$R_A$** | 159.2 | 232 (DEC 27) | 90 (DEC 15) |

This rotation included many groups, some larger than those of the previous two rotations. Once again, these were mainly of Modified Zurich Classes C and D. Even so, the overall activity was down from Rotation 1822.

The largest region of this rotation was **AR5852**, which came onto the disk on DEC 22 in the S Hemisphere. It shared the disk with another large region, **AR5854**; somewhat smaller and in the N Hemisphere. The former was seen first as several umbrae in a rudimentary penumbra, followed by a collection of a half-dozen umbral spots and pores. On DEC 23, it was much the same, but on the next day the leader had been reduced to two spots with rudimentary penumbrae, while the follower had grown to two spots with rudimentary penumbrae! There was a scattering of umbral spots about the follower. When many of us were enjoying Christmas Day, Clement and Maxson recorded a sudden spurt of growth. The leader was then two collections of 3-4 umbrae each, aligned in E-W rows, surrounded and connected by disorganized penumbra. The follower was a jumble of penumbrae and small umbrae, connected to the leader by a penumbral bridge. This was followed by several small umbrae in a rudimentary penumbra.

The group was visible to the naked eye on DEC 26, when Garfinkle recorded the group as a large jumble. The leader was several small spots with penumbrae and light bridges. In the middle were two large umbrae in one penumbra, while the follower comprised two smaller spots. The group reached the central meridian on the next day, when the leader was a fairly round spot with penumbra, followed by a smaller spot with penumbra. The middle spot was the largest, with a dozen umbrae in an irregular penumbra with penumbral light bridges connecting it to the leader and followers. Following were two spots, as on the day before, and a string of smaller spots that ran under the follower, with the largest on the following end. This string dissolved rapidly between 16h30m and 18h30m U.T.

The next data in our files are for DEC 30. The leader by then had merged with the small spot following. The middle spot was only a small umbra in a large irregular penumbra. The follower was two smaller round spots, aligned E-W with a penumbral island between and to the S of these. Although this was the day of maximum area, the groups had the form of an aged spot. Dissolution and reduction in size and complexity continued as the group neared the limb.

## CONCLUSION

The volume of data in this report, more than for any previous report, showed strong peaks on Saturdays and Sundays! The reason is obvious. Ideally, we would want equal volume for all days, but we realize that this is not likely. Still, this reporting period often had weekends that had over a dozen observers reporting, and weekdays with only one or two observers. While it is true that solar observing is best done in the pre-noon (local) hours, it is also true that a few data are better than no data. If you can observe only in the late afternoon, then please do so. Also, I encourage observers to do an all-day patrol at their observing site. I did so some years ago and was quite surprised to find that the seeing was quite good several hours before local noon, and then about four hours after local noon! Try it—you may find a new observing window!

On many instances in this report, there were flares of significant strength that should have produced white-light flares. It is a pity that no observers are yet maintaining a white-light flare patrol. It is not difficult to do so, provided that one uses the McIntosh Sunspot Classification System to guide one as to which groups need patrolling. Even the H-α observers included in this report failed to check the Sun in white light when such a flare was taking place. These data are of great importance to us and to the professional community. Such observations can be carried out with modest equipment of almost any aperture. Those interested in beginning such patrolling are invited to contact this Section Recorder.

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9.) ________, No. 548, March, 1990.

# GETTING STARTED: RECORDING YOUR SOLAR SYSTEM OBSERVATIONS

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

## PREFACE

Many years ago, this Journal had a frequent column titled "For the Beginner." More recently, a number of readers have commented that the contents of *J.A.L.P.O.* have become overly technical and thus somewhat unintelligible and uninteresting to many members. It appears to be the proper time to reintroduce the basic concepts of Solar System observation, here beginning with the essential documentation without which even the best observation is useless. This issue's column is written by the founder of our organization. Future issues, we hope, will contain such columns written by others of our more-experienced members.

## ABSTRACT

Even the highest-quality observation is useless unless it is accompanied by the proper supporting information. This includes: name and address of observer; station of observation; telescope used—aperture, type, and equivalent focal length; date and time in a specified time system; object observed; magnification used; seeing or atmospheric steadiness; atmospheric transparency; color filters used, if any; and any other items helpful to evaluate the observation. This article describes standard terms and conventions for recording these data.

A story is told of Sir Christopher Wren, the famous architect of St. Paul's Cathedral in London. King Charles II graciously invited Sir Christopher to an audience at court. Knowing his propensity to forget appointments and knowing the importance of promptness with royalty, Sir Christopher wrote himself a note—and then went about his other business. Some time later he came upon his note and was shocked to discover that his audience was on the next day. Hurriedly he prepared himself and went to meet his king. After the usual introduction, the monarch spoke, "Sir Christopher, we are delighted that you are with us on the appointed day. We are also delighted that you have come at the time we asked. However, we beg your permission to point out that your appointment was for *one year ago* today."

To be sure, similar incompleteness of our recorded data is not likely to expose us to royal displeasure. Still, let us define *Class A* as the group of all observers who look at or photograph the planets, the Moon, the Sun, comets, or meteors. Further, let *Class B* designate those persons who submit their observations to places where they will be carefully analyzed or studied in a scientific manner. Finally, let *Class C* be those persons who properly document their submitted observations. We may accept as a fact of life in the real world that Class B will be small compared to Class A. However, is there any reason or even an excuse why Class C should not be exactly as large as Class B? It is disappointing for a Jupiter Recorder of the A.L.P.O. to discover that a fine-looking photograph of the Giant Planet was made on "Tuesday November," and clearly no positional information will ever be obtained. When a comet is reported to have a tail 12 degrees long, we really need to know something of the accompanying sky conditions; for example, transparency, twilight or moonlight present, and amount of artificial lighting.

The following items should be recorded and reported with every visual observation of a bright planet or a lunar feature:

1. The name and address of the observer.
2. The station of observation if not the same as the address.
3. The telescope employed; aperture, type, and equivalent focal length.
4. The date, including the year, in a specified time system.
5. The time in the same time system. The date and the time together allow us to calculate essential relevant physical parameters.
6. The object observed.
7. The magnification or magnifications employed.
8. The seeing or atmospheric steadiness.
9. The atmospheric transparency.
10. The color filters used, if any.
11. Any other items helpful to evaluate the observation—admittedly a very flexible matter.

As remarked above, this list was developed for the visual lunar and planetary observer. The photographic observer will not want to omit any of these items, although Number 7 should be replaced by equivalent focal length or some other measure of photographic scale. The photographer will also want to report such additional items as exposure time, film type and speed, whether or not the film has been hypered, and the developer employed.

The observer of comets will want to state the size and degree of condensation of the coma, the length and direction of any tail, the estimated stellar magnitude, and perhaps the angular motion and right ascension and declination. The visual observer of meteors must tell what region of the sky he or she is watching. This article cannot supply complete requirements for all possible Solar System observations. The interested reader should get this information from the person or society to whom he or she is contributing his or her observational data. Meantime, some discussion of the eleven items listed above may be instructive and helpful.

The reported **station of observation** is ordinarily just the village, town, or city at, or nearest to, the site of observation. Its geographic location can be used, for example, to compute the local time of sunrise, sunset, or the beginning or ending of twilight and thus to evaluate the brightness of the sky background and its effect on the observation, in case the observer failed to note these relevant circumstances. Again, the brightness of the Moon in total eclipse or of a bright comet may be determined by means of comparisons to stars of known stellar magnitude. If we are to correct for the effect of atmospheric extinction, we must find the altitude above the horizon of each object involved; the needed computation requires latitude, longitude, and the time of observation. It will almost always suffice for these applications to know the latitude and longitude of the observer to within a few minutes of arc. It is true that there are some valuable and specialized observations where the observer's latitude, longitude, and elevation above sea level must be given with great accuracy; but these are perhaps of limited interest to the beginner. Examples are occultations of stars by asteroids or by the rings of Saturn.

The **date and time** must always be given in a known time system. An excellent practice for beginners is to use a double date, the first one the civil date before midnight and the second one the civil date after midnight. The date *always* includes the year (Remember Sir Christopher?). The best system to choose is surely Universal Time (U.T.) because that system is widely used in our tables of astronomical data. (Although Ephemeris Time and Dynamic Time sometimes appear in such tables, the differences between them and Universal Time are very minor for our purposes.) Unfortunately, our clocks and watches run on a civil time, not Universal Time. Even more unfortunately, most of us change to Daylight Saving Time during a large part of each year. In North America the values listed below must be *added* to local civil times in order to obtain Universal Time. Of course, the same amounts are *subtracted* when we go from U.T. to a civil time. [Note: "ST" means Standard Time; "DT", Daylight Time.]

| | |
|---|---|
| Hawaii ST.......................... | 10 hours |
| Hawaii DT, Alaska ST....... | 9 hours |
| Alaska DT, Pacific ST....... | 8 hours |
| Pacific DT, Mountain ST... | 7 hours |
| Mountain DT, Central ST.. | 6 hours |
| Central DT, Eastern ST..... | 5 hours |
| Eastern DT, Atlantic ST.... | 4 hours |
| Atlantic DT........................ | 3 hours |

Experience has shown that errors are often made in these conversions. It is an excellent practice for the novice to record both his local time and his Universal Time, allowing blunders in the conversion to be spotted. The local civil time must be treated as being in a 24-hour system starting at midnight, the same as U.T. Thus 5 A.M. on your watch is 5 hours, but 6 P.M. is 18 hours (12 + 6). Note that the U.T. date may differ from the civil date. Thus 7 P.M. on November 7 PST. is 3 hours on November 8 by U.T. Likewise, 5 hours by U.T. on November 15 is 23 hours or 11 PM on November 14 for an observer on CST.

As an obvious mechanical solution to these puzzles, I suggest the purchase of an accurate watch made to run on U.T. Don't try to use it to get to the office on time, but make it your telescope's close companion. Many models would record the U.T. date for you, and maybe even know about leap years. If the watch face only runs up to 12 hours, you can still easily learn when to add 12 hours.

There is now a necessary question: with what precision should the time be recorded? Many years ago I ceased to believe that the fine lunar photographs by my colleagues were actually usually taken on the even hour or half-hour. The criterion on time becomes a matter of how rapidly changes are occurring in whatever object we are observing—for example, as Mars rotates or as the early morning solar lighting of a lunar crater advances. A practical working rule is to record the time of each observation *to the nearest whole minute*. There are some exceptions. Thus the eclipse disappearance or reappearance of a Galilean Satellite of Jupiter should be timed to the nearest second by the visual observer. When lunar features are at the edge of the moving umbral shadow during an eclipse, the observed times may properly be expressed to the nearest one-tenth of a minute. Lunar occultations of stars are recorded to one-tenth of a second.

The discussion above obviously assumes that the observer knows the correct time. He or she must be using a sufficiently accurate watch or clock, and he or she must at times check against WWV shortwave or telephone signals or some other exact source.

Having the correct time, we can now go to an astronomy handbook and compute quantities needed to interpret the observation. Examples are the central meridian of longitude on Mars and the height of a meteor radiant above the horizon.

As for the **telescope**, the most important item to record is its aperture in centimeters. Diehard conservatives may use inches. Whether you choose English or metric units, be consistent! The focal length in centimeters or inches is of interest; or what is equivalent, report the focal ratio. Another item of interest is the type of telescope; refractor, Newtonian reflector, Schmidt-Cassegrain, and so forth.

We now consider three transient parameters which affect the quality of the observation: the magnification employed, the seeing or atmospheric steadiness, and the atmospheric transparency.

As is well known, the **magnification** is computed as the focal length of the primary lens or mirror, or sometimes the equivalent focal length of a compound optical system, divided by the focal length of the eyepiece. Of course, an observation may be made with two or more different eyepieces and correspondingly more than one magnification. It may sometimes be of interest to record the type of eyepiece; for example, 1/2-inch Ramsden, or 6-mm orthoscopic. When a Barlow Lens is employed, that fact should be noted.

The **atmospheric seeing** is of the greatest importance in the recording of the finer lunar, solar, and planetary detail. While words such as "poor," "excellent," and "terrible" have some value, it is better to try to be more quantitative. The ideal would perhaps be to specify the magnitude of the image blur created by the atmospheric tremors and the time interval over which they occur—say, 1.5 seconds of arc every second of time. Both items are tricky to evaluate with simple methods and often change rapidly while one is observing. Many American amateur observers employ a subjective scale ranging from zero (worst) to ten (absolutely perfect). The practice has been found to be satisfactory even if not optimum. In Europe many observers employ the Antoniadi Scale of I (best) to V (worst). Probably any well-known scale is permissible if it is clearly defined.

Worthy of study as you gain experience is a seeing scale proposed by Drs. Clyde Tombaugh and Bradford Smith and described in *Sky and Telescope*, Vol. XVII, No. 9, July, 1958, p. 149. The amount of image blur is determined by comparison to double stars of known separation, and this amount is the actual attained resolution for the telescope used at the time of observation. Perhaps the chief weakness of this method is the need to find double stars in order to estimate the seeing, and it appears almost essential to me to use the object being observed to make the estimates.

The **transparency** of the atmosphere affects telescopic observation of lunar and planetary detail and greatly influences observations of comets and meteors. (The lucky solar observer can be less concerned about transparency.) Subjective scales are often used, as with the seeing, but it is better to consider transparency to be the stellar magnitude of the faintest star visible on a clear, dark sky. We might do well to follow the practice of some observers of meteors; they use star counts in selected, familiar regions of the sky to determine the faintest stars that can be seen. Unfortunately, subjective corrections must often be made for moonlight, twilight, daylight, and even the visual acuity of the observer. The estimate *must* naturally refer to the location in the sky of the object being observed. If Mars is 20 degrees above the horizon, do not search for the dimmest star visible in the zenith. It has been pointed out that the observer having an artificially brightened urban or suburban sky may find the naked-eye visibility of stars to be an imperfect guide to visibility limits in the telescope. This problem may deserve more study. Thus as with the seeing, we estimate the transparency on a scale which is useful but hardly perfect.

The **color filters** employed, if any, come number 10 in the list above, but there are outstanding observers, like Jeff Beish and Don Parker, who would surely make this item number 1 or number 2. Viewing an object in a selected wavelength gives critical information about the physical nature of what we see or photograph. Color filters assist the observer by lessening irradiation of the image, by reducing the effect of seeing tremors, by diminishing the amount of atmospheric dispersion of the image through the use of a smaller spectral region of transmission, and by giving us a picture of our object of study in selected wavelengths; for example, certain kinds of Martian clouds are best revealed in blue or violet light. It is absolutely essential to employ commercial color filters whose transmission characteristics are accurately known. In the United States the easiest choice is probably the gelatin Wratten Filters of the Eastman Kodak Company. The Schott Filters can also be recommended. The observer will want a number of filters, according to his fields of study; a good set of three filters is Wratten 25 (red), 58 (green), and 47 (deep blue). A considerable literature exists on the transmission characteristics and applications of color filters, and A.L.P.O. Section Recorders will assist beginners and others to find helpful materials.

The final item is "**Miscellaneous**," which can cover many sins. What is wanted, of course, is any further information which would be helpful in the proper evaluation of the observation. Examples might be "Wind shaking telescope," "Drawing incomplete because of clouds," and "Seeing improved notably five minutes after observation started."

The chief impression from reading the above may well be one of great confusion. In reality, we should feel challenged rather than confused. Most or all of the A.L.P.O. Sections can furnish observing forms, and these guide us in recording what is needed. The forms also help us not to forget essential items. It would really not be difficult to design your own form for a particular project or planet, but its use should then be coordinated with the intended recipient. (Indeed, Mr. Phillip Budine once designed a form intended to be useful for all visual lunar and planetary observations.)

The purpose of this article is to instruct the beginner in how to document the observations he or she contributes and to encourage him or her to do so. We have touched lightly upon such subjects as types of optical telescopes, atmospheric seeing, and the effective utilization of color filters. These have been discussed often and sometimes in depth in the astronomical literature. I would especially recommend *Introduction to Observing and Photographing the Solar System* by Thomas A. Dobbins, Donald C. Parker, and Charles F. Capen. Another fine source is Clay Sherrod's *A Complete Manual of Amateur Astronomy.*

And now, readers, take just a little more time while making your observations; and record the conditions discussed above. Thank you!

# COMET CORNER

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

### COMET FINDS FOR THE FIRST HALF OF 1990

Four new comets were discovered, and four returning comets were recovered, during the first half of 1990. Comet Austin (1989c1) attained naked-eye visibility but did not become so bright as expected. Below, all dates are for 1990 unless otherwise indicated.

**Periodic Comet Wild 4 (1990a).**—Paul Wild found this new comet at magnitude 13 on plates exposed on JAN 21. It orbits the Sun every 6.2 years and was closest to the Sun on JUL 03 at 1.99 AU [*i.e.,* Astronomical Unit; 1 AU = 149,600,000 km.]. It did not get any brighter than magnitude 12.

**Comet Cernis-Kiuchi-Nakamura (1990b).**—On MAR 14 Kazimieras Cernis of the USSR discovered this, his third comet. He had spent 631 search hours since his previous find in 1983. He was using a 12-cm f/4.6 refractor at 35×. The comet was then 2 degrees north of the galaxy M31 in the evening sky at magnitude 8.5.

Tsuruchiko Kiuchi picked up this comet nearly two days later, using 25×150 binoculars to find this, his first comet. At the same time, in Japan as was Kiuchi, Yuji Nakamura found the object using 20×120 binoculars.

This comet was closest to the Sun at 1.06 AU on MAR 17 and did not become any brighter after discovery. Its elongation from the Sun increased in the evening sky for a few weeks, then it faded from view by mid-May.

**Comet Levy (1990c).**—Former A.L.P.O. Comets Recorder David Levy of Tucson, Arizona, discovered his sixth comet on MAY 20. He was using his 16-in (41-cm) f/5 reflector and had searched for about 60 hours since his previous find in August, 1989. The comet was then at magnitude 10 in the morning sky, along the northern edge of the Square of Pegasus. For its appearance in July, 1990, see *Figure 19* (p. 181) and the front cover.

This comet is probably new to the Solar System and it was closest to the Sun at 0.94 AU on OCT 24. Its inclined and retrograde orbit brought it to within 0.43 AU of the Earth in mid-August, when it became a naked-eye object near opposition. The comet will remain visible to us through the Spring of 1991.

**Periodic Comet Peters-Hartley (1990d).**-Robert McNaught of Siding Spring Observatory, Australia, recovered this comet on MAY 26 at magnitude 14. This comet has an 8.1-year orbital period and was closest to the Sun on JUN 23 at 1.62 AU, and is now dimming again.

**Periodic Comet Wolf-Harrington (1990e).**—The A.L.P.O.'s Assistant Comets Recorder Jim Scotti used the 36-in (91-cm) Spacewatch Telescope at Kitt Peak to record the image of this returning comet on JUN 14. It was then at magnitude 19, but should brighten to magnitude 13 by the end of 1990. Its orbital period is 6.5 years.

**Periodic Comet Honda-Mrkos-Pajdusakova (1990f).**—Jim Scotti at Kitt Peak and Jim Gibson at JPL and OAO Corporation, working at Palomar Mountain, recovered this comet on JUN 17 at magnitude 20. This object has a short orbital period, 5.3 years, and was closest to the Sun at 0.54 AU on SEP 12. It brightened to magnitude 8 at that time but now is dimming and is in the solar glare.

**Comet McNaught-Hughes (1990g).**—Robert McNaught and Shaun Hughes of Siding Spring Observatory, discovered this comet on plates taken on JUN 19, when it was at magnitude 17 and 4 AU from the Sun. We now know that it will reach perihelion at 2.68 AU on 1991 FEB 27, but it is not expected to get much brighter.

**Periodic Comet Johnson (1990h).**—Jim Gibson recovered this comet on JUN 17 from Palomar Mountain. The comet was then at magnitude 18, and may brighten slightly by its November, 1990, perihelion at 2.31 AU. Its orbital period is 7.0 years.

### PRESENT COMET ACTIVITY

At the time of writing (1990 AUG 29), we know of four comets that should be visible in our skies during the last part of 1990 and the first part of 1991.

**Periodic Comet Schwassmann-Wachmann 1.**—This comet is in a near-circular 15-year orbit. It is usually near magnitude 17, but will occasionally outburst to magnitude 12 to 14. Please report all positive and negative observations of it to this Recorder (address on inside back cover).

**Periodic Comet Wild 2 (1989t).**—This comet orbits the Sun every 6.2 years and will be closest to the Sun at 1.58 AU in December, 1990. During the observing window covered in this report, its distance from the Sun stays between 1.58 and 1.75 AU, while its distance from the Earth slowly decreases from 2.5 to 1.5 AU.

**Comet Levy (1990c).**—Remaining in the Southern Hemisphere of the sky for these months, this comet should be an interesting binocular object.

**Comet Tsuchiya-Kiuchi (1990i).**—Discovered in July, 1990, this comet was closest to the Sun at 1.09 AU on SEP 28. It is better placed for Southern Hemisphere viewers, rather than Northern; but its large elongation from the Sun will put it into dark skies for most of the period covered here.

Note: In the "Elong. from Sun" column, **E** refers to evening, and **M** to morning visibility. "Total Mag." values are forecasts and are subject to considerable uncertainty.

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

| 1990-91 U.T. Date (0h U.T.) | 2000.0 Coörd. R.A. h m | Decl. ° ' | Elong. from Sun ° | | Total Mag |
|---|---|---|---|---|---|
| DEC 05 | 01 14.4 | +19 11 | 131 | E | +17.2 |
| 10 | 01 13.8 | +19 00 | 126 | E | +17.2 |
| 15 | 01 13.6 | +18 50 | 121 | E | +17.2 |
| 20 | 01 13.5 | +18 42 | 116 | E | +17.3 |
| 25 | 01 13.7 | +18 35 | 111 | E | +17.3 |
| 30 | 01 14.3 | +18 30 | 106 | E | +17.3 |
| JAN 04 | 01 15.1 | +18 26 | 101 | E | +17.4 |
| 09 | 01 16.2 | +18 25 | 096 | E | +17.4 |
| 14 | 01 17.6 | +18 25 | 091 | E | +17.4 |
| 19 | 01 19.3 | +18 26 | 087 | E | +17.5 |
| 24 | 01 21.1 | +18 29 | 082 | E | +17.5 |
| 29 | 01 23.3 | +18 34 | 078 | E | +17.5 |
| FEB 03 | 01 25.6 | +18 40 | 073 | E | +17.5 |
| 08 | 01 28.1 | +18 48 | 069 | E | +17.6 |
| 13 | 01 30.9 | +18 57 | 064 | E | +17.6 |
| 18 | 01 33.8 | +19 07 | 060 | E | +17.6 |
| 23 | 01 36.8 | +19 19 | 056 | E | +17.6 |
| 28 | 01 40.1 | +19 31 | 052 | E | +17.7 |

**Table 2. Ephemeris of Periodic Comet Wild 2.**

| 1990-91 U.T. Date (0h U.T.) | 2000.0 Coörd. R.A. h m | Decl. ° ' | Elong. from Sun ° | | Total Mag |
|---|---|---|---|---|---|
| DEC 05 | 13 16.5 | -06 31 | 053 | M | +11.0 |
| 10 | 13 30.6 | -07 46 | 054 | M | +10.9 |
| 15 | 13 44.7 | -08 58 | 055 | M | +10.9 |
| 20 | 13 58.7 | -10 08 | 057 | M | +10.8 |
| 25 | 14 12.7 | -11 13 | 058 | M | +10.8 |
| 30 | 14 26.7 | -12 16 | 060 | M | +10.8 |
| JAN 04 | 14 40.6 | -13 14 | 061 | M | +10.8 |
| 09 | 14 54.3 | -14 08 | 063 | M | +10.8 |
| 14 | 15 07.9 | -14 57 | 065 | M | +10.8 |
| 19 | 15 21.2 | -15 42 | 067 | M | +10.8 |
| 24 | 15 34.3 | -16 22 | 068 | M | +10.8 |
| 29 | 15 47.2 | -16 57 | 070 | M | +10.8 |
| FEB 03 | 15 59.6 | -17 27 | 072 | M | +10.9 |
| 08 | 16 11.8 | -17 53 | 075 | M | +10.9 |
| 13 | 16 23.4 | -18 15 | 077 | M | +10.9 |
| 18 | 16 34.7 | -18 32 | 079 | M | +10.9 |
| 23 | 16 45.4 | -18 46 | 082 | M | +11.0 |
| 28 | 16 55.5 | -18 55 | 084 | M | +11.0 |

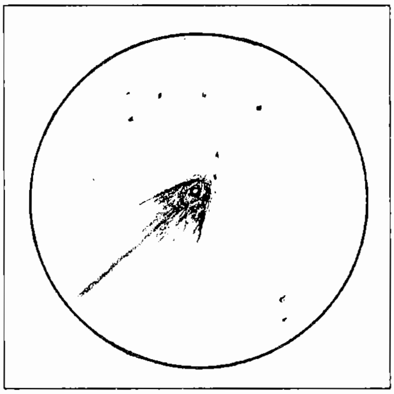
Figure 19 (to the right). Drawing of Comet Levy (1990c) on 1990 JUL 22, 06h 30m U.T. by Mark Mattox at Calaveras Big Trees in the Sierra Nevada of California. He used a 12.5-in (31.8-cm) f/6 reflector with a 32-mm eyepiece (60× magnification) at a 0°.5 field of view. He estimated the comet's magnitude as +7.0 and noted a bright nucleus, fan-shaped coma, and a 1° tail. See also front cover.

**Table 3. Ephemeris of Comet Levy (1990c).**

| 1990-91 U.T. Date (0h U.T.) | 2000.0 Coörd. R.A. h m | Decl. ° ' | Elong. from Sun ° | | Total Mag |
|---|---|---|---|---|---|
| DEC 05 | 14 08.1 | -40 50 | 038 | M | +7.0 |
| 10 | 14 01.4 | -40 51 | 043 | M | +7.1 |
| 15 | 13 54.0 | -40 50 | 048 | M | +7.3 |
| 20 | 13 45.7 | -40 48 | 054 | M | +7.4 |
| 25 | 13 36.0 | -40 44 | 060 | M | +7.5 |
| 30 | 13 24.9 | -40 34 | 066 | M | +7.6 |
| JAN 04 | 13 12.0 | -40 16 | 073 | M | +7.7 |
| 09 | 12 56.9 | -39 47 | 080 | M | +7.8 |
| 14 | 12 39.4 | -39 01 | 088 | M | +7.8 |
| 19 | 12 19.8 | -37 52 | 096 | M | +7.9 |
| 24 | 11 57.8 | -36 13 | 105 | M | +8.0 |
| 29 | 11 34.0 | -33 57 | 114 | M | +8.0 |
| FEB 03 | 11 09.1 | -31 02 | 124 | M | +8.1 |
| 08 | 10 44.1 | -27 28 | 133 | M | +8.2 |
| 13 | 10 20.1 | -23 22 | 142 | M | +8.4 |
| 18 | 09 57.9 | -18 57 | 149 | M | +8.5 |
| 23 | 09 38.0 | -14 29 | 153 | M | +8.8 |
| 28 | 09 21.3 | -10 10 | 153 | E | +9.0 |

**Table 4. Ephemeris of Comet Tsuchiya-Kiuchi (1990i).**

| 1990-91 U.T. Date (0h U.T.) | 2000.0 Coörd. R.A. h m | Decl. ° ' | Elong. from Sun ° | | Total Mag |
|---|---|---|---|---|---|
| DEC 05 | 07 41.3 | -40 29 | 105 | M | +7.7 |
| 10 | 06 48.0 | -43 22 | 110 | M | +7.9 |
| 15 | 05 53.2 | -44 16 | 112 | M | +8.1 |
| 20 | 05 03.7 | -43 21 | 112 | E | +8.4 |
| 25 | 04 23.2 | -41 15 | 111 | E | +8.7 |
| 30 | 03 52.2 | -38 37 | 107 | E | +9.1 |
| JAN 04 | 03 29.0 | -35 51 | 103 | E | +9.4 |
| 09 | 03 11.8 | -33 13 | 099 | E | +9.9 |
| 14 | 02 59.2 | -30 46 | 095 | E | +10.0 |
| 19 | 02 49.9 | -28 33 | 090 | E | +10.3 |
| 24 | 02 43.1 | -26 34 | 086 | E | +10.6 |
| 29 | 02 38.2 | -24 46 | 081 | E | +10.9 |
| FEB 03 | 02 34.8 | -23 09 | 077 | E | +11.2 |
| 08 | 02 32.6 | -21 42 | 073 | E | +11.4 |
| 13 | 02 31.4 | -20 24 | 068 | E | +11.7 |
| 18 | 02 30.8 | -19 12 | 064 | E | +11.9 |
| 23 | 02 30.9 | -18 07 | 060 | E | +12.1 |
| 28 | 02 31.5 | -17 08 | 056 | E | +12.3 |



## METEORS SECTION NEWS

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

### THE DECEMBER, 1990, METEOR SHOWERS

By the time that you read these pages, it will be time for the notable meteor showers of December: the Geminids and the Ursids.

The observing window for the Geminids begins on the morning of DEC 11, when a waning crescent Moon will not interfere with meteor observing. Rates will gradually climb from 20 per hour on that morning until a peak of 100 per hour on DEC 14. Rates on the 15th will have fallen back down to 20 per hour, and activity will be nearly over by DEC 16. The radiant position for the 14th is 07h28m/+33°. Stream members are visible all night, but the best hour usually occurs between 2 and 3 A.M. local time. The night of DEC 13-14 is probably the only night of the year when you could go outside for five minutes and be sure that you will see at least one meteor. If you have ever contemplated meteor photography, DEC 13 and 14 are prime dates; contact this Recorder (address on inside back cover) for further information on meteor photography.

The second December shower, the Ursids, peaks on Saturday, DEC 22. At that time, the waxing crescent Moon will have set in the late evening, and will be absent during the prime after-midnight hours for meteor observing. Data from this shower are scarce, but it has been determined that at least two strong bursts of activity have occurred during the last 50 years. The mean ZHR (Zenithal Hourly Rate) is 10 per hour, and the radiant position lies at 14h28m/+75° on the morning of maximum activity.

Any observer who observes both these showers from dark, rural locations could easily be rewarded with several hundred meteors. I am looking forward to your results! (For more information, see *International Meteor Organization Information Pamphlet Number 2*, April, 1990.)

### RECENT METEOR OBSERVATIONS

*Table 1*, below, summarizes the observations received by the A.L.P.O. Meteors Section between 1990 JUN 02 and SEP 01. A sample plot of the observed paths of meteors is shown in *Figure 20* (p. 186).

**Table 1. Recent A.L.P.O. Meteor Observations.**

| 1990 U.T. Date | Observer and Location | Universal Time | Number and Type of Meteors Seen* | Comments* (+*N* = Limiting Magnitude) |
|---|---|---|---|---|
| JUN 02 | J. Kenneth Eakins, CA | 09:10-10:10 | 1 τ Her; 2 SP | +5.3 |
| | " " " " | 10:10-11:10 | (none seen) | +5.3 |
| 03 | J. Kenneth Eakins, CA | 09:00-10:00 | 1 τ Her | +5.1 |
| | " " " " | 10:00-11:00 | (none seen) | +5.1 |
| 04 | J. Kenneth Eakins, CA | 09:15-10:15 | 3 SP | +5.1 |
| | " " " " | 10:15-11:15 | 2 SP | +5.4 |
| 12 | Mark Davis, VA | 03:00-04:00 | 3 SP | +5.1; 20% cloudy |
| 13 | Mark Davis, VA | 02:30-03:30 | 2 SP | +5.1 |
| 17 | Mark Davis, VA | 03:00-04:00 | 2 SP | +5.1 |
| | " " " | 04:00-05:00 | 4 SP | +5.1 |
| 20 | J. Kenneth Eakins, CA | 09:30-10:30 | 3 SP | +5.3 |
| 21 | J. Kenneth Eakins, CA | 09:00-10:00 | 2 SP | +5.3 |
| JUL 01 | James Richardson, CA | 05:15-06:15 | 7 SP | +5.0; 40% cloudy |
| | " " | 06:15-07:15 | 5 SP | +5.2; 50% cloudy |
| | " " | 07:15-08:15 | 11 SP | +5.7; 20% cloudy |
| | " " | 08:15-09:00 | 5 SP | +6.0; 10 % cloudy |
| | Phyllis Eide, HI | 10:40-11:45 | 5 SP | +5.0; 50% cloudy |
| 16 | Phyllis Eide, HI | 07:00-08:00 | 3 SP | +5.0 |
| | Michael Morrow, HI | 07:00-08:00 | 3 SP | +5.0 |
| | Phyllis Eide, HI | 08:00-09:00 | 5 SP | +5.0 |
| | Michael Morrow, HI | 08:00-09:00 | 1 SP | +5.0 |
| | Phyllis Eide, HI | 09:00-10:00 | 3 SP | +5.0 |
| | Michael Morrow, HI | 09:00-10:00 | 1 N. δ Aqr; 4 SP | +5.0 |
| 17 | Michael Morrow, HI | 10:15-11:15 | 1 S. δ Aqr; 3 SP | +5.0 |
| | " " " | 11:15-11:45 | 1 SP | +5.2 |
| 22 | James Richardson, CA | 04:30-05:08 | 6 SP | +5.5 |

---------------------------- *Table 1 continued on p. 183 ; notes on p. 186* --------------------------------

*Table 1—Continued.*

| 1990 U.T. Date | Observer and Location | Universal Time | Number and Type of Meteors Seen* | Comments* (+N = Limiting Magnitude) |
|---|---|---|---|---|
| JUL 22 | James Richardson, CA | 05:08-06:00 | 3 α Cap; 5 SP | +6.0 |
| | " " " | 07:20-08:08 | 1 α Cap; 1 S. δ Aqr; 2 SP | +6.0 |
| | " " " | 08:08-09:08 | 1 α Cap; 3 N. δ Aqr; 6 SP | +6.0 |
| | " " " | 09:08-10:08 | 2 N. δ Aqr; 6 SP | +6.0 |
| | Robert Lunsford, CA | 09:17-10:17 | 5 α Cap; 1 N. δ Aqr; 2 S. ι Aqr; 1 S. δ Aqr; 2 Per; 12 SP | +6.7 |
| | James Richardson, CA | 10:08-11:08 | 3 υ Peg; 1 S. δ Aqr; 1 α Cap; 8 SP | +6.0 |
| | Robert Lunsford, CA | 10:17-11:17 | 1 S. δ Aqr; 1 N. δ Aqr; 2 Per; 6 SP | +6.5 |
| | James Richardson, CA | 11:08-11:50 | 1 S. δ Aqr; 4 SP | +5.0 |
| | Robert Lunsford, CA | 11:17-11:47 | 1 α Cap; 3 Per; 9 SP | +5.8 |
| | Phyllis Eide, HI | 12:20-13:20 | 1 N. δ Aqr; 1 S. δ Aqr; 3 SP | +5.0; 30% cloudy |
| | Michael Morrow, HI | 12:20-13:20 | 1 N. δ Aqr; 1 S. δ Aqr; 3 SP | +6.0; 30% cloudy |
| | Phyllis Eide, HI | 13:20-14:20 | 3 SP | +5.0; variable cloudy |
| | Michael Morrow, HI | 13:20-14:20 | 3 SP | +6.0; variable cloudy |
| | Phyllis Eide, HI | 14:20-14:50 | 2 Per; 8 SP | +6.0; 20% cloudy |
| | Michael Morrow; HI | 14:20-14:50 | 1 Per; 4 SP | +6.0; 20% cloudy |
| 25 | Michael Morrow, HI | 10:30-11:30 | 2 S. δ Aqr | +4.8; 60% cloudy |
| 26 | Michael Morrow, HI | 09:00-10:00 | 5 SP | +5.2 |
| | " " " | 10:00-11:00 | 5 S. δ Aqr; 2 N. δ Aqr; 2 α Cap; 1 Per; 6 SP | +5.2 |
| 27 | Karl Simmons, FL | 04:04-05:04 | 1 Per; 1 S. δ Aqr; 3 SP | +6.0 |
| | Stephen Simmons, FL | 04:04-05:04 | 2 Per; 2 S. δ Aqr; 1 α Cap; 5 SP | +6.0 |
| | Wendy Simmons, FL | 04:04-05:04 | 1 Per; 3 S. δ Aqr; 1 α Cap; 5 SP | +6.0 |
| | Robert Lunsford, CA | 07:00-08:00 | 3 α Cap; 1 Per; 5 S. δ Aqr; 1 N. δ Aqr; 1 υ Peg; 7 SP | +6.6 |
| | " " " | 08:00-09:00 | 4 S. ι Aqr;1 α Cap; 3 S. δ Aqr; 1 N. δ Aqr; 1 υ Peg; 6 SP | +6.7 |
| | " " " | 09:00-10:00 | 1 S. ι Aqr;3 α Cap; 7 S. δ Aqr; 1 N. δ Aqr; 1 υ Peg; 2 Per; 10 SP | +6.5 |
| | " " " | 10:00-11:00 | 1 S. ι Aqr;1 α Cap; 6 S. δ Aqr; 6 Per; 12 SP | +6.5 |
| | " " " | 11:00-12:00 | 1 α Cap; 5 S. δ Aqr; 4 Per; 9 SP | +5.7 |
| 28 | Alton Smith, TN | 06:00-07:00 | 4 S. δ Aqr; 1 SP | +4.5 |
| | Phyllis Eide, HI | 09:15-10:15 | 1 S. δ Aqr; 1 N. δ Aqr; 3 α Cap; 1 PsA; 1 Per; 7 SP | +5.5 |
| | Michael Morrow, HI | 09:15-10:15 | 1 S. δ Aqr; 1 N. δ Aqr; 2 α Cap; 1 PsA; 1 Per; 6 SP | +5.2 |
| | Phyllis Eide, HI | 10:15-11:15 | 4 S. δ Aqr; 2 N. δ Aqr; 1 α Cap; 6 SP | +5.5 |
| | Michael Morrow, HI | 10:15-11:15 | 5 S. δ Aqr; 6 SP | +5.3 |
| | Phyllis Eide, HI | 11:15-12:15 | 3 S. δ Aqr; 3 N. δ Aqr; 1 υ Peg; 4 SP | +5.5 |
| | Michael Morrow, HI | 11:15-12:15 | 4 S. δ Aqr; 1 N. δ Aqr; 1 α Cap; 9 SP | +5.4 |
| | " " " | 12:15-12:30 | 1 S. δ Aqr; 1 PsA; 1 Per; 3 SP | +5.5 |
| | Phyllis Eide, HI | 12:15-12:45 | 2 S. δ Aqr; 1 N. δ Aqr; 1 Per; 3 SP | +5.5 |
| 29 | Barbara Hands, NC | 02:00-03:00 | 1 S. δ Aqr | +7.0; 30% cloudy |
| | Dennis Hands, NC | 02:00-03:00 | 2 SP | +7.0; 30% cloudy |
| | Alton Smith, TN | 05:15-06:15 | 6 S. δ Aqr; 3 Per; 3 SP | +5.5 |
| | James Richardson, CA | 05:16-06:08 | 2 S. δ Aqr; 1 S. ι Aqr; 8 SP | +5.5 |
| | James Richardson, CA | 06:08-07:08 | 1 S. δ Aqr; 3 α Cap; 1 υ Peg; 4 SP | +5.9 |

---------------------------- *Table 1 continued on p. 184; notes on p. 186* ------------------------------

*Table 1—Continued.*

| 1990 U.T. Date | Observer and Location | Universal Time | Number and Type of Meteors Seen* | Comments* (+*N* = Limiting Magnitude) |
|---|---|---|---|---|
| JUL 29 | Alton Smith, TN | 06:15-07:15 | 13 S. δ Aqr; 1 α Cap; 4 Per; 2 SP | +5.5 |
| | James Richardson, CA | 07:08-08:08 | 2 S. δ Aqr; 3 α Cap; 7 SP | +6.0 |
| | Alton Smith, TN | 07:45-08:45 | 7 S. δ Aqr; 1 α Cap; 4 Per; 2 SP | +5.5 |
| | James Richardson, CA | 08:08-09:08 | 2 S. δ Aqr; 2 N. δ Aqr; 5 α Cap; 1 Per; 6 SP | +6.0 |
| | " " " | 09:08-10:08 | 11 S. δ Aqr; 1 S. ι Aqr; 6 α Cap; 1 Per; 6 SP | +6.0 |
| | Phyllis Eide, HI | 09:20-10:20 | 1 S. δ Aqr; 2 υ Peg; 4 SP | +5.0; 20% cloudy |
| | Michael Morrow, HI | 10:00-11:00 | 2 N. δ Aqr; 2 υ Peg; 1 Per; 6 SP | +5.2 |
| | James Richardson, CA | 10:08-11:00 | 1 S. δ Aqr; 2 α Cap; 1 Per; 9 SP | +6.0 |
| | Phyllis Eide, HI | 10:20-11:20 | 2 N. δ Aqr; 4 υ Peg; 1 Per; 9 SP | +5.5; 30% cloudy |
| | " " " | 11:20-12:30 | 3 S. δ Aqr; 2 υ Peg; 4 Per; 15 SP | +5.5; 10% cloudy |
| JUL 30 | Milton Hays, FL | 04:05-05:05 | 1 S. δ Aqr; 1 SP | +6.0 |
| | Becky Kirkwood, FL | 04:05-05:05 | 7 S. δ Aqr; 6 SP | +6.0 |
| | David Kirkwood, FL | 04:05-05:05 | 8 S. δ Aqr; 1 α Cap; 8 SP | +6.0 |
| | Brian Simmons, FL | 04:05-04:55 | 8 S. δ Aqr; 3 SP | +6.0 |
| | Karl Simmons, FL | 04:05-05:05 | 6 S. δ Aqr; 1 α Cap; 1 Per; 6 SP | +6.0 |
| | Stephen Simmons, FL | 04:05-05:05 | 7 S. δ Aqr; 1 α Cap; 5 SP | +6.0 |
| | Wendy Simmons, FL | 04:05-05:05 | 7 S. δ Aqr; 1 Per; 9 SP | +6.0 |
| | Becky Kirkwood, FL | 05:05-06:05 | 12 S. δ Aqr; 1 Per; 2 SP | +6.5; 3 minute break |
| | David Kirkwood, FL | 05:05-06:05 | 13 S. δ Aqr; 1 α Cap; 1 Per; 7 SP | +6.5 |
| | Karl Simmons, FL | 05:05-06:05 | 8 S. δ Aqr; 2 Per; 2 SP | +6.5 |
| | Wendy Simmons, FL | 05:05-06:05 | 1 S. δ Aqr; 1 Per; 1 SP | +6.5 |
| | Alton Smith, TN | 05:15-06:15 | 8 S. δ Aqr; 2 Per; 2 SP | +5.0 |
| | Becky Kirkwood, FL | 06:05-06:35 | 5 S. δ Aqr; 3 α Cap; 1 Per; 1 SP | +6.5 |
| | David Kirkwood, FL | 06:05-06:35 | 4 S. δ Aqr; 2 α Cap; 1 SP | +6.5; 3 minute break |
| | Karl Simmons, FL | 06:05-06:35 | 1 S. δ Aqr; 2 Per; 2 SP | +6.5 |
| | Alton Smith, TN | 06:15-07:15 | 5 S. δ Aqr; 1 Per; 1 SP | +5.5 |
| AUG 01 | Karl Simmons, FL | 04:16-04:46 | 1 α Cap; 1 SP | +5.5 |
| | Stephen Simmons, FL | 04:16-04:46 | 1 S. δ Aqr; 1 α Cap; 2 SP | +5.5 |
| 02 | George Gliba, MD | 07:19-08:19 | 2 S. δ Aqr; 3 Per; 4 SP | +5.4; 30% cloudy |
| 11 | Phyllis Eide, HI | 07:00-08:00 | (none seen) | +5.0; 10% cloudy |
| | Michael Morrow, HI | 07:00-08:00 | (none seen) | +5.2 |
| | Phyllis Eide, HI | 08:00-09:00 | 1 Per; 4 SP | +5.0; 15% cloudy |
| | Michael Morrow, HI | 08:00-09:00 | 1 κ Cyg; 6 SP | +5.0 |
| | Phyllis Eide, HI | 09:00-10:00 | 1 Per; 1 SP | +5.0; 25% cloudy |
| | Michael Morrow, HI | 09:00-10:00 | 1 SP | +4.8 |
| | Phyllis Eide, HI | 10:00-10:30 | 1 SP | +5.0; 40% cloudy |
| | Michael Morrow, HI | 10:00-10:30 | 1 SP | +4.6 |
| 12 | Brian Simmons, FL | 05:00-05:45 | 6 Per; 2 SP | +5.0 |
| | Karl Simmons, FL | 05:00-05:45 | 7 Per | +5.0 |
| | Stephen Simmons, FL | 05:00-05:45 | 4 Per; 2 SP | +5.0 |
| | Wendy Simmons, FL | 05:00-05:45 | 2 Per; 1 SP | +5.0 |
| | Phyllis Eide, HI | 07:00-08:00 | (none seen) | +5.5 |
| | Michael Morrow, HI | 07:00-08:00 | 2 SP | +5.2 |
| | Phyllis Eide, HI | 08:00-09:00 | 2 Per; 6 SP | +5.5 |
| | Michael Morrow, HI | 08:00-09:00 | 2 Per; 7 SP | +5.0 |
| | Phyllis Eide, HI | 09:00-10:00 | 4 Per; 1 SP | +5.5 |
| | Michael Morrow, HI | 09:00-10:00 | 3 Per; 1 SP | +5.0; 30% cloudy |
| | Phyllis Eide, HI | 10:00-10:27 | 1 Per; 1 SP | +5.5; tape loss |
| | Michael Morrow, HI | 10:00-11:00 | 3 Per; 1 SP | +5.0; 30% cloudy |
| | James Richardson, CA | 10:30-11:40 | 21 Per; 2 SP | +4.0 |

---------------------------- *Table 1 continued on p. 185; notes on p. 186* -------------------------------

*Table 1—Continued.*

| 1990 U.T. Date | Observer and Location | Universal Time | Number and Type of Meteors Seen* | Comments* (+N = Limiting Magnitude) |
|---|---|---|---|---|
| AUG 12 | Michael Morrow, HI | 11:00-12:00 | 14 Per; 1 υ Peg; 2 SP | +5.0 |
| | Phyllis Eide, HI | 11:59-13:00 | 17 Per; 5 SP | +4.5 |
| | Michael Morrow, HI | 12:00-13:00 | 12 Per; 6 SP | +5.0 |
| | Phyllis Eide, HI | 13:00-13:45 | 10 Per; 4 SP | +3.0 |
| | Michael Morrow, HI | 13:00-13:45 | 13 Per; 2 SP | +4.5 |
| 13 | Becky Kirkwood, FL | 03:45-04:45 | 4 Per; 5 SP | +6.0 |
| | David Kirkwood, FL | 03:45-04:45 | 9 Per; 5 SP | +6.0; 4 minute break |
| | Brian Simmons, FL | 03:45-04:57 | 7 Per; 7 SP | +6.0 |
| | Karl Simmons, FL | 03:45-04:45 | 3 Per | +6.0 |
| | Stephen Simmons, FL | 03:45-04:45 | 6 Per; 2 SP | +6.0 |
| | Wendy Simmons, FL | 03:45-04:45 | 4 Per; 4 SP | +6.0 |
| | Milton Hays, FL | 03:55-04:55 | 1 Per; 2 SP | +6.0 |
| | Becky Kirkwood, FL | 04:45-05:45 | 7 Per; 8 SP | +5.5; 10% cloudy; 2 minute break |
| | David Kirkwood, FL | 04:45-05:45 | 18 Per; 9 SP | +5.5; 10% cloudy; 2 minute break |
| | Karl Simmons, FL | 04:45-05:45 | 12 Per; 4 SP | +5.5; 10% cloudy; 3 minute break |
| | Stephen Simmons, FL | 04:45-05:45 | 11 Per; 10 SP | +5.5; 10% cloudy; 1 minute break |
| | Wendy Simmons, FL | 04:45-05:45 | 14 Per; 4 SP | +5.5; 10% cloudy; 8 minute break |
| | Stephen Simmons, FL | 05:45-06:05 | 3 Per; 1 SP | +5.0 |
| | Becky Kirkwood, FL | 05:45-06:17 | 9 Per; 1 SP | +5.0 |
| | David Kirkwood, FL | 05:45-06:17 | 13 Per; 3 SP | +5.0 |
| | Karl Simmons, FL | 05:45-06:17 | 8 Per; 1 SP | +5.0 |
| | Phyllis Eide, HI | 07:30-08:30 | 1 SP | +5.0; 30% cloudy |
| | Michael Morrow, HI | 07:30-08:30 | 1 SP | +5.0; 30% cloudy |
| | Phyllis Eide, HI | 08:30-09:30 | 3 Per; 3 SP | +5.0; 30% cloudy |
| | Michael Morrow, HI | 08:30-09:30 | 2 Per; 1 SP | +5.0; 30% cloudy |
| 14 | Robert Lunsford, CA | 07:40-08:40 | 4 Per; 1 α Cap; 2 SP | +5.8 |
| | " " " | 08:40-09:40 | 4 Per | +5.4 |
| | " " " | 09:40-10:40 | 6 Per; 2 SP | +5.2 |
| | " " " | 10:40-11:20 | 11 Per; 1 SP | +5.0 |
| 15 | George Gliba, MD | 05:55-06:55 | 3 Per; 2 SP | +5.2 |
| | " " " | 06:55-07:55 | 4 Per; 5 SP | +5.2 |
| | Robert Lunsford, CA | 09:00-10:00 | 10 Per; 4 SP | +6.2 |
| | " " " | 10:00-11:00 | 12 Per; 2 κ Cyg; 5 SP | +6.0 |
| | " " " | 11:00-12:00 | 7 Per; 3 SP | +5.5 |
| 18 | Phyllis Eide, HI | 07:00-08:00 | 2 SP | +5.5 |
| | Michael Morrow, HI | 07:00-08:00 | 3 SP | +5.2; 10% cloudy |
| | Phyllis Eide, HI | 08:00-09:00 | 1 N ι Aqr; 2 SP | +5.5 |
| | Michael Morrow, HI | 08:00-09:00 | 1 SP | +5.3; 15% cloudy |
| | Phyllis Eide, HI | 09:00-10:00 | 4 SP | +5.5 |
| | Michael Morrow, HI | 09:00-10:00 | 1 N ι Aqr; 5 SP | +5.5; 20% cloudy |
| 19 | Phyllis Eide, HI | 09:00-10:00 | 1 SP | +4.5; 70% cloudy |
| | Phyllis Eide, HI | 10:00-11:00 | 1 SP | +4.0; 70% cloudy |
| 20 | Mark Davis, VA | 04:00-05:00 | 2 SP | +5.6; 25% cloudy |
| 22 | Robert Lunsford, CA | 08:00-09:00 | 1 Per | +5.3; variable cloudy |
| 23 | Robert Lunsford, CA | 08:48-09:48 | 7 SP | +5.3 |
| | " " " | 09:48-10:48 | 1 SP | +5.0; 50% cloudy |
| | " " " | 10:48-11:48 | (none seen) | +5.0; 70% cloudy |
| | " " " | 11:48-12:18 | 2 SP | +4.8; variable cloudy |
| 27 | Mark Davis, VA | 08:08-09:08 | 5 SP | +5.3; 15% cloudy |
| 28 | Mark Davis, VA | 08:30-09:30 | 1 α Aur; 3 SP | +5.2; 20% cloudy |
| 31 | Mark Davis, VA | 08:20-09:20 | 1 α Aur; 5 SP | +6.0 |
| SEP 01 | Mark Davis, VA | 06:45-07:45 | 9 SP | +5.9 |
| | " " " | 07:45-08:45 | 2 α Aur; 3 SP | +5.9 |

---------------------------------- *The notes for Table 1 are on p. 186* ----------------------------------

*Notes for *Table 1*. Abbreviations: α Aur = Alpha Aurigid; α Cap = Alpha Capricornid; κ Cyg = Kappa Cygnid; N. δ Aqr = North Delta Aquarid; N. ι Aqr = North Iota Aquarid; Per= Perseid; PsA = Piscis Austrinid; S. δ Aqr = South Delta Aquarid; S. ι Aqr = South Iota Aquarid; SP = Sporadic; τ Her = Tau Herculid; υ Peg = Upsilon Pegasid

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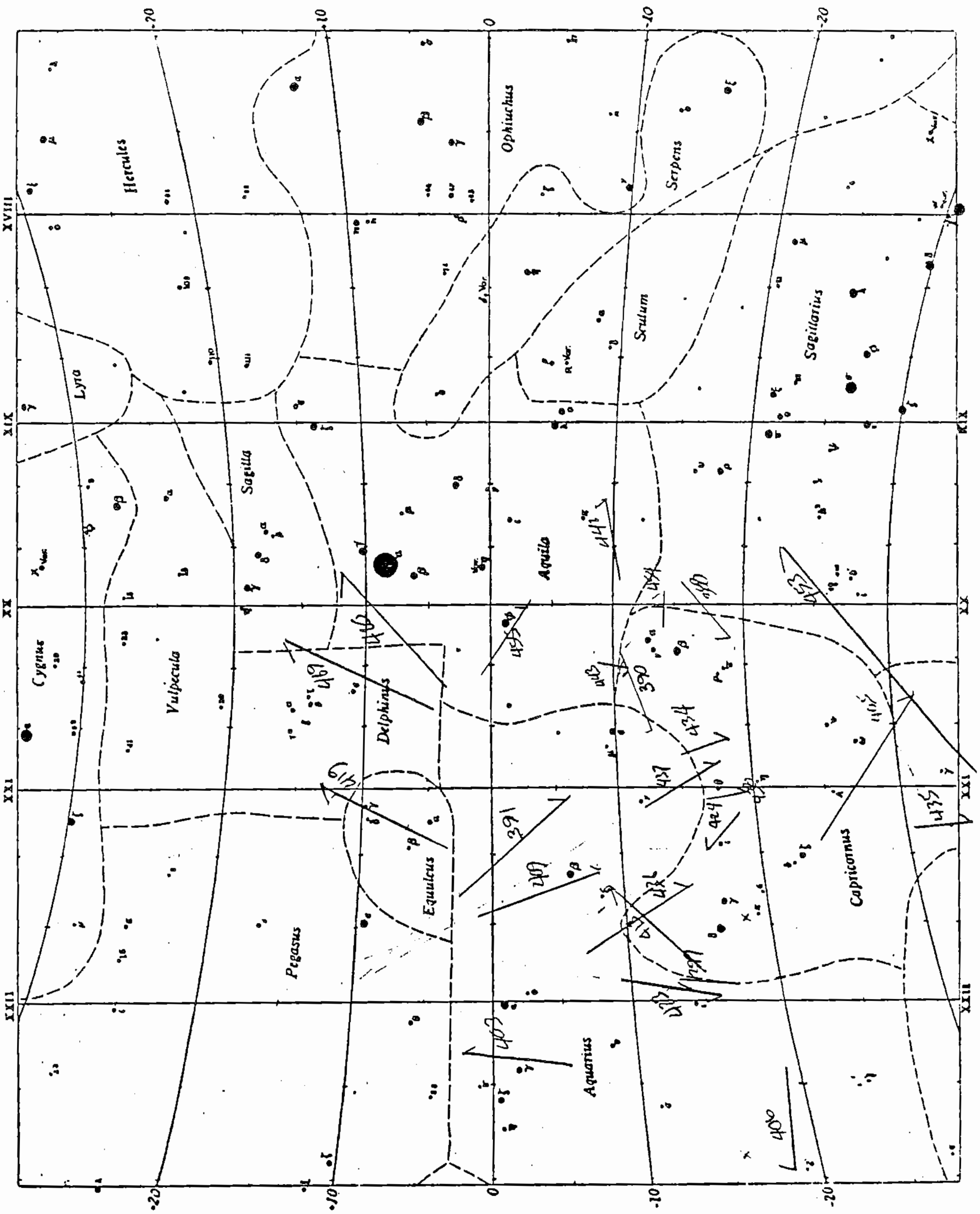
Figure 20. Sample plot of meteors observed by Robert D. Lunsford on 1990 JUL 27. Meteor paths are plotted with an arrowhead indicating the direction of motion. The numbers by the paths are for identification only, and are in chronological order. Background sky chart supplied by the American Meteor Society; the constellation boundaries are not the "official" ones adopted by the International Astronomical Union. This chart is rotated so that celestial north is to the left.



# COMING SOLAR-SYSTEM EVENTS: DECEMBER, 1990 - JANUARY, 1991

## WHAT TO LOOK FOR

We use this column to alert our readers about events happening in the Solar System during the next two months; giving the visibility conditions for major and minor planets, the Moon, comets, and meteors. You can find more detailed information in the 1990 and 1991 editions of the *A.L.P.O. Solar System Ephemeris*. (See p. 196 to find out how to obtain this publication.) Celestial directions are abbreviated. The symbol " indicates arc-seconds. All dates and times are in Universal Time (U.T.). For the time zones in the United States, U.T. is found by adding 10 hours to HST (Hawaii Standard Time), 9 hours to AST (Alaska Standard Time), 8 hours to PST, 7 hours to MST, 6 hours to CST, and 5 hours to EST. Note that this addition may put you into the next U.T. day!

## THE PLANETS: SATURN FADING; MARS, JUPITER, AND VENUS TAKE OVER

The only time left to observe **Saturn** and its new "Great White Spot," if it is still visible, is in the early evening in the southwest; it is best placed for S-Hemisphere observers at declination 22°S in Sagittarius. The Ringed Planet is at magnitude +0.6 and reaches conjunction with the Sun on 1991 JAN 18. It is no longer practical to observe **Uranus** and **Neptune**, which reach conjunction on 1990 DEC 31 and 1991 JAN 05 respectively.

**Mars** is now the most prominent object in the evening sky, low in the east in the twilight S of the Pleiades in the constellation of Taurus. The Red Planet was in opposition to the Sun on NOV 27 and fades from magnitude -2.0 to -0.1 in December and January as its disk diameter shrinks from 18" to 10", remaining close enough for photography and high-resolution visual observation.. The planet is well-placed for N-Hemisphere observers; at declination 22°N at opposition. During this period Mars' S Hemisphere is presented to us.

When you finish with Mars, **Jupiter** should be rising in the E as it approaches opposition on JAN 29. Located in Cancer, Jupiter is at declination 19°N and thus favorably located for observers in the Earth's N Hemisphere. During December and January, Jupiter's equatorial diameter grows from 41" to 45" while its magnitude brightens from -2.4 to -2.6. Among other features, watch the S Equatorial Belt as it continues to reëstablish itself. Jupiter is providing extra excitement with its **mutual satellite events**, which are described in the next article (pp.189-190).

**Venus**, at magnitude -3.9, is slowly pulling away from the Sun in the evening sky, increasing its elongation from 7° on DEC 01 to 22° on FEB 01. Its almost-full disk drops from 99 percent to 93 percent illuminated, while it remains small, growing only from 10" to 11".

The innermost planet, **Mercury**, has two visibility periods during our two-month forecast; when it is more than 15° from the Sun. The first is an evening apparition between NOV 18 and DEC 16, with a Greatest Elongation East of 21°.1 on DEC 06, more favorable for viewing from our S Hemisphere. The second "window" falls between JAN 01 and FEB 09, centered on the date of Greatest Elongation West of 23°.7 on JAN 14; this morning apparition favors southern observers.

During December and January there are several close conjunctions between pairs of planets, although they will all occur near the Sun in the sky. The only one of these involving bright planets happens on 1991 JAN 01, 15h, when Venus passes 1°.2 S of Saturn while both lie 15°E of the Sun.

There are no less than seven **minor planets** that reach opposition between DEC 06 and JAN 31 with magnitudes +10.0 or brighter. Their 10-day ephemerides are given in the 1990 and 1991 *A.L.P.O. Solar System Ephemeris*, but their opposition circumstances are summarized below:

| | Opposition Data | | |
|---|---|---|---|
| Minor Planet | 1990-91 Date | Stellar Magnitude | Declination& Constellation |
| **16 Psyche** | DEC 06 | +9.4 | 18°N Tau |
| **19 Fortuna** | DEC 23 | +9.4 | 21°N Ori |
| **354 Eleonora** | DEC 23 | +9.9 | 01°N Ori |
| **532 Herculina** | JAN 01 | +9.1 | 19°N Gem |
| **5 Astraea** | JAN 07 | +9.1 | 17°N Gem |
| **9 Metis** | JAN 23 | +8.7 | 27°N Cnc |
| **27 Euterpe** | JAN 31 | +8.9 | 19°N Cnc |

Although not in opposition, three other minor planets will be fairly bright: **1 Ceres** at Mag. +8.8-8.2, approaching its opposition on 1991 APR 17; **2 Pallas**, Mag. +8.5-7.4, with opposition on 1991 MAR 06; and **4 Vesta**, Mag. +6.7-7.9, which was in opposition to the Sun on 1990 NOV 17.

## THE MOON

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

| New Moon | First Quarter | Full Moon | Last Quarter |
|---|---|---|---|
| NOV 17.4 | NOV 25.5 | DEC 02.3 | DEC 09.1 |
| DEC 17.2 | DEC 25.1 | DEC 31.8 | JAN 07.8 |
| JAN 16.0 | JAN 23.6 | JAN 30.3 | FEB 06.6 |

The three lunations above are Numbers 840-842 in Brown's series. The New Moon of JAN 16.0 marks an **annular solar eclipse**, while the following Full Moon on JAN 30.3 has a **penumbral lunar eclipse**. Both events are described later in this article (p. 188).

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

| South | East | North | West |
|---|---|---|---|
| NOV 30 | DEC 08 | DEC 13 | DEC 25 |
| DEC 27 | JAN 06 | JAN 09 | JAN 21 |
| JAN 23 | FEB 03 | FEB 05 | FEB 17 |

Lunar E and W above follow the usage of the International Astronomical Union, with Mare Crisium near the *east* limb.

## ANNULAR SOLAR ECLIPSE: 1991 JAN 15-16

During 1991 JAN 15-16, the shadow of the Moon strikes the Earth; first touching the Indian Ocean (JAN 15d 21h 59.9m; 109° 35'.6 E/29° 51'.9 S), and then moving across SW and S Australia, Tasmania, the South Island of New Zealand, ending in the E Pacific Ocean (JAN 16d 01h 45.9m; 114° 17'.4 W/00° 27'.4 N). The Moon's umbral shadow will not be quite long enough to strike the Earth, so this will be an *annular* solar eclipse; in the shadow track the Moon's diameter will appear smaller than the Sun's, leaving a ring of light at mid-event. Naturally, an extensive area to either side of the track will see a partial eclipse. The circumstances for some stations in the eclipse area are:

| Place | U.T. of Max. Eclipse | Mag-nitude | Duration, Annular Phase | Solar Alt. |
|---|---|---|---|---|
| Perth, AUS | 22:00.3 | .951 | 5m28s | 6° |
| Adelaide, AUS | 22:09.8 | .840 | --- | 27° |
| Melbourne, AUS | 22:18.5 | .877 | --- | 34° |
| Canberra, AUS | 22:21.3 | .789 | --- | 38° |
| Brisbane, AUS | 22:22.0 | .550 | --- | 41° |
| Wynyard, AUS (T) | 22:22.6 | .961 | 6m43s | 35° |
| Sydney, AUS | 22:23.1 | .741 | --- | 40° |
| Hobart, AUS (T) | 22:26.4 | .918 | --- | 37° |
| Dunedin, NZ (S) | 23:03.5 | .854 | --- | 57° |
| Christchurch, NZ (S) | 23:07.8 | .910 | --- | 61° |
| Blenheim, NZ (S) | 23:11.1 | .961 | 7m39s | 63° |
| Wellington, NZ (N) | 23:13.0 | .964 | 7m42s | 64° |
| Auckland, NZ (N) | 23:15.3 | .842 | --- | 67° |
| Suva, Fiji | 23:53.4 | .357 | --- | 84° |
| Pago Pago, AM SAM | 00:39.2 | .436 | --- | 73° |
| Moerai, Rurutu | 00:57.8 | .954 | 6m46s | 52° |
| Papeete, Tahiti | 01:10.0 | .886 | --- | 47° |
| Tukuhora, Anaa | 01:14.7 | .948 | 6m08s | 42° |

*Notes:* AM SAM = American Samoa; AUS = Australia; (N) = North Island; NZ = New Zealand; (S) = South Island ; (T) = Tasmania. Moerai is at 151° 20' W/22° 27' S. Tukuhora is at 145° 30' W/17° 20' S. Magnitude = the fraction of the apparent diameter of the Sun's disk covered by the Moon at maximum eclipse, given in units of the Sun's diameter.

## PENUMBRAL LUNAR ECLIPSE: 1991 JAN 30

During this eclipse, the Moon passes to the S of the center of the Earth's shadow, and the penumbral magnitude is 0.906, so there should be strong penumbral shading on the Moon's N limb near mid-eclipse. Also, just prior to the beginning of the eclipse, or just after its end, are times when the Moon's *phase angle* is as small as is possible outside of eclipse (i.e., the Moon is almost exactly opposite to the Sun); a condition highly favorable for lunar photometry and for studying its tonal features without any appreciable shadow interference. The *first penumbral contact* is at 03h 57.6m, *mid-eclipse* occurs at 05h 58.6m, and *last penumbral contact* is at 07h 59.2m. Note that Jupiter will lie only 2°.3 NW of the Moon at mid-eclipse. The entire eclipse can be seen from North and South America, Greenland, Iceland, Ireland, and Scotland. The beginning only will be visible from Africa (except the E portions), Europe, and W Asia. Only the end of the eclipse will be seen from the Central Pacific, N New Zealand, N Japan, and NE Asia.

## OCCULTATIONS

One major, and eight minor, planets are busy occulting stars in the December-January period, as shown in the table below which lists the date, occulting object, visual magnitude of planet/star, and zone of visibility for each of these occultations.

DEC 04.57. **31 Euphrosyne**, 13.0/8.3. W U.S.A.
DEC 08.90. **Mercury**, -0.3/8.8. Brazil
DEC 12.18. **216 Kleopatra**, 11.9/9.4. Cent. So. America, W Africa
DEC 19.69. **451 Patientia**, 11.8/8.1. E Europe, Cent. & E Asia.
DEC 25.36. **216 Kleopatra**, 11.8/8.1. W So. America
JAN 04.01. **4 Vesta**, 8.1/8.0. N & Cent. Canada, E U.S.A., Caribbean, N So. America.
JAN 11.72. **184 Dejopeja**, 12.5/9.2. Australia
JAN 13.50. **351 Myrrha**, 13.7/**1.9**.China, India, Hawaii?
JAN 19.22. **216 Kleopatra**, 11.7/9.3. N & E U.S.A., W Africa.
JAN 21.20. **230 Athamantia**, 11.6/8.6. W & SW Europe, NW Africa
JAN 23.05. **165 Lorely**, 13.2/9.3. S Atlantic Oc.

The occultation of the 1.9-magnitude star **Alhena** (**γ Geminorum**) on the local evening of January 13 is an extremely rare event that can be observed with the naked eye by millions of people if they know when and where to look. Along the occultation track, Alhena will disappear for up to 8 seconds, but it is a spectroscopic binary star so that disappearance and reappearance could occur in steps. The nominal occultation track crosses the China coast near Shanghai at about 12h01m U.T., crosses S China, and then continues into N India (at about 12h03m). The path will be about 124 km wide, but its uncertainty amounts to several hundred kilometers, and the track could cross Japan and even Hawaii.

**Two occultations of bright planets by the Moon** are observable in our time period, just one day apart. First, on DEC 18 (06h), Venus is occulted, 11° E of the Sun, visible from the S Pacific Ocean. Then, on DEC 19 (16h), Saturn is hidden by the Moon when 26°

E of the Sun. The latter event will be visible from the SE Pacific Ocean, S South America, the S Atlantic Ocean, and Central Africa.

Meanwhile, there will be two occultations of the +1.2-Mag. star **Antares**: (1) **DEC 15**, 21h (15° W of the Sun); from the Pacific Ocean, Hawaii, and W North America. (2) **JAN 12**, 04h (42°W of the Sun); from Asia.

The series of passages of the Moon across the **Pleiades** open star cluster (M45) continues: **DEC 01**, 15h, 99-percent sunlit Moon; visible from Asia. **DEC 29**, 03h, 90-percent Moon; from North America. **JAN 25**, 12h, 71-percent Moon; from E Asia and the W Pacific Ocean.

### COMETS

Several telescopic comets will be present in the sky. For more information, see the article by Don E. Machholz, "Comet Corner," on pp. 180-181 of this issue.

### METEOR SHOWERS

*(Contributed by Robert D. Lunsford, A.L.P.O. Meteors Recorder. For more information see "Meteors Section News" on p. 182)*

The strongest annual shower, the **Geminids**, will be most active on the mornings of December 13th and 14th (local time). Rates have often exceeded 100 per hour for early-morning observers with dark skies. Unlike the case with most showers, stream members may be seen at all hours of the night.

The **Ursids** peak on DEC 22 under favorable conditions; a waxing crescent Moon that will set before midnight. Best seen after midnight, this radiant usually produces 5-10 meteors per hour.

Finally, the **Quadrantids** of January are spoiled by a waning gibbous Moon. With the intense moonlight, rates on the morning of January 3rd (local time) will be limited to 10 per hour at best.

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## THE MUTUAL ANTICS OF THE GALILEAN SATELLITES

**By: John E. Westfall, A.L.P.O. Assistant Jupiter Recorder, Galilean Satellites**

Every six years, the Earth and the Sun pass through the orbital planes of Jupiter's four Galilean Satellites. At such times, these four worlds occult and eclipse each other. Between November 13, 1990, and April 12, 1992, more than 300 such events take place.

These phenomena are fascinating to watch, even in a small telescope. They usually last just a few minutes, although some events take over an hour. With a mutual occultation, the two satellites will appear to merge into a joint image that dims near mid-event, then brightens again as the satellites draw apart. In a mutual eclipse, the eclipsed satellite will dim or even disappear. In a large telescope, under good conditions, a mutual occultation may be seen as the disk of one satellite actually moving across the other. Likewise, in a mutual eclipse, the shadow of one satellite may be seen to move across the disk of the other.

The next stage beyond "just looking" is to make a series of drawings. Likewise, the amount of light loss in magnitudes can be estimated by comparing satellites in the same way as that used for variable stars. This project may give significant results if the estimates are made frequently and the results plotted on a graph in order to determine the accurate time of minimum light.

With a medium-size telescope, the satellites can be photographed in a few seconds' exposure, which should be done at regular intervals while the event goes on. One can tape-record the events with a sensitive video camera and a telescope of at least 8 inches (20 cm) aperture. One may then use a computer "frame grabber" and the tape for photometry if accurate times are also recorded.

Photoelectric measurements of the light changes during an occultation or eclipse are probably the most useful amateur observations. Here, a frequent series of measurements is needed, each ideally timed to 0.1-second accuracy. The most convenient way to do this is to have the photometer output read into a computer that is equipped with a clock card. Another approach is to speak the photometer readings into a tape recorder along with WWV shortwave time signals.

The most serious difficulty to overcome in doing any photometry involving Jupiter's satellites is accurately to measure and subtract the scattered light from Jupiter. This essentially precludes doing photometry for events near Jupiter's limb. For more observable events, we recommend placing the photometer aperture at equal and small amounts to the zenocentric north and the south of the satellite, reading the sky background at both locations, and then taking the mean as the skylight at the satellite's position. With an occultation, or an eclipse near opposition, both satellites will need to be measured; in such a case, it is important to measure the brightness ratio of the two.

The resulting series of measurements can be plotted against time on a graph or can be analyzed statistically. From this, one can find the *time* of maximum light loss; this can be used to determine the satellites' orbital *longitudes* accurately. Also, the *amount* of maximum light loss is useful to find the orbital *latitudes* of the satellites; this cannot be done with "normal" satellite events.

Among the mutual events, the occultations of Io by Europa are the subject of a special study by the "International Jupiter

Watch," which hopes to map the extent and location of volcanic activity on Io. Those few so equipped will make thermal infrared measurements during these occultations. However, it is important that the IR measures be supplemented by standard wide-band photometry in the **V** or **B** bands; ideally both, so as to get time-dependent (**B-V**) differences. Through such means, we can map the extent of "resurfacing" on Io caused by the volcanic ejecta.

### Communication

Predictions for the events for November, 1990-February, 1991, are listed below. Future issues of this Journal will continue this listing in the regular "Coming Solar System Events" column. See also the appropriate annual volumes of the *A.L.P.O. Solar System Ephemeris.*

The other aspect of communication is to let people know your results:

—The Association of Lunar and Planetary Observers will be happy to receive drawings, photographs, and visual photometry, and will publish and display a selection of them; these should be sent to: John E. Westfall, A.L.P.O., P.O. Box 16131, San Francisco, CA, 94116. (We plan to give an interim report at our 1991 convention.)

—(B-V) photometry of occultations of Io by Europa should be sent to Westfall at the above address, who will make them available to the International Jupiter Watch.

—Reports on single-color photometry and copies of video tapes (VHS format) of all events should be sent to:

Fred Franklin,
Center for Astrophysics, 60 Garden Street
Cambridge, MA 02138.

and also to:

Dr. Jean E. Arlot, Bureau des Longitudes;
77, avenue Denfert-Rochereau;
75014 - Paris, France.

Drs. Franklin, Arlot, and Westfall will be glad to answer inquiries from interested observers. These mutual events are not only an opportunity to see something interesting, but also to find out more about Jupiter's satellites and their orbits, and about Io's volcanism in particular.

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### Schedule of Galilean Satellite Mutual Events

The condensed table below gives: First the date (mmdd, in Universal Time). Next is the form of event, where the satellites are numbered 1 for Io, 2 for Europa, 3 for Ganymede, and 4 for Callisto. The occulting or eclipsing satellite is given first, followed by "O" for occultation or "E" for eclipse, then by the occulted or eclipsed satellite; finally by "P" for partial, "A" for annular, or "T" for total. Then follow the Universal Times of the event's beginning and end, each given as hhmm. The next set of two digits is the percentage maximum light loss ("DL"). Finally is given the apparent distance from Jupiter's center in Jovian equatorial radii ("R"). *Italicized events are not recommended for photoelectric photometry but may be observed visually.*

| U.T. Date | Event Type | U.T. Begin | U.T. End | DL | R |
|---|---|---|---|---|---|
| 1990-1991 | | | | | |
| 1113 | 2O3P | 0144 | 0151 | 07 | 09 |
| 1120 | 2O3P | 0505 | 0515 | 16 | 09 |
| 1127 | 2O3P | 0827 | 0838 | 23 | 09 |
| 1204 | 2O3A | 1148 | 1200 | 23 | 09 |
| 1211 | 2O3A | 1510 | 1524 | 23 | 09 |
| *1218* | *2E3P* | *1512* | *1515* | *00* | *11* |
| 1218 | 2O3A | 1833 | 1848 | 23 | 09 |
| 1225 | 2E3P | 1853 | 1904 | 03 | 11 |
| 1225 | 2O3A | 2159 | 2216 | 23 | 09 |
| 1228 | 2O1P | 1920 | 2022 | 03 | 04 |
| 0101 | 2O1P | 0613 | 0648 | 15 | 03 |
| 0101 | 2O1P | 1022 | 1051 | 09 | 05 |
| 0101 | 2E3P | 2245 | 2301 | 13 | 10 |
| 0102 | 2O3A | 0130 | 0150 | 23 | 09 |
| *0104* | *2O1P* | *1751* | *1820* | *21* | *02* |
| 0105 | 2O1P | 0010 | 0028 | 10 | 06 |
| *0107* | *2O1P* | *1949* | *1952* | *00* | *06* |
| 0108 | 2E1A | 0716 | 0800 | 71 | 02 |
| 0108 | 2E1A | 1136 | 1218 | 68 | 05 |
| 0108 | 2O1P | 1337 | 1352 | 12 | 06 |
| 0109 | 2E3P | 0252 | 0314 | 24 | 10 |
| 0109 | 2O3A | 0513 | 0538 | 23 | 09 |
| 0110 | 4O2P | 1548 | 1558 | 62 | 09 |
| 1991 | | | | | |
| *0111* | *2O1P* | *0906* | *0911* | *01* | *06* |
| 0112 | 2E1A | 0140 | 0205 | 69 | 05 |
| 0112 | 2O1P | 0258 | 0311 | 13 | 06 |
| *0114* | *2O1P* | *2225* | *2234* | *01* | *06* |
| *0115* | *2O1A* | *0525* | *0557* | *40* | *01* |
| 0115 | 2E1A | 1519 | 1538 | 69 | 06 |
| 0115 | 2O1P | 1613 | 1626 | 15 | 06 |
| 0116 | 2E3A | 0728 | 0759 | 30 | 10 |
| 0116 | 2O3A | 0923 | 0959 | 23 | 09 |
| 0118 | 2O1P | 1153 | 1207 | 03 | 05 |
| 0118 | 2O1P | 1708 | 1746 | 39 | 02 |
| *0118* | *2E1P* | *1800* | *1833* | *54* | *01* |
| 0119 | 2E1A | 0450 | 0507 | 70 | 06 |
| 0119 | 2O1P | 0527 | 0539 | 18 | 06 |
| 0122 | 2O1P | 0132 | 0202 | 07 | 05 |
| 0122 | 2O1P | 0430 | 0530 | 29 | 03 |
| 0122 | 2E1P | 0527 | 0607 | 37 | 02 |
| 0122 | 2E1A | 1815 | 1829 | 71 | 06 |
| 0122 | 2O1P | 1837 | 1848 | 20 | 06 |
| 0123 | 2E3P | 1331 | 1443 | 29 | 08 |
| 0123 | 2O3A | 1521 | 1814 | 23 | 07 |
| 0123 | 2E3P | 1950 | 2050 | 03 | 05 |
| *0125* | *2E1P* | *1539* | *1645* | *01* | *04* |
| 0126 | 2E1A | 0737 | 0750 | 71 | 06 |
| 0126 | 2O1P | 0747 | 0757 | 23 | 06 |
| 1991 | | | | | |
| 0129 | 2O1P | 2054 | 2104 | 26 | 06 |
| 0129 | 2E1A | 2056 | 2108 | 68 | 06 |
| 0202 | 2O1P | 1002 | 1012 | 29 | 06 |
| 0202 | 2E1A | 1014 | 1026 | 67 | 06 |
| 0205 | 2O1P | 2308 | 2317 | 33 | 06 |
| 0205 | 2E1A | 2330 | 2341 | 69 | 06 |
| 0209 | 2O1P | 1214 | 1223 | 36 | 06 |
| 0209 | 2E1A | 1246 | 1256 | 70 | 06 |
| 0213 | 2O1P | 0119 | 0128 | 39 | 06 |
| 0213 | 2E1A | 0200 | 0209 | 70 | 06 |
| 0216 | 2O1A | 1425 | 1433 | 40 | 06 |
| 0216 | 2E1A | 1513 | 1522 | 69 | 06 |
| 0220 | 2O1A | 0329 | 0337 | 40 | 06 |
| 0220 | 2E1A | 0426 | 0434 | 67 | 06 |
| *0220* | *3O4P* | *1517* | *1612* | *01* | *13* |
| 0221 | 3O4P | 0105 | 0327 | 12 | 09 |
| 0223 | 2O1P | 1634 | 1642 | 38 | 06 |
| 0223 | 2E1A | 1738 | 1746 | 68 | 06 |
| 0227 | 2O1P | 0539 | 0546 | 35 | 06 |
| 0227 | 2E1A | 0650 | 0658 | 65 | 05 |

# THE GREAT WHITE SPOT ON SATURN

On 1990 SEP 25 U.T., Stuart Wilber, an amateur astronomer in Las Cruces, New Mexico, discovered an intense white spot in the northern Equatorial Zone of Saturn. Such "Great White Spots" have appeared in 1876, 1903, 1933, and 1960; about one Saturnian year (29.4 terrestrial years) apart. Indeed, a notice by Frank J. Melillo in our July, 1989, issue (p.138) had alerted our readers to the likelihood of another outbreak at about this time. At the time of writing (late November, 1990), the "Wilber Spot" had diffused over the entire Equatorial Zone, making it unusually bright. *Figure 21*, below, shows three recent CCD images of this feature.

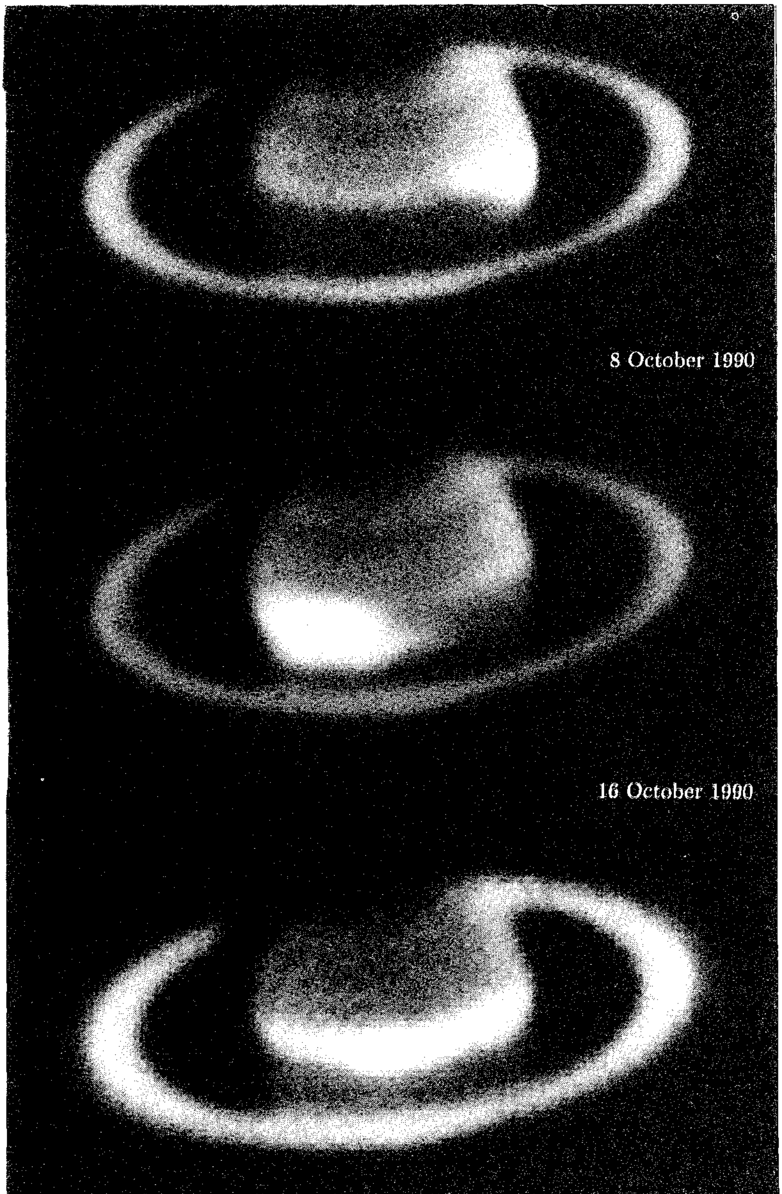


Figure 21. Three images of Saturn showing the Great White Spot of 1990, taken at the European Southern Observatory at La Silla, Chile, under conditions of mediocre seeing. The two upper views were taken with the New Technology Telescope, the lower with the 2.2-meter reflector. Top: 1990 OCT 08, 00h 00m U.T., CM(I) = 036°, 1 second with Johnson-U (ultraviolet) Filter. Middle: 1990 OCT 16, 00h 00m U.T., CM(I) = 309°, 1 second with 4680Å filter. Bottom: OCT 23, 00h 01m U.T., CM(I) = 099°, 10 seconds with 3880Å filter. Note the development of the spot in longitude over the 15 day-interval of these images. The Spot's saturnigraphic latitude is about +12°. North is at top and IAU west to the left.

# MINUTES OF THE 1990 A.L.P.O. BUSINESS MEETING

**By: Peter Rasmussen, Acting Secretary**

The annual A.L.P.O. Business Meeting was held as part of the ALCON'90 convention at Washington University in St. Louis, Missouri. The meeting was called to order by John Westfall at 7:05 PM on August 2, 1990, with 19 members present. The order of business follows.

## I. A.L.P.O. REPORTS.

**A. Finances.**—The total of our three bank accounts (San Francisco, Heber Springs, Las Cruces) as of July 29, 1990, was $3632. The amount owed to the Director for A.L.P.O. expenses was $1735 as of that date.

**B. Staff Changes.**—None.

**C. Publications.**—The number of subscribers to the *Journal, A.L.P.O.* ("The Strolling Astronomer") for the July, 1990, issue was 658. Of these 78 percent were in the United States and 22 percent in other countries. The costs for the issue before that (April, 1990) were $607 for postage and $924 for printing, for 687 subscribers. This averages to be $2.23 per subscription, or about $9 per year, but does not include our mailing service, envelopes, renewal notices, or exchange subscriptions. In the immediately previous year, we published four quarterly issues (from Vol. 33, Nos. 11-12 through Vol. 34, No. 3), totaling 196 pages.

One hundred copies of the *A.L.P.O. Solar System Ephemeris: 1990* had been distributed; 83 sold and 17 free. The total expenses of this 100-page publication were $489, and the revenue from sales was $505. [Regarding the 1991 edition, see the "Announcements" section on p. 193.]

**D. Foreign Membership Fund.**—During the past year, 7 foreign amateur astronomers were awarded 1-year A.L.P.O. memberships, at a cost of $112 ($16 each). We also received 5 donations totaling $94. However, the fund remains at the low balance of $12, insufficient for a single further award unless we receive more donations.

**E. Membership Trends.**—The number of members of the A.L.P.O. had recently declined, as shown by the following statistics:

| Issue | Date | U.S.A | Abroad | Total |
|---|---|---|---|---|
| 31, 3-4 | 9/85 | 545 | 158 | 703 |
| 31, 5-6 | 1/86 | 534 | 154 | 688 |
| 31, 7-8 | 3/86 | 525 | 157 | 682 |
| 31, 9-10 | 7/86 | 516 | 155 | 671 |
| 31, 11-12 | 10/86 | 507 | 157 | 664 |
| 32, 1-2 | 3/87 | 523 | 155 | 678 |
| 32, 3-4 | 7/87 | 523 | 154 | 677 |
| 32, 5-6 | 10/87 | 517 | 153 | 670 |
| 32, 7-8 | 2/88 | 520 | 160 | 680 |
| 32, 9-10 | 7/88 | 539 | 163 | 702 |
| 32, 11-12 | 10/88 | 555 | 163 | 718 |
| 33, 1-3 | 1/89 | 552 | 154 | 706 |
| 33, 4-6 | 4/89 | 546 | 160 | 706 |
| 33, 7-9 | 7/89 | 550 | 160 | 710 |
| 33, 10-12 | 10/89 | 551 | 157 | 708 |
| 34, 1 | 2/90 | 546 | 155 | 701 |
| 34, 2 | 4/90 | 526 | 161 | 687 |
| 34, 3 | 7/90 | 510 | 148 | 658 |

*- Continued in upper right -*

**F. Incorporation.**—For the first time, the A.L.P.O. is legally incorporated. We are now at California non-profit corporation and we have applied to the Internal Revenue Service for approval as a tax-exempt organization [and now have received a favorable decision].

## II. NEW BUSINESS.

**A. 1991 Meeting.**–The A.L.P.O. had received two invitations for our 1991 convention: (1) To join the Western Amateur Astronomers at Mammoth Lakes, California, on August 8-11, 1991. (2) To join the Symposium for Research Amateur Astronomy at La Paz, Baja California Sur, Mexico, on July 8-12, 1991. The La Paz site was approved by membership vote after a motion was made by Mr. Stevens and was seconded by Frederick Pilcher.

**B. Title Change.**–Director Westfall proposed that the title of "Director" be changed to "Executive Director" because, given the incorporation, we now have an entire Board of Directors [see below]. The title change was unanimously approved following a motion by Jeff Beish and a second by Mr. Stevens.

**C. Subscription Agency Dues Surcharge.**— Harry Jamieson moved to have a 20-percent surcharge for charges to subscription agencies. The motion was seconded by Jeff Beish and then approved.

**D. Other New Business.**—

1. Ephemeris.—It was suggested that we add the Ephemeris to the dues description at the top of the inside back cover of the Journal in a "continued account" type format along with the membership renewal in order to emphasize its importance, but not to make it a mandatory purchase.

2. Membership Decline.—There was considerable discussion as to the possible reasons for the decline in membership. It was stated that the decrease may be caused by the increase in dues; or that new members may be trying out the Journal, having difficulty in reading it, and then losing interest. A suggestion was made for a section of articles for the "beginner" in each issue. Jose Olivarez made a motion to simplify the Journal. This motion was seconded by Jeff Beish. The motion passed with 11 in favor, 4 opposed.

3. Future A.L.P.O. Conventions.—There was a discussion as to whether or not future A.L.P.O. conventions should be held with or without other organizations and at locations

selected by other groups. A motion to explore the option of meeting on our own was made by Jeff Beish, seconded by Dan Joyce, and approved.

4. Associate Membership.—A motion was made to create the status of "Associate Membership" in the A.L.P.O., with annual dues of $3.00, which would include all the rights of full membership *except* for subscription to the Journal. This motion was then seconded and passed.

With no further business, Jeff Beish made a motion to adjourn, which was then seconded and passed. The meeting was adjourned at 8:30 P.M.

### III. BOARD OF DIRECTORS MEETING

The Business Meeting was followed immediately by a meeting of the A.L.P.O. Board of Directors, as required by our new Articles of Incorporation. The initial Board of Directors consisted of Walter H. Haas, John E. Westfall, and Elizabeth W. Westfall. They called the Board Meeting to order and then appointed additional Board members, who had indicated previously their willingness to serve. The A.L.P.O. Board of Directors is now constituted:

Walter H. Haas
Harry D. Jamieson, *Treasurer.*
Jose Olivarez
Donald C. Parker
Elizabeth W. Westfall, *Secretary.*
John E. Westfall, *Chair.*

This Board is required to meet at least once each year and is the legal authority for all A.L.P.O. business. Thus, the results of Business Meetings by the general membership are legally only recommendations. The first decision of the newly-constituted Board was to ratify all decisions made at the preceding Business Meeting. After this, the Board Meeting was adjourned at 8:45 P.M.

## ANNOUNCEMENTS

***Board of Directors.***—The Association of Lunar and Planetary Observers now has a Board of Directors. For its composition and duties, see Section III of the report on our 1990 Business Meeting, directly above.

***Staff Change.***—We regret to report that Richard G. Hodgson is no longer able to continue as Recorder of the Remote Planets Section. We are grateful for his years of service to the A.L.P.O. in the past. Fortunately, **Richard W. Schmude, Jr.**, 3000 Trinity #5, Los Alamos, New Mexico 87544, has agreed to serve as Acting Remote Planets Recorder.

***Staff Address Changes.***—Two A.L.P.O. Section Recorders have changed their mailing addresses effective immediately. Their *new* addresses are:

Philip W. Budine
Jupiter Recorder
R.D. 3, Box 145C
Walton, NY 13856

Don E. Machholz
Comets Recorder
P.O. Box 1716
Colfax, CA 95713

Please also note that the distributor of the Minor Planets Section's *Minor Planet Bulletin*, Derald D. Nye, now resides at: 10385 East Observatory Drive, Tucson, AZ 85747.

***New and Revised A.L.P.O. Publications.***– In recent months, five A.L.P.O. publications have been produced or revised.

An **A.L.P.O. Membership Directory** is now available from the A.L.P.O. Membership Secretary, Harry D. Jamieson, whose address is on this magazine's front cover. The price, including postage, is $5.00 for members in North America, and is $6.00 for other countries (surface mail). Except for a very few members who wish to remain anonymous, this booklet lists all members alphabetically, followed by listings by country and Zip Code, and by topic or topics of interest. Unfortunately, only a few persons have told Mr. Jamieson what they are interested in! *Please let him know*; the interest codes are: 0 = the Sun, 1 = Mercury, 2 = Venus, 3 = the Moon, 4 = Mars, 5 = Jupiter, 6 = Saturn, 7 = Remote Planets (Uranus, Neptune, Pluto), A = Asteroids (Minor Planets), C = Comets, H = Astronomical History, M = Meteors , P = Astronomical Photography, S = Astronomical Software, T = Astronomical Telescopes, and V = Video/CCD Astronomy.

A new edition of the **Mars Observer's Handbook**, by Jeffrey D. Beish and Charles F. Capen, is now available. The price is $8.00 postpaid from: Astronomical League Sales, Four Klopfer Street, Pittsburgh, PA 15209.

The Astronomical League has also published our Solar Section's **The New Observe and Understand the Sun**. This handbook is available for $5.75 postpaid and should be ordered from: Astronomical League Sales, Four Klopfer Street, Pittsburgh, PA 15209.

Now, here are two publications that should also be available by the time you read this:

The 1990-1991 edition of the **A.L.P.O. Section Directory** can be obtained free from the A.L.P.O. Membership Secretary; simply send a stamped, self-addressed envelope. This publication tells about the personnel, projects, and publications of our Observing Sections.

Finally, **The A.L.P.O. Solar System Ephemeris: 1991** can be ordered from: Mark Davis, Pioneer Apartments, Apt. E-10, Christianburg, VA 24073. The price includes air mail postage and is $6.00 for orders from the United States, Canada, and Mexico, and $8.50 for other countries.

***Associate Memberships.***—As decided at our recent Business Meeting, the A.L.P.O. has a new category of membership; *Associate Membership*. The annual dues for Associate Membership are $3.00, which gives a person all rights of membership except there is no subscription to our *Journal*. Thus, this form of membership might be suitable for persons in the family of a full member, or for members of clubs where the club receives the *Journal*.

***Subscription Agency Surcharge.***—The Membership Secretary, and the Director before him, have found that dealing with subscription agencies takes more time and postage than with individuals. Our recent Business Meeting voted to impose a 20 percent surcharge on all dues payments made through subscription agencies. This surcharge also applies whenever an invoice is required of us.

***Paying the A.L.P.O.***—Sometimes we have problems in depositing checks that are mailed to us. Please remember that checks should be made out simply to "A.L.P.O." (don't add someone's name) for membership dues, the *A.L.P.O. Membership Directory*, the *A.L.P.O. Solar System Ephemeris*, for donations, and for payments for advertising. If you live abroad, remember that all checks or money orders must be in US$, drawn on a U.S. bank, and contain an American bank routing number.

***Reach Out and Touch the A.L.P.O.***—The Postal Service will doubtless remain the most common way to contact the "head office" of the A.L.P.O., but there are now two electronic alternatives if you are in a hurry: (1) We are on the **CompuServe** computing network via the identification **73737,1102**. (2) Our FAX number is **415-731-8242**.

***1991 A.L.P.O. Convention.***–We will hold our 41st Convention with the Symposium for Research Amateur Astronomy in La Paz, Baja California Sur, Mexico, on July 8-12, 1990. This meeting will include the very long total solar eclipse of July 11th; we expect 382 seconds of totality at our observing site, with a solar altitude of 82 degrees! The Symposium now has over 200 registrants from North and Latin America, Europe, Asia, and the Pacific. Hotel space remains available, and we now have arranged an airplane charter as well as some seats on scheduled airlines. However, the number of available spaces is shrinking rapidly; if you plan to come, write *soon* to: Corporation for Research Amateur Astronomy, P.O. Box 16542, San Francisco, CA 94116 U.S.A. The basic registration cost is $130; this includes a Welcome Party on Sunday evening (July 7), lunch and attendance at sessions for Monday-Wednesday, a copy of the *Proceedings*, and access to the eclipse viewing site on Thursday, July 11th. Added-cost options include a Post-Eclipse Banquet on Thursday evening; and a Transit of Venus Historical Field Trip on Friday, going to the observing site in San José del Cabo used for the 1769 Transit of Venus. *Because paper abstracts will be translated into Spanish (or English if submitted in Spanish) send your abstract no later than December 31, 1990, if you plan to give a talk or poster paper.*

## PUBLICATIONS OF THE ASSOCIATION OF LUNAR AND PLANETARY OBSERVERS

**(All Section Publications must be ordered directly from the appropriate Recorders.)**
**(Checks must be in U.S. funds, payable to an American bank with bank routing number.)**

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**Order from: Mark Davis, Pioneer Apts., Apt. E-10, Christianburg, VA 24073, U.S.A.**

***The A.L.P.O. Solar System Ephemeris: 1991.*** $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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**Order from: A.L.P.O., P.O. Box 16131, San Francisco, CA 94116, U.S.A.**

***An Introductory Bibliography for Solar System Observers.*** *Free* for a stamped, self-addressed envelope. A 4-page list of books and magazines about Solar System bodies and how to observe them. The current edition was updated in September, 1989.

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**Order from: A.L.P.O. Membership Secretary, P.O. Box 143, Heber Springs, AR 72543, U.S.A.**

① ***A.L.P.O. Section Directory--1990/91.*** *Free*; just send a stamped, self-addressed envelope. A 10-page description of each Observing Section's personnel, projects, and publications.

② ***A.L.P.O. Membership Directory.*** $5.00 in the United States, Canada, and Mexico; $6.00 elsewhere. Continuously-updated list of members: alphabetically, by location, and by interest or interests. Make payment to "A.L.P.O."

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

Back issues of ***The Strolling Astronomer (J.A.L.P.O.).*** The 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); 6. *8* (1954); 7-8. *11* (1957); 11-12. *20* (1967-68);9-10.
*21* (1968-69); 3-4 and 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, and 11-12 [each $1.75].
*27* (1977-79); 3-4, 5-6, 7-8, 9-10, and 11-12 [each $1.75].
*28* (1979-81); 3-4 [each $1.75]. *31* (1985-86); 1-2, 3-4, 5-6, and 9-10 [each $2.50].
*32* (1987-88); 1-2, 5-6, and 11-12 [each $2.50].
*33* (1989); 1-3, 4-6, 7-9, and 10-12 [each $2.50]. *34* (1990); 1, 2, and 3 [each $2.50].

***Current Issue*** [*34*, 4]—$3.00.

### KEEPING YOUR MEMBERSHIP CURRENT—

Because all regular A.L.P.O. memberships include a subscription to the *Strolling Astronomer (J.A.L.P.O.),* the top line of your mailing label gives the volume and issue number for which your membership will expire (e.g., "34.04" means Volume 34, Number 4). 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 longer than two pages, begin with a 75-150 word abstract (our Journal 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 but 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 has approximately 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. Associate Memberships, which do not include a Journal subscription, are $3.00 per year. There is a 20-percent surcharge on all memberships obtained through subscription agencies or which require an invoice.

Our advertising rates are $85.00 for a full-page display Ad., $50.00 for a half-page, and $35.00 for a quarter-page. Classified Ads. are $10.00 per column-inch. There is a 10-percent discount for a 3-time insertion on all advertising.

All payments should be in U.S. funds, drawn on a U.S. bank with a bank routing number, and payable to "A.L.P.O." When writing our staff, please furnish stamped, self-addressed envelopes.


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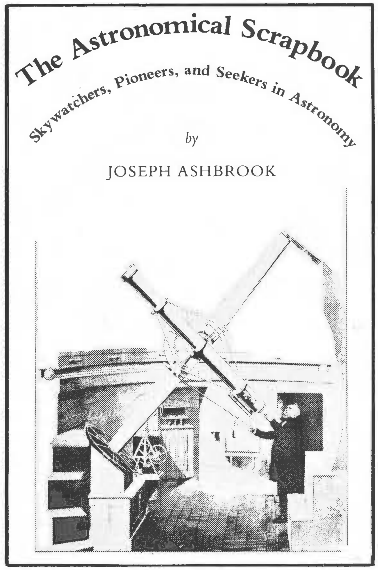
# The Astronomical Scrapbook

Joseph Ashbrook

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