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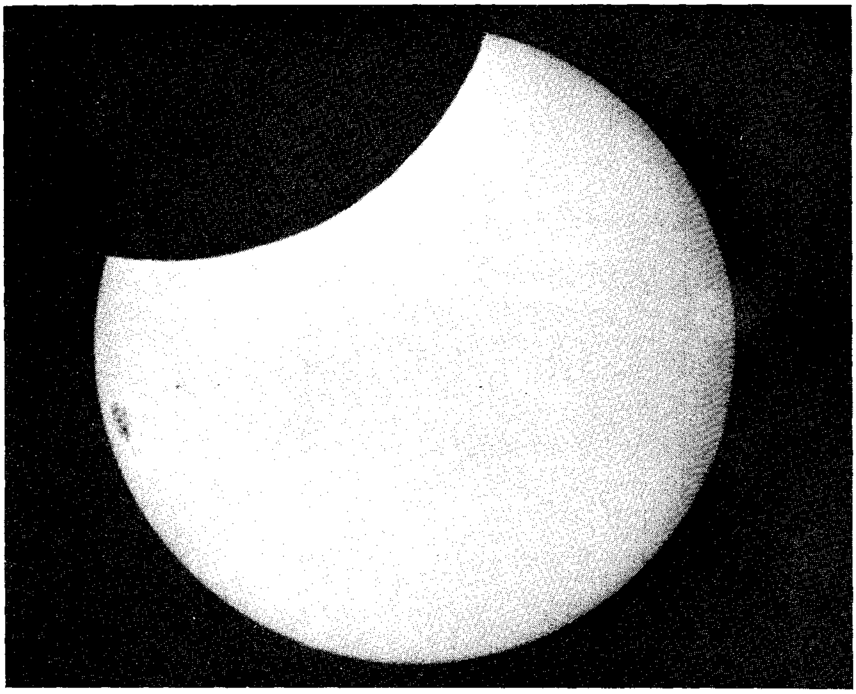

The partial solar eclipse of March 7th, 1989, was widely viewed from the United States and Canada. A.L.P.O. Solar Recorder Paul Maxson's observations of this event are reported on pages 122-123 of this issue. He took the photograph to the left at 17h 50m Universal Time on that date, at Phoenix, Arizona, using a 10-inch (25-cm.) Newtonian reflector stopped down to 6 inches (15 cm.) aperture, with Solar Skreen and Wratten 47 (blue) filters. North is to the top and the Moon's limb to the upper left. On the Sun's left (celestial east) limb is the large sunspot group SESC 5395.

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c/o Dr. John E. Westfall, Director/Editor

Membership Secretary, Harry D. Jamieson
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IN THIS ISSUE

THE APPARITION OF COMET BRADFIELD 1987S

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

ABSTRACT

This report examines the 1987-1988 passage of Comet Bradfield 1987s (also 1987 XXIX), covering the discovery, orbit, observing conditions, magnitude, coma size, and tail length. The majority of data used with the report was submitted by A.L.P.O. members.

DISCOVERY

William A. Bradfield of Dernancourt, near Adelaide, Australia, discovered this comet on Tuesday evening (local time), 1987 AUG 11.437 U.T. [This comet is also designated based on order of discovery as "1987s" and on order of perihelion passage as "1987 XXIX."] He reported the comet as magnitude 10, at right ascension 14h 10.5m, declination -23° 21' (1950.0 coordinates). International Astronomical Union *Circular 4431*, which reported the find, stated that this was William Bradfield's thirteenth comet discovery, and that he is "..the first person to find more than twelve comets during the present century." [*1*]

Bradfield had searched for 307 hours since his last previous find in January, 1984, the third largest number of hours that he had taken to find a comet, and his longest time period (3.7 years) between comets. During the 1970's, he averaged a comet a year, finding two annually on four occasions. Through the discovery of 1987s, he had spent 2287 hours for 13 comets, or 176 hours each. All of Bradfield's comets were found south of the celestial equator, and all bear his name alone.

This comet was found with his 6-inch (15-cm.) f/5.5 refractor, with a 26-power eyepiece giving a 2°.2 field. Eleven of his comets have been discovered with this instrument, while one was found with a 10-inch (25-cm.) reflector, and one with 7X35mm binoculars.

On the evening of the discovery, the Moon was only 2.0 days past full. Usually, comet hunters will wait another day before starting evening sky sweeps, which will give them over an hour of dark sky before moonrise. Bradfield discusses this point in his description of the discovery:

> "For my forward planning on comet hunting sessions I had figured that my first evening opportunity for August, after Full Moon, was August 11th with about 46 minutes of dark sky viewing possible between astronomical twilight and moon rise. Although the following nights with longer viewing times were more attractive for a drive out into the country, I found out on August 11 that the weather forecast predicted several days of cloudy weather. The evening of August 11 was fine and clear so I decided to make use of the brief spell of suitable conditions." [*2*]

Bradfield drove 35 miles to a location north of the large city of Adelaide. Sweeping started near the end of astronomical twilight and included parts of the constellations Virgo, Libra, and Hydra. He continues:

> "At 8 PM when the moon started to rise above the eastern horizon I decided to make a few more sweeps before ceasing operations. Then suddenly I detected a comet [-appearing object] in Hydra. I watched the field for an hour despite bright moonlight for signs of comet motion, but I could not be certain that movement had finally occurred, because some of the nearby faint stars which I had been using as marker stars were lost in the moonlight." [*2*]

No comet hunter wants to report an object that is not a comet; Bradfield had a tough decision to make. This part of the sky is visible to northern-hemisphere observers, and, if it were a comet, comet hunters there would possibly pick it up in a matter of days. Meanwhile, Bradfield was expecting cloudy weather where he lived. Additionally, this was a fuzzy object where none is plotted on the star maps, so the evidence and conditions suggested that this was a comet and that it should be reported. On the other hand, a comet must move in relation to the background stars; and the disappearance of faint stars near the object, due to the Moon rising and this part of the sky setting, made motion impossible to confirm. With all these ideas in mind, Bradfield reported the object to Dave Seargent, the Director of the Australian Comet Section. Seargent could pass the information on to other observers who could then be able to confirm the existence of the comet. This was done, and the new comet was spotted by others: Alan Gilmore of New Zealand, and Robert McNaught and T. Lovejoy of Australia. Being the nineteenth comet recovered or discovered in 1987, this comet was also designated 1987s.

This was the fourth amateur discovery of 1987, coming more than seven months after the last previous amateur find. The year 1987 turned out to have a large number of amateur-found comets; nine in all, two of them photographic finds. Bradfield himself went on to find his fourteenth comet on 1989 JAN 06.

Could the comet have been found sooner? For the previous ten days a bright Moon was in the evening sky. But in late July, 1987, the comet was within ten degrees southwest of its discovery position and "postdicted" to be of magnitude 10.0. From the mid-Northern Hemisphere it set about an hour after astronomical twilight ended; near the equator it was up for about four hours, and from the Southern Hemisphere this increased to nearly seven hours. Six weeks before discovery it was presumably about magnitude 11 and above the horizon for even longer periods of time. Why wasn't it found then?

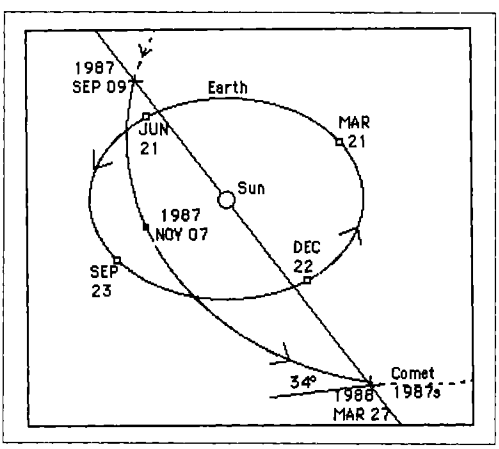
From the Northern Hemisphere, Comet Bradfield was low in the south and southwest. Northern comet hunters usually concentrate on areas north of the equator in the summer. I swept sections north of the comet myself, and on July 16 missed its location by about 8°. I'm not sure why southern-hemisphere hunters didn't find it then; July can have poor weather, and the southern sky is usually less well covered than the northern. Also, it is possible that the comet remained quite faint, brightening rapidly before discovery.

Orbit

An early orbit was calculated by Dan Green on 1987 AUG 14, and was not very different from the final orbit which was based on 326 observations. The latter was calculated by T. Kobayashi and was given in MPC (*Minor Planet Circular*) No. 13597. Their elements were (with the date given in Ephemeris Time):

Time of Perihelion..........1987 NOV 07.27405
Perihelion Distance.........0.8689556 A.U.
Argument of Perihelion..073°.91094
Ascending Node............. 267°.38478
Inclination...................... 034°.08791
Eccentricity.................... 0.9947452

Figure 1. Sketch of orbit of Comet Bradfield 1987s in relation to the Earth's orbit with selected dates indicated.



A sketch of this orbit is shown in *Figure 1* to the lower left. The shape of the orbit is very close to that of a parabola, and the comet has an orbital period of 2126 years. At perihelion the comet traveled at 28 miles per second (45 km./sec.). The perihelion distance of 0.87 A.U. was not unusual. Surprisingly, five of the ten comets found by amateurs near this time had perihelion distances between 0.84 and 0.92 A.U. [Note: "A.U." stands for *astronomical unit*; the mean distance of the Earth from the Sun, about 149,600,000 km. Ed.]

The comet-Earth distance at discovery, 1.52 A.U., decreased to a minimum of 0.84 A.U. in early December, before increasing again. The comet-Sun distance decreased from 1.68 A.U. at discovery to 0.87 A.U. on November 7th, and was 1.32 by the end of 1987. Comet 1987s crossed the ecliptic, passing northward, on 1987 SEP 09, and crossed it again moving south on 1988 MAR 27. Because the distance of the comet from the Sun on those dates was 1.33 A.U. and 2.40 A.U. respectively, there was no chance of the comet's leaving meteor-producing material.

After discovery, this comet continued to move northward in the evening sky, with its elongation from the Sun decreasing slowly from 81° at discovery to a minimum of 47° in late October, then increasing again. It dimmed below the reach of small telescopes by about mid-March, 1988. These circumstances allowed the Northern Hemisphere to witness the growth and development of this comet as it neared the Sun, followed by its diminishment as it pulled away from the Sun; all visible in the evening sky at reasonable solar elongations. Southern-hemisphere observers lost Comet Bradfield over their northern horizon in mid-November.

The comet passed near the globular cluster M10 on 1987 OCT 22, then entered the Milky Way and remaining in it for two months. On 1988 MAR 12, Comet Bradfield passed 2° south of the Pleiades star cluster, M45.

Magnitude

The favorable position of this comet resulted in many reports by A.L.P.O. comet observers. Gary Kronk, a veteran comet observer, author, and A.L.P.O. member, analyzed the magnitude data. He wrote, "..it is one of the smoother light curves that I have investigated during the last few years, with each bend being easily explained by variations in the comet-Earth-Sun geometry." [*3*]

Figures 2 and *3*, on page 99, were generated by Mr. Kronk. The first shows the *apparent* magnitude, corrected for aperture, as a function of the date of observation. We see that the comet was brightest near the date of perihelion (1987 NOV 07). It brightened rapidly to a smooth peak and then slowly declined.

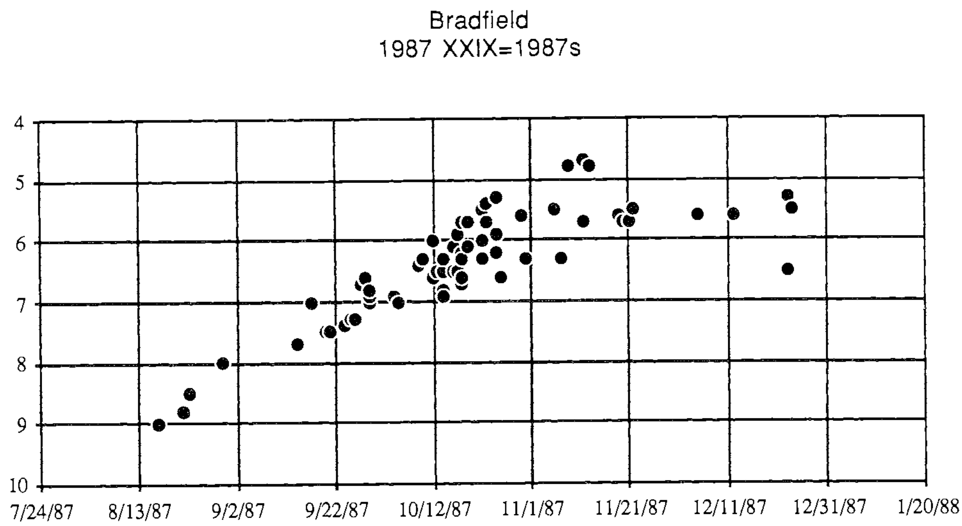


Figure 2. Graph of apparent stellar magnitude of Comet Bradfield as a function of date of observation, generated by Gary Kronk.

On the other hand, the *absolute* magnitude of a comet is its brightness at a standard distance of 1 A.U. from both the Earth and the Sun. Because a comet is hardly ever at that specific position, we transpose the following formula in order to calculate it:

$\mathbf{m} = \mathbf{H_o} + 5 \log \mathbf{D} + 2.5\, \mathbf{n} \log \mathbf{R}$, where:

m = apparent magnitude;
$\mathbf{H_o}$ = absolute magnitude;
D = Comet-Earth distance in A.U.;
R = Comet-Sun distance in A.U.;
n = a constant representing the rate of brightness change as the comet-Sun distance changes.

For Comet Bradfield, Gary Kronk determined an absolute magnitude of 5.86±0.05, with an **n**-value of 3.2. This absolute magnitude is about one magnitude brighter than the average comet, while the **n**-value is slightly lower than average for comets new to the inner Solar System, but is about average for comets that have been in this region before.

Figure 3, below, shows absolute magnitude versus date. The scatter is reasonably small, showing consistency among A.L.P.O. comet observers.

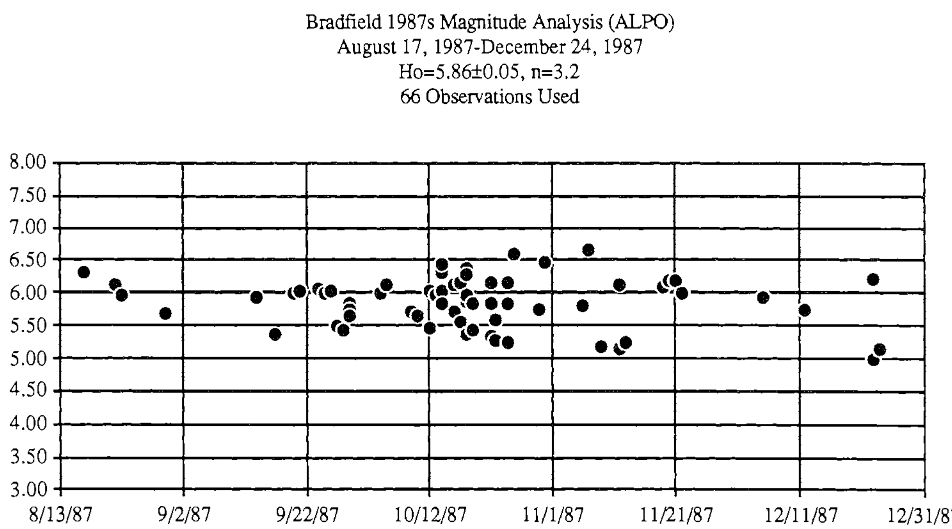


Figure 3. Graph of absolute stellar magnitude of Comet Bradfield as a function of date of observation, generated by Gary Kronk.

Coma Size

Another property of Comet Bradfield that was observed was the apparent size of the coma, or head of the comet. This consists of the thin atmosphere that surrounds the tiny nucleus, which itself is usually not observable and only 5 to 15 miles (8 to 24 km.) across. From the Earth, observers measure the angle that the round coma subtends. This usually ranges from 1 to 10 arc-minutes, and depends upon the comet-Earth distance, along with the observer's eyes, skies, and instrument.

Figure 4, below, shows the coma's actual size in units of thousands of kilometers (denoted by an "O"), compared to the date. We see a fair amount of scatter, but the size of the coma appears to hover near 260,000 kilometers (160,000 mi.) in diameter.

Tail Length

Tail length is difficult to measure because a comet's tail is rather tenuous and it is not always easy to determine the end of the tail. Moreover, in the case of Comet Bradfield, the Milky Way background reduced contrast and made tail measurement even more difficult than usual. *Figure 5* (bottom of page) shows the actual length of the tail in units of millions of kilometers (symbolized by "O") versus date. We see that a tail length of 6 million kilometers (about 4 million mi.) was not uncommon.

Appearance

Arriving less than two years after Halley's Comet, Comet Bradfield was impressive enough to be compared favorably with the well-known periodic visitor. A.L.P.O. members were generous in their comments. Two of our members, Paul Camilleri of Australia and Kermit Rhea of Arkansas, explicitly commented on the similarities between Comets Bradfield and Halley.

Artist Edwin Faughn was struck by the "..beautiful long tail structure and the fact so many bright stars were clearly visible through the tail." [*4*] A colored drawing by him of Comet Bradfield is reproduced in black-and-white as *Figure 6* (p. 101).

Kermit Rhea noted a bright arc in the tail of at least one-half degree in length on 1987 NOV 20. In December, he reported a bluish coma. Rhea, as did other observers, described it as a "classic comet," visible to the naked eye for several weeks.

Daniel Louderback of South Bend, Washington, mentioned the sparkling "stardust" appearance of the region between the coma and the tail.

```
640+      +      +      +      +      +      +      +      +      +640
576+      +      +      +      +   O  +      +      +      +      +576
512+      +      +      +      +  O   +      +      +      +      +512
448+      +      +      +      +      +      +      +      +      +448
384+      +      +      +      +OO    +      +      O      +      +384
320+      +O     +     O+ OOO  +  OO  +      +      +      +      +320
256+      +      +     OOOO   OO     +O      +      +      +      +256
192+      + O    +     OO     OOO    + O OOO        O      +      +192
128+      + O   O+      +      +   OOO       +      +      +      +128
 64+      +     O+      +      +      +      +      +      +      + 64
  0+      +      +      +      +      +      +      +      +      + 00
 07/24  08/13  09/02  09/22  10/12  11/01  11/21  12/11  12/31  01/20
```

Figure 4. Actual coma diameter of Comet Bradfield. The diameter, plotted vertically, is in units of thousands of kilometers. The dates, plotted horizontally, are for 1987/88.

```
8.8+      +      +      +      + O    +      +      +      +      +8.8
8.0+      +      +      +      +      +      +      +      +      +8.0
7.2+      +      +      +      +      +      +      +      +      +7.2
6.4+      +      +      +      +OO    +      +      +      +      +6.4
5.6+      +      +     O+      + O    +      +      +      +      +5.6
4.8+      +      +      +      +OO    +      +      +      +      +4.8
4.0+      +      +      +O    OOOOOO  + O    +      +      +      +4.0
3.2+      +      +      +O     + O    + O    +      +     O+      +3.2
2.4+      +      +      +      O     +OO    OO      O      +      +2.4
1.6+      +      +      +      OOOO   +      OO     +      +      +1.6
0.8+      +      +     OO     O+ O   +O      +      +      +      +0.8
0.0+      +      +      +      +      +      +      +      +      +0.0
 07/24  08/13  09/02  09/22  10/12  11/01  11/21  12/11  12/31  01/20
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Figure 5. Actual tail length of Comet Bradfield. The length, plotted vertically, is in units of millions of kilometers. The dates, plotted horizontally, are for 1987/88.

Bennett Copeland of Surrency, Georgia, noting the large coma and long tail, had difficulty in discerning the separate gas and dust components of the tail. He was not alone. Although photographs showed the two distinct tails, visual observations of them were rare, with only M. Clark of Western Australia reporting tail streamers, in this case on 1987 NOV 08. Two-color photographs by James Melka showing the two tails are given here as *Figures* 7 and 8 (p. 102).

Veteran comet observer David Seargent of The Entrance, New South Wales, Australia, described the tail as being fan-shaped in mid-October. Andrew Pearce, also of Australia, suggested that the tail subtended an angle of 20-30° on 1987 OCT 17.

Peter Williams of Heathcote, New South Wales, Australia, pointed out that the coma consisted of three parts: a dim portion 4 arc-minutes in diameter, an inner 3 arc-minutes appearing much brighter, and a star-like center.

Finally, Robert Modic of Richmond Heights, Ohio, reported a stellar central condensation under high magnification.

THANKS

A.L.P.O. comet observers sent in several dozen visual observations, drawings, and photographs, which made this report possible. We extend our thanks to those mentioned above for contributing their observations. Many thanks also to: Karl and Wanda Simmons, Gary Kronk, and Frank Melillo.

REFERENCES

1. Central Bureau for Astronomical Telegrams. *International Astronomical Union Circular No. 4431*, issued 1987 AUG 12 by Brian Marsden.

2. Private Communication, 1987 SEP 18.

3. Private Communication, 1989 JAN 31.

4. Private Communication, 1989 FEB 09.

Figure 6. Drawing of Comet Bradfield by Edwin Faughn. 1987 NOV 21, *ca.* 02h 30m U.T. Composite view using 8.1-cm. refractor, 10X50 binoculars, and 15-cm. reflector.

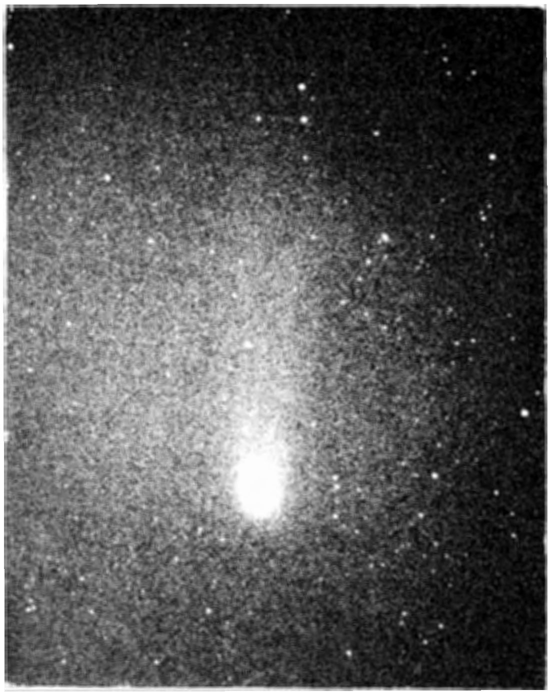

Figure 7. Photograph of Comet Bradfield taken on 1987 NOV 22 at 00h 28m U.T. by James Melka. Taken with 3M1000 film at the prime focus of an 8-inch (20-cm.) f/5 reflector. 2.0 minutes exposure, guided with a 2.25-inch (57 mm) refractor. The star field is in Aquila and the field of view is approximately 1°.3 X 2°.0. Celestial north is to the upper right. Copied from the original color slide with a blue W47 Filter in order to accentuate the gas tail which is narrow, long, and asymmetrical. Compare with *Figure 8* below.

Figure 8. The same photograph as *Figure 7* above, but copied with a red W92 Filter, highlighting the dust tail, which is wide, short, and symmetrical when compared with the gas tail.

THE 1986-87 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 carried out by A.L.P.O. Saturn Section observers between 1987 FEB 07 and 1987 OCT 18. Saturn showed about the same level of atmospheric activity in 1986-87 as was apparent in 1985-85. Observer participation and the incidence of simultaneous observations increased for the latter apparition. A few persons made central meridian transit timings for atmospheric detail, but none of the features persisted long enough for confirmation or for reliable rotation rates to be found. The northerly inclination of the ring plane, reaching +26°.812 during this period, exposed the Northern Hemisphere of Saturn's globe and the northern face of its Ring System. The text is accompanied by tables, graphs, and references.

INTRODUCTION

A very fine collection of visual and photographic observations of the planet Saturn and its Ring System was gathered during the 1986-87 Apparition. These observations, made between 1987 FEB 07 and 1987 OCT 18 U.T., constitute the basis of this analytical report. ["U.T." indicates Universal Time, which is used throughout this report.]

Table 1, below, gives pertinent geocentric data for the 1986-87 Apparition of Saturn. Note that the saturnicentric latitude of the Earth, **B**, which is referred to the ring plane and positive when north, varied from +26°.445 on 1987 MAY 15 to +26°.812 on 1987 OCT 18, while the saturnicentric latitude of the Sun, **B**', ranged from +26°.372 on 1987 FEB 07 to +26°.735 on 1987 OCT 18.

Table 1. Geocentric Phenomena for Saturn in the 1986-87 Apparition.

Conjunction	1986 DEC 04, 16^h
Opposition	1987 JUN 09, 05
Conjunction	1987 DEC 16, 03

Opposition Data:

Visual Magnitude	+0.0
B	+26°.448
B'	+26°.611
Declination of Saturn	-21°.282
Globe Diameter: Equatorial	18".36
Polar	16".77
Rings: Major Axis	41".64
Minor Axis	18".55

Table 2, to the right, lists the 19 persons who submitted observations to the A.L.P.O. Saturn Section for the 1986-87 Apparition, together with their observing sites, number of observations, and descriptions of their telescopes. A total of 205 observations were submitted for the apparition.

Table 2. Contributing Observers, 1986-87 Apparition of Saturn.

Observer & Location	No. of Obser.	Telescope Data*
Michael Andrews Essex, England	3	25.4cm (10.0in) NEW
Julius L. Benton, Jr. Wilmington Island, GA	33	15.2cm (6.0in) REFR
Paul H. Bock Sterling, VA	4	8.0cm (3.1in) REFR
Jean Bourgeois Pic du Midi, France	4	105cm (41.3in) NEW
Julian Davies South Wales, U.K.	1	15.2cm (6.0in) NEW
Donald E. DeKarskie Colorado Springs, CO	6	10.2cm (4.0in) REFR
Marc Gelinas Quebec, Canada	3	15.2cm (6.0 in) REFR
David L. Graham N. Yorkshire, England	19	15.2cm (6.0in) REFR
Francis G. Graham Pittsburgh, PA	1	20.3cm (8.0in) NEW
Peter Grego Winchester, England	3	15.2cm (6.0in) NEW
Walter H. Haas Las Cruces, NM	30	31.8cm (12.5in) NEW; 20.3cm (8.0in) NEW
Charles Haun Morristown, TN	49	33.3cm (13.1in) NEW
Alan W. Heath Nottingham, England	9	30.5cm (12.0in) NEW
Daniel Louderback South Bend, WA	2	20.3cm (8.0in) NEW
Frank Melillo North Valley Stream, NY	4	20.3cm (8.0in) S-C
Gary Nowak Williston, VT	5	22.9cm (9.0in) REFR
Ian Phelps Warrington, England	4	11.4cm (4.5in) NEW
Michael E. Sweetman Tucson, AZ	18	26.2cm (10.3in) CASS; 10.2cm (4.0in) REFR
Simon Taylor Brierly Hill, England	7	11.4cm (4.5in) NEW
Total Observations	*205*	
Total Observers	*19*	

[over]

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

Figure 9, below, gives the distribution of observations by month, showing that most of the observations were made for the months of April through September, 1987 (91.3 percent). There was a perceptible decline in the number of observations on either side of this peak period. Note in *Figure 10* (below *Figure 9*) that 35.6 percent of the observations were made before opposition (1987 JUN 09), 0.5 percent on that date, and 63.9 percent after that date. As usual, the maximum coverage was near or slightly after the time of opposition. We therefore encourage observers to try to monitor Saturn throughout its apparitions, starting as soon after, and ending as soon before, conjunction as possible.

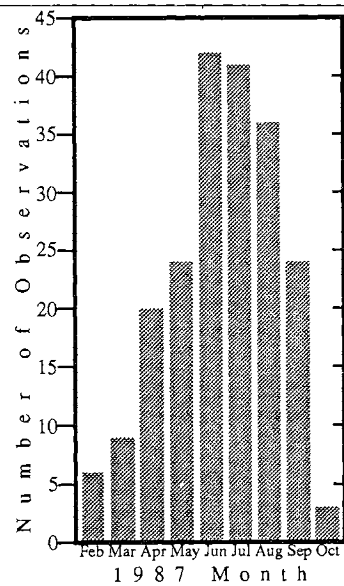

Figure 9. Distribution of observations of Saturn by month during the 1986-87 Apparition (205 observations total).

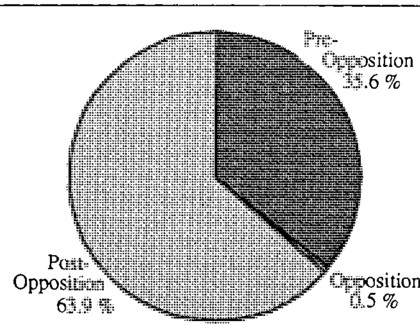

Figure 10. Distribution of observations of Saturn for the 1986-87 Apparition in relation to opposition date.

Figures 11 and *12*, below, show that the observer base for this apparition report was truly international in character, with almost half the observers residing outside the United States. However, three-quarters of the observations were made within that country.

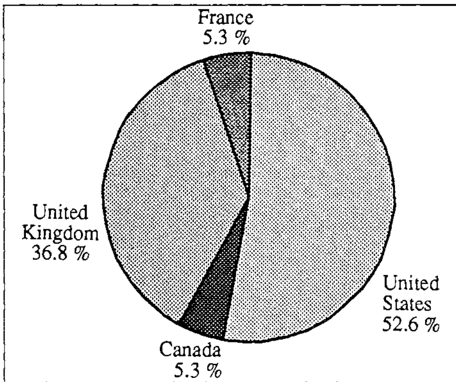

Figure 11. Distribution of observers by location by country for the 1986-87 Saturn Apparition.

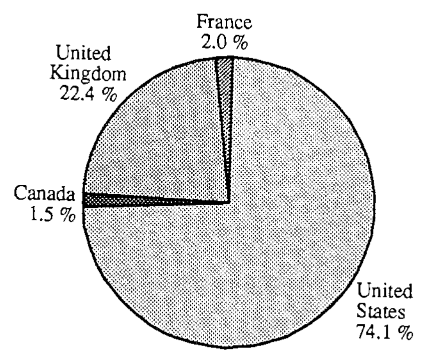

Figure 12. Distribution of observations by location by country of observer for the 1986-87 Saturn Apparition.

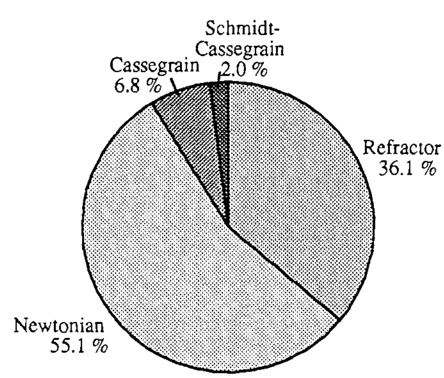

Figure 13. Distribution of 1986-87 Saturn Apparition observations by type of telescope.

Figure 13 (p. 104) shows that telescopes of classical design—refractors and Newtonian reflectors—dominated the scene in 1986-87 as in the immediately preceding apparitions. This was due chiefly to their overall soundness of design and consistent favorable performance with respect to image resolution and contrast. In terms of aperture, 88 percent of the observations were made with telescopes of 15.2 cm. (6.0 in.) or greater.

Seeing conditions during the 1986-87 Saturn Apparition averaged about 5.0 on the A.L.P.O. seeing scale, where 0 represents the worst possible seeing and 10 is used to record perfect seeing. Atmospheric transparency, defined as the magnitude of the faintest star visible near Saturn to the unaided dark-adapted eye, averaged about +4.0 for this observing season.

This writer here expresses his sincere gratitude to all the dedicated colleagues who are mentioned in this report and who carried out their observations as part of the A.L.P.O. Saturn Section. He heartily invites individuals throughout the world to continue working with us in the coming observing seasons. Efforts are now underway to encourage and coordinate intensified and more comprehensive coverage of Saturn in future apparitions. The cooperation of the A.L.P.O. with such groups as the British Astronomical Association and the Royal Astronomical Society of Canada has begun, and we have now broadened our horizons to include Australia, Belgium, Germany, Hungary, and Spain. We are attempting to establish and maintain an ever-growing international observer base in the coming years. The interested reader, regardless of experience, is encouraged to join us.

THE GLOBE OF SATURN

This description has been derived from an analysis of the reports contributed to the A.L.P.O. Saturn Section throughout the 1986-87 Apparition. For the sake of brevity, the names of observers are not given except when the identity of an individual is pertinent to the discussion. We encourage readers to refer to the numerical tables that accompany the discussion. The features of the Globe are discussed in north-to-south order, and can be identified in the nomenclature diagram in *Figure 14* (p. 106). Southern-hemisphere features are not described because most of that region was hidden from view by the Ring System during the 1986-87 Apparition.

Northern Portions of the Globe.—The Northern Hemisphere of Saturn showed limited activity during this observing season, and it is evident that there was about the same frequency of recurrent local phenomena as in the immediately preceding apparition. The detail recorded in Saturn's Northern Hemisphere was often poorly defined and usually ephemeral in 1986-87, but there were a few cases when discrete features could be seen without much difficulty. These were located in the North Temperate Belt (NTeB), North Tropical Zone (NTrZ), North Equatorial Belt (NEB), North Equatorial Belt Zone (NEBZ), and Equatorial Zone (EZ).

The following summary of northern-hemisphere features compares data between apparitions, as has been done in previous Saturn observational reports. [4] This should help the reader to appreciate the subtle but recognizable variations that may be underway, both in terms of Saturn's seasons and for longer periods. It is often held that the changing tilt of Saturn's rotational axis with respect to the Sun and the Earth plays a significant role in any recorded fluctuations in the intensities of the belts and zones, which are given in *Table 3* (p. 108).

North Polar Region (NPR).—The brightness of the usually greyish NPR diminished slightly between 1985-86 and 1986-87, with an apparent intensity decrease of -0.6. This is expressed on the A.L.P.O. intensity scale, which ranges from 0.0 for complete black to 10.0 for the brightest possible white. The intensity of the NPR was mostly uniform except for a few localized mottlings and a barely discernible light dusky greyish-yellow North Polar Cap (NPC). As in 1985-86, the NPC was just a little lighter than the surrounding NPR in the 1986-87 period. The North Polar Belt (NPB), usually seen encircling the NPR, was not reported in 1986-87. No truly abnormal activity was noticed in association with any of these polar features in the latter period.

North North North Temperate Belt (NNNTeB).—This rarely seen globe feature was described in 1986-87 as a light brownish-grey diffuse linear band, seen only at times of excellent seeing with large apertures. The NNNTeB was rather similar to the Equatorial Band (EB) in 1986-87, both in intensity and in overall appearance.

North North Temperate Zone (NNTeZ).– The NNTeZ was sighted rarely in 1986-87, and seen as a light yellowish-white region, uniform in intensity from limb to limb.

North North Temperate Belt (NNTeB).— During the 1986-87 Apparition, the NNTeB was described as a thin, continuous linear feature, dusky yellowish-grey in hue, and devoid of detail or intensity variations across the Globe.

North Temperate Zone (NTeZ).—Observers sighted the dusky yellowish-grey NTeZ throughout 1986-87 as a fairly distinct zone. It showed occasional mottling or subtle intensity differences, but these were largely transient in nature and quite ill-defined. The NTeZ, with the exception of the NEBZ, was the darkest

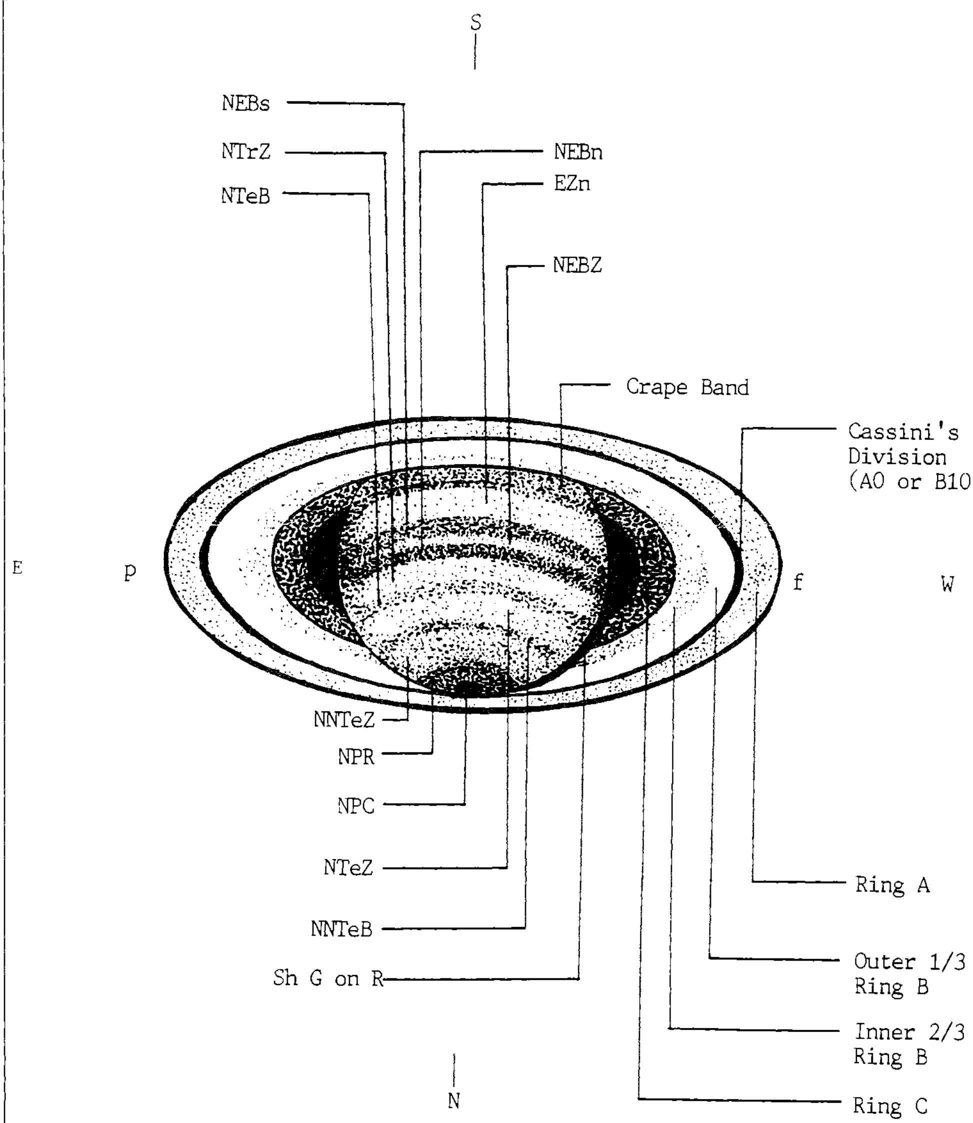

Figure 14. The general appearance of Saturn near opposition (1987 JUN 09), with nomenclature of the principal Globe and Ring features that were easily detected with moderate apertures in good seeing. South is at the top and global features move across the planet from right to left in this normal inverted view (i.e., as seen in an astronomical telescope 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 their celestial sense; in the International Astronomical Union (IAU) convention, East would be to the left. The numerical value of **B** is about +27°. See the text for a discussion of the Globe and Ring features shown here. Some minor features that are not depicted include the: North Polar Belt (NPB), encircling the NPR; 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 intensity minima in several Ring components, mentioned in the text. The easternmost and westernmost extensions of the Rings are called the ansae. "p" stands for preceding and "f" for following.

and the most difficult-to-perceive zone in Saturn's Northern Hemisphere.

North Temperate Belt (NTeB).—On several occasions, observers recorded a narrow, usually uniform, very dusky yellow to yellowish-grey NTeB extending from one limb to the other. This belt was slightly darker (-0.3 mean intensity points) in 1986-87 as compared with 1985-86. A rather obvious but unconfirmed condensation was reported by Haas on 1987 MAY 17 (09h 08m - 09h 50m U.T.); and even though the NTeB was the most active region on Saturn in 1986-87, no phenomena persisted long enough for transit timings across the CM (central meridian) to give rotation rates at that specific northern latitude.

North Tropical Zone (NTrZ).—The NTrZ in 1986-87 showed an increase in brightness (by +0.5 mean intensity points) since the immediately preceding observing season. Observers assigned a yellowish-white color to the NTrZ in 1986-87, and the region was usually consistent in intensity from limb to limb through the apparition.

North Equatorial Belt (NEB).—The greyish-brown NEB was seen as a differentiated feature in 1986-87; divided into the NEBn (North Equatorial Belt, North Component) and NEBs (North Equatorial Belt, South Component), separated by the NEBZ (North Equatorial Belt Zone). This condition was fairly common during 1986-87; however, the NEB was also seen as a single feature about as often as its multiple aspect was noted. As a whole, the NEB was equal in intensity to what it had been in 1985-86.

The greyish-brown NEBs was the darkest belt on the Globe of Saturn in 1986-87, as had been the situation in 1985-86 and for several other recent apparitions. However, compared with 1985-86, the NEBs had brightened by +0.8 mean intensity points by 1986-87. This belt component was slightly diffuse at its edges and exhibited a mainly uniform overall intensity across the Globe for much of the 1986-87 period. Nonetheless, several diffuse and vague features were seen in it, but all were short-lived.

The dark greyish-brown NEBn also showed an increase in brightness of +0.8 mean intensity points between 1985-86 and 1986-87. Observers detected occasional discrete detail in the NEBn in 1986-87, although these did not persist long enough for central meridian transit timings.

The NEBZ was yellowish-white during most of 1986-87 and had increased its brightness only slightly between 1985-86 and 1986-87 (+0.3 mean intensity points). It was similar in appearance to the NTeZ throughout the 1986-87 Apparition. The NEBZ had the distinction of being the darkest zone visible on the Globe of Saturn in 1986-87. Although this circumstance might mean that a zone was troublesome to see in contrast to its environment, particularly as the Globe north of the Rings was actually brighter than the NEBZ, the location of the NEBZ between the dark NEBs and NEBn made it possible to recognize the zone. Some very subtle festoon activity was seen on rare occasions in the NEBZ in 1986-87, but the zone remained uniform in intensity throughout most of the apparition.

Equatorial Zone (Chiefly the EZn).—The pale yellowish-white EZn (Equatorial Zone, North Component) was of nearly the same brightness in 1986-87 as it had been in 1985-86, brightening only by an insignificant +0.1 mean intensity points. The EZn was the brightest global feature on Saturn during 1986-87; and indeed was brighter than any feature in the Saturn System except for Ring B and the contrast-induced Terby White Spot (TWS), also on the Rings. No definite features were sighted in the EZn during 1986-87 other than vague suspicions of a few whitish spots and wispy festoons that faded rapidly. The intensity of the EZn thus remained fairly constant during all of 1986-87.

The Equatorial Band (EB) was detected very infrequently during the apparition; and when seen to any advantage, the EB was yellowish-gray in hue, very narrow and often discontinuous along its linear extent across the Globe, and a little brighter than in the 1985-86 Apparition (by +0.8 mean intensity points).

Shadow of the Rings on the Globe (Sh R on G).—The shadow of the Rings on the Globe of Saturn was noted by observers throughout 1986-87 as a rather uniform greyish-black feature, of regular geometric form, and seen to advantage under good seeing conditions. It is known that poor seeing, inadequate aperture, or any other factors that reduce contrast or resolution, all conspire to render this shadow as something other than black.

Shadow of the Globe on the Rings (Sh G on R).—The shadow of the Globe on the Rings was seen in 1986-87 as a greyish-black feature, regular in form. Any deviation from the true black shadow condition could be attributed to poor seeing.

Latitudes of Saturn's Belts.—Benton and Haas were the only observers to submit visual latitude estimates for features on the Globe of Saturn during the 1986-87 Apparition, using the method developed by Haas many years ago. They made estimates of the fraction of the polar semidiameter of the planet's disk that was subtended on the central meridian between the limb and the belt of interest. This method is easy to use, and the results compare well with similar values obtained by filar micrometer measurements. The results of the mathematical reduction of these estimates are given in *Table 4* (p. 109). In that table, *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 local surface normal and

[Text continued on p. 109.]

Table 3. Visual Numerical Intensity Estimates and Colors: Saturn, 1986-87.

Globe/Ring Feature	Relative Intensity (1986-87) Number of Estimates	Mean and Standard Deviation	Change Since 1985-86	"Mean" Derived Hue (1986-87)
ZONES:				
NPC	4	4.1 ±0.61	-0.6	Very dusky greyish-yellow
NPR	79	4.0 ±0.69	-0.4	Greyish
NNTeZ	6	6.1 ±0.53	--	Light yellowish-white
NTeZ	17	5.3 ±0.44	--	Dusky yellowish-grey
NTrZ	33	5.8 ±0.56	+0.5	Yellowish-white
NEBZ	12	5.1 ±0.42	+0.3	Yellowish-grey
EZn	72	6.7 ±0.45	+0.1	Pale yellowish-white
Globe North of Rings	45	5.4 ±0.46	+0.3	Dusky yellowish-grey
BELTS:				
NNNTeB	3	5.0 ±1.23	--	Light brownish-grey
NNTeB	6	4.7 ±0.41	--	Dusky yellowish-grey
NTeB	25	4.4 ±0.48	-0.3	Very dusky yellowish-grey
NEB (entire)	44	3.8 ±0.63	0.0	Greyish-brown
NEBn	36	4.1 ±0.46	+0.8	Greyish-brown
NEBs	40	3.7 ±0.57	+0.8	Greyish-brown
EB	4	5.2 ±0.67	+0.8	Yellowish-grey
RINGS:				
Ring A (entire)	72	5.9 ±0.72	0.0	Dusky white
Ring A (outer half)	9	6.2 ±0.86	+0.1	Dusky white
Encke's Division (A5)	6	3.5 ±1.32	-0.3	Greyish
Intensity Minimum (A3)	1	5.0 ---	--	Light grey
Ring A (inner half)	9	6.5 ±0.22	+0.2	Pale dusky white
Cassini's Division (A0/B10)	77	0.9 ±0.48	+0.3	Greyish-black
Ring B				
Ring B (outer third)	STD	8.0 ---	--	White
Ring B (inner two-thirds)	59	6.9 ±0.64	+0.3	Yellow-white
Intensity Minima: B1	5	3.5 ±1.21	+0.7	Dark grey
B2	1	3.0 ---	+0.2	Dark grey
B3	1	5.8 ---	--	Light dusky grey
Ring C (ansae)	54	1.2 ±1.02	+0.6	Very dark greyish-black
Crape Band	70	2.1 ±1.14	-0.9	Very dark grey
Sh G on R	54	0.6 ±0.52	+0.1	Greyish-black
Sh R on G	7	1.0 ±1.09	-0.3	Greyish-black
TWS	15	7.4 ±0.22	+0.3	Pale yellowish-white

Notes: For nomenclature see text and *Figure 14* (p. 106). A letter with a digit (e.g., A3) 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 ("STD") 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 1985-86" is in the sense of the 1985-86 value subtracted from the 1986-87 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.

Table 4. Latitudes of the Belts of Saturn in the 1986-87 Apparition.

	Form of Latitude								
	Planetocentric			Eccentric			Planetographic		
Saturnian Belt **B** =	+26°	+27°	+26°.448	+26°	+27°	+26°.448	+26°	+27°	+26°.448
	°	°	°	°	°	°	°	°	°
South edge NPR	+80.8	+82.0	+81.3	+81.8	+82.8	+82.2	+82.6	+83.6	+83.0
Center NTeB	+38.7	+38.1	+38.4	+41.9	+41.2	+41.6	+45.2	+44.5	+44.9
South edge NEB	+23.3	+24.3	+23.7	+25.8	+26.8	+26.2	+28.4	+29.5	+28.9
North edge NEB	+14.8	+16.9	+15.7	+16.5	+18.8	+17.5	+18.4	+20.8	+19.5
Center EB	-07.4	-06.4	-07.0	-08.2	-07.2	-07.8	-09.2	-08.0	-09.6

[*Notes:* For nomenclature see text and *Figure 14* (p. 106). The three forms of latitude are defined on p. 107. The author has furnished belt latitudes based on planetocentric tilts (**B**) of +26° and +27°; the editor has linearly interpolated between these to obtain a value for **B** at the date of opposition (+26°.448 on 1987 JUN 09). *Ed.*]

[Text continued from p. 107.]

the equatorial plane; and *eccentric latitude* (or "mean" latitude) is the arctangent of the geometric mean of the tangents of the other two forms of latitude.

It must be stressed, though, that it is often risky to place too much confidence in data collected by only one or two observers; but Haas in particular has been using this technique for many years with usually reliable results. We strongly encourage other observers to use this procedure whenever it is possible, even if filar micrometers are available. Data from both visual estimates and micrometer measures would be useful for comparison. A full discussion of this technique is given in *The Saturn Handbook.* [**2**]

THE RING SYSTEM

This section covers the analysis of the observations of Saturn's Ring System that were submitted throughout the 1986-87 Apparition, together with a continuing comparative study of mean intensity data as has been done for previous apparitions. As remarked in the introduction, the northern face of the Rings was very accessible to our view during the 1986-87 observing season.

Ring A.—Considered as a whole. Ring A was dusky-white during 1986-87, maintaining the same mean intensity as in 1985-86. There were a few sightings of Encke's Division (A5) at the ring ansae with favorable seeing. Other than a single view of an intensity minimum at A3, there were no intensity variations noted in Ring A in 1986-87.

On fairly infrequent occasions in 1986-87, Ring A was described as having a distinct inner and outer half in terms of intensity, and the inner half of Ring A was pale dusky white and +0.3 mean intensity points brighter than was the dusky-white outer half. Similar impressions were reported in 1985-86. These two areas showed only insignificant increases in brightness between 1985-86 and 1986-87 (+0.2 and +0.1 mean intensity points respectively).

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 1986-87, the outer third of Ring B appeared white, stable in intensity, and the brightest feature on either Saturn's Globe or Rings.

The inner two-thirds of Ring B, chiefly yellow-white in hue, was +0.3 intensity points brighter in 1986-87 than in the 1985-86 period. It was usually uniform in intensity in 1986-87 except for rare sightings of intensity minima at B1, B2, and B3 (i.e., about 0.1, 0.2, and 0.3 of the distance between the inner [B0] and the outer [B10] edges of Ring B, respectively). These dark greyish intensity minima were seen at the ansae only and are characteristically impermanent, as was shown by the *Voyager* missions.

Cassini's Division (A0 or B10) was frequently and easily visible at the ansae, and under good seeing it was often seen all the way around the Ring System. Observers with even the smallest telescopes had no difficulty in seeing this classical feature in the 1986-87 Apparition. It had a dark greyish-black appearance although it appeared +0.3 mean intensity points brighter than it had in 1985-86.

Ring C.—Observers of Ring C in 1986-87 described this feature as fairly easy to see at the ansae, very dark greyish-black in hue, and lighter in appearance than in 1985-86 (by +0.6 mean intensity points). Note 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 1986-87.

The Crape Band, or Ring C as it passes in front of the Globe, was -0.9 mean intensity points darker in 1986-87 than in the immediately preceding apparition, and individuals described this feature as mostly uniform in intensity and very dark grey in color.

Ring Components Other than A, B, or C.—No indications of Ring D (inside Ring C) or Ring E (outside Ring A) were reported in 1986-87. Of course, these Ring components are exceedingly difficult to observe except under optimum conditions when using large apertures.

Terby White Spot (TBS).—Several observers recorded a pale yellowish-white, somewhat bright TBS during 1986-87. However, this feature, as in 1985-86, did not exhibit its characteristic dazzling brilliance as seen in much earlier apparitions. Nevertheless, it was the brightest feature in Saturn's Rings except for the outer third of Ring B. The TBS is most probably a contrast phenomenon and is not usually considered to be an important, nor intrinsic, saturnian feature. Even so, it would be interesting to investigate any correlation that might exist between the brilliance of the TBS and varying Ring inclinations.

Bicolored Aspect of the Rings.—Quite a few individuals attempted to observe the bicolored aspect of the Rings of Saturn, but only Haas was able to notice any difference between the brightnesses of the east and west ansae during 1986-87. (In Haas' report, *east* and *west* are used in the celestial sense, rather than that of the IAU.) He employed a W47 (Wratten 47 blue) Filter, a W25 (red) Filter, and integrated light (IL; no filter). Observing a total of 15 evenings, on 12 of them Haas recorded slight or suspected differences in brightness between the two ansae with the west ansa slightly brighter than the east in blue light. On one night (1987 JUN 17) the west ansa was distinctly brighter than the east in that wavelength range. However, on two other occasions, the east ansa appeared slightly brighter than the west ansa, when using the W25 Filter. On one evening, 1987 APR 16, the west ansa was brighter than the east ansa in both blue and red wavelengths. In 1986-87, no difference whatever could be detected in integrated light, and variations were noted only rarely with the W25 Filter.

In most cases, observing conditions were mediocre when slight or inconsistent differences were suspected. Even on 1987 JUN 17, when the brightness difference was definite, the seeing and transparency were only fair. The circumstances of Haas' observations are listed on *Table 5* (p. 111).

The writer cannot stress strongly enough the critical need for individuals to participate in a simultaneous observing program which emphasizes, among other endeavors when viewing Saturn, a meaningful investigation of the bicolored aspect of Saturn's Rings. Systematic filter observations, both visual and photographic, should help shed light on this curious phenomenon, which has been reported for decades.

SATURN'S SATELLITES

A handful of observers submitted reports in 1986-87 of seeing Saturn's brighter satellites, plotting their positions relative to the planet. No systematic program of magnitude estimation, or any other study of the satellites, was carried out during the apparition. We encourage our regular observers to pursue investigations of Saturn's satellites in future apparitions, using filter techniques and undertaking magnitude estimates. Information for undertaking such projects can be found in the *Saturn Handbook*. [**2**]

SIMULTANEOUS OBSERVATIONS

The more thorough coverage of Saturn by A.L.P.O. Saturn Section participants in 1986-87 generated several bona fide simultaneous observations of the planet. We define a simultaneous observation as simultaneous telescopic work by two or more independent observers. If individuals carried out all of the routine programs discussed in this report, there would be a greater chance for observers to draw and make intensity estimates of Saturn at the same time. We are seeking to establish simultaneous observations of Saturn as the rule rather than to rely on chance occurrence of such corroborating work. Thus all observers are encouraged strongly to participate in our simultaneous program.

During 1986-87, simultaneous observations provided limited confirmation of the appearance of Saturn, but most of the simultaneous reports did not contain the standardized content needed for successful comparative analysis. Readers interested in how we carry out simultaneous studies of Saturn should contact the writer for specific instructions, schedules, and standardized methodology. Variable phenomena in the atmosphere of Saturn and in the Rings can be objectively evaluated by such work, and the importance of these endeavors cannot be stressed enough.

CONCLUSIONS

Participants in the A.L.P.O. Saturn Section programs followed the planet reasonably well during 1986-87, and an increase of observer interest and in the number of observations submitted was noted in comparison with 1985-86. Most individuals remarked that, despite the southerly declination of Saturn in 1986-87 (making the planet low in the sky in the Northern Hemisphere), the planet still displayed a reasonable level of interesting phenomena for systematic investigation.

With Saturn's Rings open nearly to their fullest extent in recent years, and with the north face of the Rings and the Northern Hemisphere of the Globe available to good observational advantage, astronomers should not miss these opportunities for meaningful research. Routine observations have included full-disk drawings of Saturn, visual numerical relative intensity estimates of Globe and Ring features, and various colorimetric studies. Areas needing much more concentration, without neglecting the previous projects, include studies of the curious bicolored aspect of the Rings, central meridian (CM) transit timings of any global phenomena, visual estimates or filar micrometer measurements of belt latitudes, and studies of Saturn's satellites.

Our goal is to continue to increase observational coverage throughout the whole of any given apparition, spread emphasis to all Saturn programs, increase the incidence of simultaneous observations, and to intensify our expansion of observer participation internationally.

This writer wishes here to convey his sincerest gratitude to everyone mentioned in this summary of the 1986-87 Apparition for their lasting interest and their participation in our programs. New observers of Saturn, as well as some of those who might have drifted away from regular participation, are welcome and are encouraged to join us in our research in the coming apparitions.

References

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3. _________. "The 1985-86 Apparition of Saturn: Visual and Photographic Observations." *J.A.L.P.O. 32*, Nos. 9-10 (Aug. 1988), pp. 197-208.
4. U.S. Naval Observatory. *The Astronomical Almanac.* Washington, DC: U.S. Government Printing Office. (Annual publication; the 1986 and 1987 editions were used, published in 1985 and 1986, respectively.)

Table 5. Observations by Haas of the Bicolored Aspect of Saturn's Rings in 1986-87.

1987 U.T. Date and Time	Telescope Aperture	Telescope Magnif.	Seeing	Transparency	Filtration IL	Filtration W47	Filtration W25
APR 16 10h 32m - 10h 36m	31.8cm (12.5in)	303X	3.0	4.0	W=E	W>E	W>E
MAY 10 08h 13m - 08h 17m	31.8cm (12.5in)	366X	4.0	4.5	W=E	W>E	W=E
MAY 14 10h 11m - 10h 15m	31.8cm (12.5in)	321X	4.0	3.0	W=E	W>E	W=E
MAY 17 08h 53m - 08h 58m	31.8cm (12.5in)	366X	3.5	4.0	W=E	W>E	W=E
MAY 30 05h 11m - 05h 16m	31.8cm (12.5in)	303X	3.0	3.5	W=E	W>E	W=E
JUN 10 04h 53m - 04h 56m	20.3cm (8.0in)	231X	4.0	4.0	W=E	W>E	W=E
JUN 17 05h 11m - 05h 14m	31.8cm (12.5in)	303X	3.0	4.0	W=E	W>E	W=E
JUN 22 04h 50m - 04h 54m	31.8cm (12.5in)	303X	3.0	3.5	W=E	W>E	W=E
JUN 29 04h 40m - 04h 44m	31.8cm (12.5in)	366X	4.0	3.0	W=E	E>W	W=E
JUL 06 04h 49m - 04h 54m	20.3cm (8.0in)	321X	4.0	4.5	W=E	W>E	W=E
AUG 12 02h 55m - 03h 01m	31.8cm (12.5in)	366X	4.0	4.0	W=E	W>E	W=E
AUG 17 04h 14m - 04h 18m	20.3cm (8.0in)	231X	4.0	3.5	W=E	W>E	W=E
AUG 27 02h 22m - 02h 27m	31.8cm (12.5in)	321X	3.5	4.0	W=E	W>E	W=E
SEP 17 01h 49m - 01h 57m	31.8cm (12.5in)	321X	3.0	4.0	W=E	W>E	W=E
OCT 09 01h 28m - 01h 32m	31.8cm (12.5in)	321X	2.0	3.5	W=E	E>W	W=E

Notes: U.T. is Universal Time. On a few occasions, Haas checked Saturn again later in the same observing session, but the results were unchanged from the previous observation. ">" here indicates "brighter than." Both telescopes were Newtonians. Seeing is on the A.L.P.O. Scale ranging from 0 for worst possible to 10 for perfect. Transparency is defined as the magnitude of the faintest star visible with the naked eye near Saturn.

No drawings or photographs accompany the above article because the original manuscript and illustrations were lost in the mail; the text could be restored but not the drawings and photographs. ***We urge all persons submitting materials to the editor to retain copies of the text and all illustrations; thus, if there is a postal mishap, nothing unique will be lost.***

THIRTY YEARS OF LUNAR ECLIPSE UMBRAE: 1956-1985

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

ABSTRACT

The table that forms the bulk of this report summarizes the apparent lunar stellar magnitude, Danjon Luminosity, and enlargement of the umbra for 30 partial and total lunar eclipses that took place between 1956 and 1985, inclusive. The sources, quality, and extent of the information differ considerably from eclipse to eclipse. For nine of these eclipses, contact times have been computed expressly for this report.

INTRODUCTION

The heart of this report is *Table 3* (pp. 114-117); a summary of the Danjon Luminosity, magnitude, and umbral enlargement for 30 partial and total lunar eclipses that occurred between 1956 and 1985, inclusive. The completeness of this information varies greatly from eclipse to eclipse, depending on: whether the eclipse was partial or total, where on the Earth the eclipse was best seen, the weather in that zone, and how well the eclipse was reported.

In these eclipses, the Earth's umbral shadow fell upon part or all of the Moon. If the Earth had no atmosphere, this portion of the Earth's shadow would be almost completely black and its diameter could be found accurately by simple geometry. Actually, refraction and scattering of sunlight in the Earth's atmosphere make the umbra larger and its interior brighter than would be the case if the Earth were airless. In addition, the brightness of the umbral interior and the actual extent of the umbra differ between eclipses. Because each umbral lunar eclipse is unique, we feel it important to summarize and preserve those numerical measurements of the umbra that have been made.

In *Table 3*, the first four items given are ephemeris values, rather than observational data. The "Oppolzer Eclipse Number" is the sequential number given in: Theodor Ritter von Oppolzer, *Canon of Eclipses* (translated by Owen Gingerich; New York: Dover Publications, Inc., 1962).

The umbral magnitude is equal, at mid-eclipse, to the distance from the Moon's limb that is nearest to the shadow center to the closer edge of the umbra, divided by the Moon's apparent diameter; thus magnitudes 1.000 or over denote total eclipses, and those between 0.000 and 1.000, partial eclipses. "N" and "S" show whether the entire Moon passed north or south of the umbral center, while "C" is used if the shadow center fell upon the Moon.

The stellar magnitudes are visual magnitudes at or near mid-eclipse, and are estimated by various means. The "naked-eye" estimates involve comparing the Moon with bright stars or planets by out-of-focus images, reflections in convex mirrors, or reversed binoculars. The few photographic or photoelectric measures ("Photo.") also involve comparison stars. When a naked-eye magnitude is given in parentheses, it was estimated indirectly from the Danjon Luminosity (see below) using the linear regression model based on 14 eclipses:

$$V = (+2.87 \pm 0.61) - (1.852 \pm .279)\mathbf{L},$$

where **V** is the estimated visual magnitude and **L** is the Danjon Luminosity (see below). This model gave a correlation coefficient of -0.8864 between visual magnitude and Danjon Luminosity; 0.0000 would mean no relationship and -1.0000 would imply a perfect inverse relationship. The standard error of estimate of the above model was ±1.04 magnitudes. (Throughout this report, the ± symbol indicates the standard error of estimate.) The uncertainties given for such estimates are statistical uncertainties only, and do not include nonlinearity in the model or error in the **L**-value itself.

Throughout *Table 3*, the number of observations, when known, is given in parentheses. When more than two individual observations are available, the standard error of the mean is given along with the umbral statistic itself. Unfortunately, some of the sources give "mean deviations" or totally unidentifiable uncertainty ranges.

The "Danjon Luminosity" (**L**) is a scale of subjective evaluation of the Moon's overall brightness at mid-eclipse, ranging from **L** = 0 for extremely dark eclipses to **L** = 4 for extremely bright events. It should be used for total eclipses only. (For more information on Danjon Luminosity, see *J.A.L.P.O., 33*, Nos. 1-3 [Jan., 1989], pp. 33-34.)

The apparent enlargement of the umbra is given in percent for limb and crater contacts with the umbra. Limb Contact **I** occurs when the Moon's limb first touches the umbra; **II** is the time when totality begins; **III** is the time when totality ends; and **IV** occurs when the Moon's limb leaves the umbra. The amount of umbral enlargement is also given as computed from crater contacts when entering (*ingress*) or leaving (*egress*) the umbra. When a mean enlargement is given for either type of contact, it is the *unweighted* mean of the means for the several forms of observed limb or crater contact times. The unweighted mean is used due to probable systematic differences between the different forms of contact.

The sources used have often published "raw" limb and crater timings without any reduction. When the original observations (or at least their means) are available but were not reduced, the writer ("JW") has reduced them. The computer program used to do this gives results that are comparable to those in the *Sky & Telescope* reports for eclipse Number 4906 and later. For earlier eclipses, that magazine's calculations did not account for a crater's displacement toward the Earth relative to the Moon's center, and also used the solar semidiameter without correcting it for irradiation. *Sky & Telescope* has recommended that 0.20 percent be subtracted from their umbral enlargement factors reported for eclipses prior to Number 4906. This has been done here, but this correction is obviously an approximation; for example, the factor probably is different for limb contacts than for crater contacts.

The final observational measure, "ellipticity," which is rarely measured, is the ratio of the difference between the north-south and east-west diameter of the umbra to the east-west diameter, as inferred from systematic differences in contact timings.

Finally, under "References," *SA* refers to the *Strolling Astronomer* and *ST* to *Sky & Telescope*. In either case, the magazine abbreviation is followed by the volume and page number, separated by a hyphen, of the reference. *Keen* refers to personal communications from Dr. Richard A. Keen of the Cooperative Institute for Research in Environmental Sciences (University of Colorado at Boulder) and *Kambah* to a letter (May 20, 1985) from David Herald of Kambah Observatory (Woden, A.C.T., Australia).

COMMENTS

Twelve eclipses are missing from the sequence because quantitative observations of them were not reported in the sources used. Dates and times are in Universal Time (U.T.). Particulars on them are given in *Table 1*, below, with umbral magnitudes given as in *Table 3*.

Table 1. Unreported Umbral Lunar Eclipses.

Oppolzer Number	U.T. Date	Umbral Magnitude	Moon in Zenith at Longitude
4898	1957 NOV 07	1.030 S	139°E
4899	1958 MAY 03	0.009 N	176°E
4900	1959 MAR 24	0.265 S	057°E
4905	1963 JUL 06	0.705 N	031°E
4909	1965 JUN 14	0.175 S	028°W
4914	1970 FEB 21	0.046 N	124°W
4920	1973 DEC 10	0.102 N	029°W
4921	1974 JUN 04	0.826 S	026°E
4925	1976 MAY 13	0.122 N	062°E
4929	1979 MAR 13	0.852 N	045°E
4935	1983 JUN 25	0.339 S	125°W
4937	1985 OCT 28	1.078 S	091°E

The fact that eight of the twelve "missed" eclipses were chiefly visible in the Eastern Hemisphere shows a selection effect, probably due both to the concentration of observers in Europe and North America, and to the fact that the sources used were American. One would expect some observations of these eclipses in at least Japan, Australia, and New Zealand. It is also relevant that ten of the twelve were partial eclipses, and in seven of those the Moon was less than half-covered by the umbra. Also, several of these eclipses were reported, but only in the form of verbal descriptions, drawings, or photographs, rather than with the quantitative data needed in *Table 3*.

There is sufficient information in *Table 3* to permit some statistical analysis; in particular the correlations between several of the umbral statistics, as shown below in *Table 2*.

Table 2. Correlation Coefficients between Umbral Statistics.

Statistics Paired	No. Observations	Correlation Coefficient	Significance
V, L	14	-0.8864	1% level
V, E	12	+0.0446	Not Signif.
L, E	16	+0.0409	Not Signif.

V and **L** were defined on page 112; **E** is the umbral enlargement. The overall means of these quantities, with the number of observations in parentheses, were:

V = -0.38±.60 (14)

L = 1.89±.18 (23)

E (in percent)—

1.99±.06 (20; crater ingress)
1.83±.09 (19; crater egress)
1.90±.10 (22; all crater contacts)

1.74±.08 (16; limb contact I)
1.92±.13 (14; limb contact II)
2.18±.11 (14; limb contact III)
1.91±.09 (17; limb contact IV)
1.94±.07 (16; all limb contacts).

We plan to present a more comprehensive statistical analysis in a later issue.

Undoubtedly, a search of foreign literature would fill some of the gaps in the 30-year period reported upon here. Besides the main goal of this paper—to consolidate previously-scattered information—I hope that it will stimulate others to forward previously unpublished observations to our Lunar Eclipse Recorder, Francis G. Graham, whose address is on the inside back cover of this magazine. We also hope that this report will encourage observers to make systematic observations of future lunar eclipses, such as the upcoming 1989 AUG 17 total eclipse, and to send their observations to Recorder Graham.

Table 3. Lunar Eclipse Umbral Statistics Summary.

Oppolzer Eclipse Number	4896	4897	4901	4902
U.T. Date	1956 NOV 18	1957 MAY 13	1960 MAR 13	1960 SEP 05
U.T. Mid-Eclipse	06h 48m	22h 31m	08h 28m	11h 21m
Umbral Mag.	1.323 N	1.304 N	1.520 C	1.431 C
Stellar Mag.				
Naked-Eye	-1.75 (2)	---	-0.9 (1)	(-0.05±.3)
Photo.	-0.9 (1)	---	---	---
Danjon Lum.	2.15±.15 (27)	---	1.9 (27)	1.8 (13)
Enlargement	%	%	%	%
Limb Con.: I	2.9 (6)	---	1.4 (26)	1.70 (3)
II	2.4 (5)	---	2.6 (39)	1.88±.07 (8)
III	3.0 (5)	---	3.1 (21)	2.08 (2)
IV	2.2 (4)	---	2.8 (14)	1.40 (2)
Mean	2.62±.19	---	2.48±.37	1.76±.14
Craters: Ingress	---	---	2.57±.08 (130)	1.99±.04 (80)
Egress	---	---	2.45±.08 (94)	1.26±.07 (34)
Mean	1.95±.12 (42)	1.6	2.51±.06 (204)	1.63
Ellipticity	---	---	---	---
References	*SA:* 11-64. *ST*: 16-142; 19-402; 19-474; 27-156.	*ST:* 19-474.	*ST:* 19-474; 21-278; 23-23; 27-156; 35-351. Keen.	*ST:* 20-341; 29-71; 34-408; 35-351. Keen. [Contact times reduced by JW]

Oppolzer Eclipse Number	4903	4904	4906	4907
U.T. Date	1961 MAR 02	1961 AUG 26	1963 DEC 30	1964 JUN 25
U.T. Mid-Eclipse	13h 29m	03h 09m	11h 07m	01h 06m
Umbral Mag.	0.806 N	0.992 S	1.340 S	1.561 C
Stellar Mag.				
Naked-Eye	---	---	---	---
Photo.	---	---	---	---
Danjon Lum.	---	1.5	0.2 (91)	0.29±.18 (14)
Enlargement	%	%	%	%
Limb Con.: I	---	---	---	---
II	---	---	---	---
III	---	---	---	---
IV	---	2.0	---	---
Mean	---	---	---	---
Craters: Ingress	---	1.79±.05	1.79±.04 (501)	---
Egress	---	1.95±.05	2.13±.08 (99)	---
Mean	3.4 (39)	1.87±.04 (293)	1.96	---
Ellipticity	---	1/104	1/139	---
References	*ST:* 21-278; 23-23; 27-156.	*ST:* 22-200; 23-23; 27-156; 50-219.	*SA:* 17-255. *ST:* 27-156; 27-243; 29-71; 29-182; 34-52; 34-408; 35-351; 50-219.	*ST:* 34-408; 35-351. Keen.

Table 3. Lunar Eclipse Umbral Statistics Summary—*Continued.*

Oppolzer Eclipse Number	4908	4910	4911	4912
U.T. Date	1964 DEC 19	1967 APR 24	1967 OCT 18	1968 APR 13
U.T. Mid-Eclipse	02h 37m	12h 06m	10h 15m	04h 47m
Umbral Mag.	1.181 N	1.342 N	1.147 S	1.117 S
Stellar Mag.				
Naked-Eye	+0.1 (10)	(-0.8±.3)	-1.0 (2)	-2.2 (10)
Photo.	---	---	---	-3.0 (1)
Danjon Lum.	1.6 (134)	2.0 (4)	3.2 (34)	2.33±.07 (124)
Enlargement				
Limb Con.: I	1.58±.05 (16)	---	1.61 (8)	1.51±.06 (19)
II	1.56±.02 (19)	---	2.53 (2)	2.13±.03 (31)
III	1.85±.05 (14)	---	1.71 (3)	2.15±.05 (17)
IV	1.75±.06 (16)	---	2.06 (1)	2.22±.04 (24)
Mean	1.69±.07	---	1.98±.21	2.00±.17
Craters: Ingress	---	---	2.44±.03 (72)	2.07±.01 (479)
Egress	---	---	1.98±.12 (12)	2.06±.02 (234)
Mean	---	---	2.21	2.06
Ellipticity	---	---	---	---
References	*ST:* 29-71; 29-182; 34-408; 35-351. [Contact times reduced by JW]	*ST:* 34-52; 34-408; 35-351; 36-413. Keen.	*ST:* 34-408; 35-351; 36-413; 51-76. [Contact times reduced by JW]	*ST:* 35-351; 36-413; 40-61. [Contact times reduced by JW]

Oppolzer Eclipse Number	4913	4915	4916	4917
U.T. Date	1968 OCT 06	1970 AUG 17	1971 FEB 10	1971 AUG 06
U.T. Mid-Eclipse	11h 42m	03h 23m	07h 45m	19h 43m
Umbral Mag.	1.174 N	0.413 S	1.313 N	1.734 C
Stellar Mag.				
Naked-Eye	(0.0±.3)	---	-1.60±.10 (13)	+0.1
Photo.	---	---	---	---
Danjon Lum.	1.6 (11)	---	2.6 (107)	2 (4)
Enlargement				
Limb Con.: I	2.08 (3)	---	1.59 (19)	---
II	1.76 (4)	---	1.82 (30)	---
III	2.47 (2)	---	2.01 (23)	---
IV	2.04 (1)	---	1.56 (19)	---
Mean	2.09±.15	---	1.74±.11	---
Craters: Ingress	2.20±.05 (85)	1.82±.06 (15)	2.13 (505)	---
Egress	0.66±.10 (17)	1.99±.05 (26)	1.62 (338)	---
Mean	1.43	1.90	1.88	---
Ellipticity	---	---	---	---
References	*ST:* 36-413. Keen. [Contact times reduced by JW]	*ST*:40-211. [Crater contact times reduced by JW]	*ST:* 41-209; 41-273; 42-243; 43-258.	*ST:* 42-243. Keen.

Table 3. Lunar Eclipse Umbral Statistics Summary—*Continued.*

Oppolzer Eclipse Number	4918	4919	4922	4923
U.T. Date	1972 JAN 30	1972 JUL 26	1974 NOV 29	1975 MAY 25
U.T. Mid-Eclipse	10h 53m	07h 16m	15h 13m	05h 48m
Umbral Mag.	1.054 S	0.548 N	1.195 N	1.431 C
Stellar Mag.				
Naked-Eye	-2.8 (1)	---	(-1.7±.3)	+0.7±.2 (7)
Photo.	-3.2 (1)	---	---	---
Danjon Lum.	2.9	---	2.5 (1)	1.64±.08 (91)
Enlargement				
Limb Con.: I	1.77 (14)	2.58±.18 (4)	---	1.6 (14)
II	2.07 (20)	---	---	1.5 (21)
III	2.19 (15)	---	---	1.9 (17)
IV	1.65 (15)	2.40±.79 (4)	---	1.6 (16)
Mean	1.92±.13	2.49	---	1.65±.09
Craters: Ingress	1.69±.06 (420)	1.85±.06 (30)	2.51±.15 (15)	1.79 (332)
Egress	1.68 (295)	1.81±.04 (34)	---	1.61 (232)
Mean	1.69	1.83	---	1.70
Ellipticity	---	---	---	---
References	*ST:* 43-258; 43-330; 53-423.	*ST:* 44-464. [Contact times reduced by JW]	*ST:* 49-128. Keen. [Unpublished JW crater contact times reduced by JW]	*ST:* 50-219; 51-76; 53-423.

Oppolzer Eclipse Number	4924	4926	4927	4928
U.T. Date	1975 NOV 18	1977 APR 04	1978 MAR 24	1978 SEP 16
U.T. Mid-Eclipse	22h 23m	04h 18m	16h 37m	19h 04m
Umbral Mag.	1.068 S	0.198 S	1.457 C	1.333 N
Stellar Mag.				
Naked-Eye	-2.93±.17 (4)	---	(-1.0±.3)	(-1.2±.5)
Photo.	---	---	---	---
Danjon Lum.	2.6±.3	---	2.1±.1 (53)	2.2±.1 (36)
Enlargement				
Limb Con.: I	1.3	2.09 (5)	---	---
II	2.3	---	---	---
III	2.2	---	---	---
IV	2.0	1.42 (5)	---	---
Mean	1.95±.23	1.75	---	---
Craters: Ingress	1.91±.13 (57)	1.75 (78)	1.85±.02 (178)	---
Egress	1.87±.09 (67)	1.76 (87)	1.88±.08 (36)	---
Mean	1.89	1.76±".10-.15"	1.86	---
Ellipticity	---	---	---	---
References	*SA:* 26-80. *ST:* 51-76; 53-423.	*ST:* 53-423. [Limb contact times reduced by JW]	*ST:* 56-168. Keen.	*SA* 27-215. Keen. Kambah.

Table 3. Lunar Eclipse Umbral Statistics Summary—*Continued.*

Oppolzer Eclipse Number	4930	4931	4932	4933
U.T. Date	1979 SEP 06	1981 JUL 17	1982 JAN 09	1982 JUL 06
U.T. Mid-Eclipse	10h 54m	04h 47m	19h 56m	07h 31m
Umbral Mag.	1.099 S	0.554 N	1.337 S	1.722 C
Stellar Mag.				
Naked-Eye	-1.6 (4)	---	-2.5 (1)	+2.1±.4 (7)
Photo.	---	---	---	+0.5
Danjon Lum.	3	---	2.75 (2)	1.46±.18 (17)
Enlargement				
Limb Con.: I	2.01 (8)	---	---	1.60 (25)
II	2.28 (7)	---	---	1.02 (21)
III	1.88 (5)	---	---	2.24 (11)
IV	1.48 (5)	---	---	2.14 (6)
Mean	1.91±.17	---	---	1.75±.28
Craters: Ingress	1.80 (122)	1.87 (80)	---	2.02±.10 (538)
Egress	1.69 (18)	2.11 (40)	---	2.24±.13 (159)
Mean	1.75	1.99	---	2.13
Ellipticity	---	---	---	---
References	*SA:* 28-116. *ST:* 58-594; 59-30. Kambah.	*ST:* 63-314.	*SA:* 29-128. *ST:* 63-423.	*SA:* 29-168; 31-207. *ST:* 64-390; 64-618.

Oppolzer Eclipse Number	4934	4936
U.T. Date	1982 DEC 30	1985 MAY 04
U.T. Mid-Eclipse	11h 29m	19h 41m
Umbral Mag.	1.188 N	1.243 N
Stellar Mag.		
Naked-Eye	+3.01	(0.0±.5)
Photo.	---	---
Danjon Lum.	0.25±.14 (7)	1.65±.21 (6)
Enlargement		
Limb Con.: I	1.39 (11)	---
II	1.50 (13)	---
III	1.71 (7)	---
IV	1.78 (11)	---
Mean	1.60±.09	---
Craters: Ingress	1.74 (298)	---
Egress	1.74 (90)	---
Mean	1.74	---
Ellipticity	1/330	---
References	*SA:* 29-259. *ST:* 65-287; 65-383.	*ST:* 70-183. Keen.

COMET CORNER

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

PRESENT COMET ACTIVITY

The apparition of Periodic Comet Brorsen-Metcalf should occupy most of us for much of the remainder of 1989 (for an ephemeris of this comet, see the next article). Another current comet, Shoemaker-Holt-Rodriquez (1988h), is dimming in the Southern Hemisphere.

The third comet in the skies these days, Periodic Comet Schwassmann-Wachmann 1, with a 15-year orbital period, will be closest to the Sun on 1989 OCT 16. It normally hovers near magnitude +17, but at times it has outbursts and brightens by several magnitudes. Those wanting to monitor it will find the ephemeris below helpful. If this comet does undergo an outburst, report this event to the Central Bureau for Astronomical Telegrams, Smithsonian Astrophysical Observatory, Cambridge, MA 02138 U.S.A. Also, please report all positive *or* negative observations to this Recorder at the end of the calendar year; my address is on the inside back cover.

Unless a bright comet is soon discovered, these comets are all we have to keep us busy through the end of 1989.

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

1989 U.T.		1950.0 Position				2000.0 Position				Elongation		Total
Date		Right Ascension		Declination		Right Ascension		Declination		from Sun	Sky*	Magnitude
		h	m	°	'	h	m	°	'	°		
JUL	26	00	02.8	+08	00	00	05.4	+08	18	118	M	+17.2
	31	00	02.2	08	06	00	04.8	08	23	123	M	17.2
AUG	05	00	01.4	+08	10	00	04.0	+08	27	128	M	+17.1
	10	00	00.4	08	12	00	02.9	08	29	133	M	17.1
	15	23	59.1	08	12	00	01.6	08	29	138	M	17.1
	20	23	57.6	08	11	00	00.1	08	27	143	M	17.1
	25	23	55.9	08	07	23	58.4	08	24	148	M	17.1
	30	23	54.0	08	02	23	56.6	08	19	153	M	17.0
SEP	04	23	52.0	+07	55	23	54.5	+08	12	158	M	+17.0
	09	23	49.8	07	47	23	52.4	08	04	163	M	17.0
	14	23	47.6	07	38	23	50.2	07	54	167	M	17.0
	19	23	45.4	07	27	23	47.9	07	44	171	M	17.0
	24	23	43.1	07	16	23	45.7	07	32	172	E	17.0
	29	23	40.9	07	03	23	43.4	07	20	169	E	17.0
OCT	04	23	38.7	+06	51	23	41.3	+07	07	165	E	+17.0
	09	23	36.7	06	38	23	39.2	06	54	160	E	17.0
	14	23	34.7	06	25	23	37.3	06	42	155	E	17.0
	19	23	33.0	06	13	23	35.6	06	30	150	E	17.1

*"M" indicates visibility in the morning, and "E" in the evening, sky, respectively.

THE PRESENT APPARITION OF PERIODIC COMET BRORSEN-METCALF

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

HISTORY

On 1847 JUL 20, the Danish astronomer Theodor Brorsen (1819-1895) of Altona Observatory in Germany discovered his third comet. [1] It appeared at magnitude +9.5 at the approximate position α 01h 52m, δ +26°.0, 83 degrees from the Sun in the morning sky. [2] The comet reached perihelion on September 10 of that year, 0.49 Astronomical Units (A.U.) from the Sun, after having attained a total magnitude of +6.5 in mid-August, with a tail length of about one-quarter degree. It was last seen on 1847 SEP 13, having faded to magnitude +9.5. [3] Because Brorsen had already discovered a periodic comet, this one became known as Periodic Comet Brorsen 2. Brorsen went on to discover two more comets, both in 1851. He later published papers dealing with the Gegenschein, and he is better known for them than for his comet discoveries.

Several orbits were computed for this comet, with orbital periods ranging from 71 to 81 years. The accepted value was 75 years, and it was thus expected to return in 1922. [4]

The second person whose name is associated with this comet was the Reverend Joel Metcalf (1866-1925), a Unitarian minister, telescope maker, and discoverer of 41 asteroids, who had already found three comets by mid-1919. He did most of his comet-sweeping from Burlington, Vermont, using a 7-inch refractor. [5]

On 1919 AUG 21, Metcalf discovered his fourth comet. It was bright, at magnitude +5.5, at the approximate coordinates α 22h 51m, δ +25°.7, 140 degrees from the Sun in the morning sky. [6] The early orbit was identical to that of Periodic Comet Brorsen 2, and it was soon realized that this was the same comet. Five more observers picked it up over the next two weeks as it brightened rapidly. Metcalf's rediscovery was 57 days before perihelion, which came on 1919 OCT 17. The renamed Periodic Comet Brorsen-Metcalf came within 0.19 Astronomical Units (28 million km.) of the Earth, reached magnitude +4.5, sported a small coma, 8 arc-minutes in diameter, and a moderate tail 1°.5 in length. Also of interest, on October 22, E.E. Barnard of Lick Observatory reported a "disassociation event," where the tail separated from the coma. A few days later a new tail formed at a 12-degree angle to the old tail. [7]

Like all good comet hunters, Metcalf did not then cease searching for comets. The next night he picked up another comet, this of eleventh magnitude. It turned out to be Periodic Comet Kopff, on its first observed return since its discovery in 1906. However, Metcalf was not the first to see it; it had been recovered three weeks earlier by Max Wolf of Germany, and Metcalf had not yet heard of the recovery.

In character, Metcalf *still* did not cease to search for comets. On the following evening, 1919 AUG 23, he discovered yet another comet. This turned out to be a new one, promptly named Comet Metcalf. Thus, in three nights Joel Metcalf visually discovered an unexpected returning comet, independently recovered a known comet, and discovered a brand-new comet. [8]

ORBIT

Until recently, it was felt that Comet Brorsen-Metcalf's orbit was well-known and that the comet could be recovered as early as July, 1988. [9] However, it was actually recovered on July 4, *1989*, by Elena Helin with the 48-inch Schmidt telescope on Palomar Mountain at magnitude 10.5, and designated Comet 1989o. When a recovery is delayed as is this one, one of two reasons is given: either the comet is not on course, or the comet has dimmed a great deal. In the first case, the comet may yet be arriving, but it will be seen in a different part of the sky than predicted. In the second case, perhaps Barnard's observation of the disassociated tail in 1919 was an indication of the comet's beginning to fade rapidly a few days after perihelion on October 17 of that year. This could also have been a sign of an active nucleus, jetting the comet slightly off course. As it turns out, the problem was in this comet's orbit, with the comet 15.6 days ahead of its prediction.

The revised orbit below are from Brian Marsden, in *IAU Circular 4805* (where ET stands for Ephemeris Time, currently about 56 seconds later than Universal Time):

Time of perihelion:	1989 SEP 11.9395 ET
Distance at perihelion:	0.478748 A.U.
Argument of perihelion:	129°.6256
Ascending node:	310°.8761
Inclination:	019°.3306
Eccentricity:	0.971970
Orbital Period:	70.6 years

A sketch of the predicted orbit of Periodic Comet Brorsen-Metcalf in relation to that of the Earth is shown below in *Figure 15*.

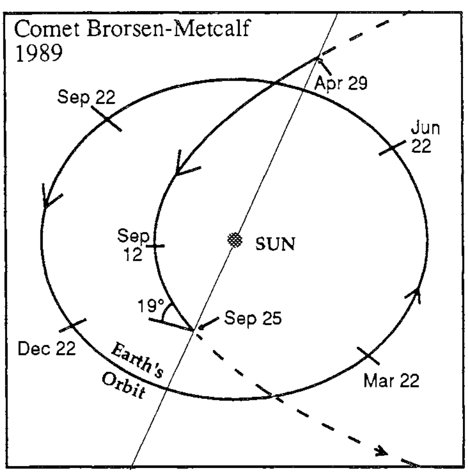

Figure 15. Diagram of the orbit of the Earth and the revised orbit of Periodic Comet Brorsen-Metcalf. The dashed portion of the comet's orbit is south of the plane of the ecliptic.

A CALL FOR OBSERVATIONS

With an orbital period of about 70 years, this comet has not been well-observed. The earliest that it has ever been seen was 57 days before perihelion; the latest was 32 days after perihelion. At the current apparition, visual observers should be able to nearly double this span, although twilight will be a problem, especially in October. Previous passages of this comet suggest rapid brightening as it nears the

Sun, followed by rapid dimming as it pulls away. *Figure 16*, below, indicates for different locations and dates the number of dark-sky hours that this comet should be visible above the horizon.

A complete set of accurate visual observations should help us better to determine this comet's behavior. Please send all visual observations, drawings, and photographs to this Recorder (address given on the inside back cover) by the end of 1989 so that he can prepare a full report in early 1990.

REFERENCES

1.) Kronk, Gary. *Comets—A Descriptive Catalog*. Enslow Publishers, 1984, p. 230.

2.) Rudenko, Michael." Catalogue of Cometary Discovery Positions," *International Comet Quarterly*, October, 1986, p. 122.

3.) Kronk, p. 230.

4.) *Ibid.*

5.) Stoneham, Rachael Metcalf. "A Wonderful Night for Comets," *Yankee Magazine*, Sept., 1979, pp. 174-184.

6.) Rudenko, *loc. cit.*

7.) Kronk, *loc. cit.*

8.) Stoneham's article (p. 184) mentioned the three comets in three nights, but fails to identify the comets or the dates. It is known, though, that Metcalf found comets on August 21 and 23, 1919. This leaves open the identity of the August 22 comet. It is inferred to be Comet Kopff, the only comet recovered in those months that was within reach of Metcalf's telescope.

9.) Hale, Alan. "Comets." *The Astronomical Calendar, 1988*, p. 62.


```
                 NUMBER OF DARK-SKY HOURS ABOVE HORIZON

  07/03   07/23   08/12   09/01   09/21   10/11   10/31   11/20
 7.0 +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   7.0
 6.5 +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   6.5
 6.0 +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   6.0
 5.5 S S +   +   + N +   +   +   +   +   +   +   +   +   +   +   5.5
 5.0 E E ESESE N N   +   +   +   +   +   +   +   +   +   +   +   5.0
 4.5 +   + N N E +   N   +   +   +   +   +   +   +   +   +   +   4.5
 4.0 + N N   S   E   S   +   +   +   +   +   +   +   +   +   +   4.0
 3.5 N   +   + S + E + N +   +   +   +   +   +   +   +   +   +   3.5
 3.0 +   +   +   +   +   N   +   +   +   +   +   +   +   +   +   3.0
 2.5 +   +   +   S   E   +   +   +   +   +   +   +   +   +   +   2.5
 2.0 +   +   +   +   + E + N +   +   +   +   +   +   +   +   +   2.0
 1.5 +   +   +   +   +   E   N   +   +   +   +   +   +   +   +   1.5
 1.0 +   +   +   + S +   + E + N +   +   +   +   +   +   +   +   1.0
 0.8 +   +   +   +   +   +   +   +   +   +   +   +   +   +   E   0.8
 0.6 +   +   +   +   +   +   E   N   +   +   +   +   +   + E +   0.6
 0.4 +   +   +   +   +   +   + E + N +   +   +   +   + E E   N   0.4
 0.2 +   +   +   +   +   +   +   E   +   +   +   + E E   +   S   0.2
 0.0 +   +   +   +   S   +   +   + E NEN +   E E E   + N NSNS+   0.0
-0.2 +   +   +   +   +   +   +   +   +   NEE +   + NSNSS +   +  -0.2
-0.4 +   +   +   +   +   +   +   +   +   + N N N NS  +   +   +  -0.4
  07/03   07/23   08/12   09/01   09/21   10/11   10/31   11/20
```

Figure 16. This graph shows the length of time in hours that Periodic Comet Brorsen-Metcalf is predicted to be above the observer's horizon before morning astronomical twilight begins. "N" is for 40° north latitude; "E" for the equator; and "S" is for 40° south latitude. Times are plotted for every five days; unless plotting overlap occurs, when the symbol is on the following space. Note the difference in vertical scales for under and over one hour; this is done better to define observing times when the comet rises near the beginning of twilight. For all dates, the comet is in the morning sky, but in mid-August it is above the horizon all night from latitudes above about 50° North.

EPHEMERIS: PERIODIC COMET BRORSEN-METCALF

The following ephemeris uses the revised orbital elements given on page 119. The magnitudes assume an absolute magnitude of +9.0 and a solar-distance coefficient, **N**, of 4.0. Part of this comet's path is plotted on *Figure 17*, below.

Table 2. Ephemeris of Periodic Comet Brorsen-Metcalf.

1989 U.T.	1950.0 Position		2000.0 Position		Elongation		Total
Date	Right Ascension	Declination	Right Ascension	Declination	from Sun	Sky*	Magnitude
	h m	° '	h m	° '	°		
JUL 28	02 30.9	+31 47	02 23.9	+32 01	079	M	+8.6
AUG 02	03 20.7	+36 43	03 23.9	+36 54	073	M	+8.1
07	04 21.4	40 25	04 24.8	40 32	065	M	7.7
12	05 28.5	41 56	05 32.0	41 58	057	M	7.3
17	06 33.3	40 59	06 36.8	40 56	049	M	7.0
22	07 29.3	38 07	07 32.7	38 01	043	M	6.7
27	08 15.0	34 09	08 18.1	34 00	037	M	6.4
SEP 01	08 52.1	+29 39	08 55.2	+29 27	033	M	+6.1
06	09 23.5	24 53	09 26.4	24 40	029	M	6.0
11	09 51.2	20 01	09 54.0	19 47	025	M	6.1
16	10 16.3	15 13	10 19.0	14 59	023	M	6.3
21	10 39.6	10 34	10 42.2	10 18	020	M	6.9
26	11 00.9	06 14	11 03.5	05 57	018	M	7.5
OCT 01	11 20.5	+02 16	11 23.1	+02 00	017	M	+8.1
06	11 38.5	-01 18	11 41.0	-01 35	017	M	8.7
11	11 55.0	04 31	11 57.6	04 48	017	M	9.3
16	12 10.4	07 25	12 13.0	07 42	018	M	9.9
21	12 24.7	10 03	12 27.3	10 19	019	M	10.3
26	12 38.0	12 26	12 40.7	12 42	020	M	10.8
31	12 50.6	14 36	12 53.2	14 53	021	M	11.2
NOV 05	13 02.4	-16 36	13 05.1	-16 52	023	M	+11.6
10	13 13.6	18 26	13 16.3	18 42	025	M	11.9
15	13 24.2	20 08	13 26.0	20 23	027	M	12.2
20	13 34.4	21 42	13 37.0	21 57	029	M	12.5
25	13 43.8	23 10	13 46.5	23 25	032	M	12.8
30	13 52.8	24 33	13 55.6	24 47	034	M	13.0

* M = Visible in morning sky.

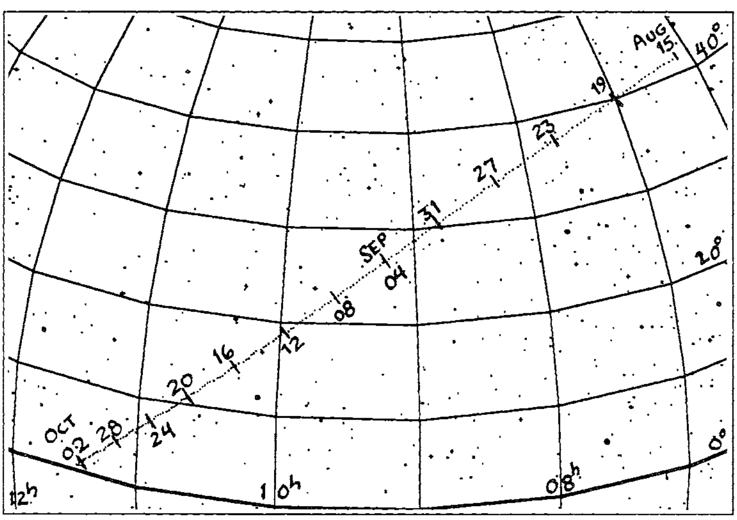

Figure 17. Predicted path of Periodic Comet Brorsen-Metcalf between 1989 AUG 15 and OCT 02, when it will be at its brightest. Position ticks are shown at four-day intervals. North at top; the declination grid interval is 10° and the right ascension spacing is 1 hour. Stars are shown to magnitude 6. Generated by Voyager program © Carina Software.

OBSERVING METEORS: XV

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

A meteor is not the sky's longest-lived event. It's there, then it's gone; and if we are not looking up we miss it. During an all-night watch there are several factors that cause us to look away from the sky; among them fatigue, a drink of hot chocolate, changing the tape on the recorder, or plotting the last meteor.

To plot or not to plot: In a typical meteor-counting watch, the minimum information that we need for hourly statistics are times, magnitudes, and shower membership. Plotting a meteor on a star chart is a valid means of obtaining additional data. The beginning and ending points are thus known, and if the meteor is a bolide—a meteor that explodes—the burst can be recorded too. The only problem is that plotting takes time. A meteor event that lasted half a second may take thirty times that interval to plot. For all that time, our attention is away from the sky and we miss meteors.

During the 1960's there was a division in philosophy between two of the most active meteor groups in Canada, the Royal Astronomical Society of Canada's Montreal and Ottawa Centres. In Montreal we believed that plotting was important and we used a set of four all-sky seasonal charts from Canada's National Research Council which were good for certain hours of each night. A meteor's path would be plotted as a line with a numbered circle at the starting point, the number representing the meteor's number as recorded on the report form. The Centre's files are filled with detailed plots of hundreds of meteors seen on many shower nights.

During one Perseid watch we recorded 906 meteors, all carefully plotted. The accurate information shown by plotting was, however, at the expense of accurate counts. How many meteors really did appear that night, of which we saw only 906? For six hours of observing with eight working observers at all times, the mean count is 151 per hour or a bit under 19 per observer per hour. If all 19 meteors were plotted, at about 15 seconds per plot, the amount of time lost for each observer would have been almost five minutes of each hour. The actual loss, however, is more than that because a plot often may take much more than 15 seconds. Also, invariably some dark adaptation is lost during plotting, which means something worse: an unknown quantity of time, but greater than five minutes, is lost from the statistical count. This is a reason why the Ottawa Centre, and many other groups, do not plot.

A good observer can instantly identify most shower meteors without plotting them; so that if your aim is strictly statistical, don't plot. In fact, you should ideally limit any recording so that no time is lost from the sky, and use a tape recorder. On the other hand, the information on distribution in the sky, trail lengths, possible burst positions, and other distribution data which plotting provides can be invaluable. However, if you do plot, make sure that you note this fact on the report form.

PERSONAL OBSERVATIONS OF THE PARTIAL SOLAR ECLIPSE OF 1989 MAR 07

By: Paul Maxson, A.L.P.O. Solar Recorder—White Light.

A successful observation of a partial solar eclipse can be due more to a combination of fortunate circumstances than to anything else. The partial eclipse of 1989 MAR 07 was an example of this for me. The fortunate circumstances included:

—The atmospheric conditions were excellent. The visibility was estimated at 60 miles, and there was little breeze.

—The eclipse occurred locally in the mid-morning. Seeing conditions from my backyard in Phoenix, Arizona, are best between 9 A.M. and noon MST (16h-19h U.T.); and the first contact was shortly after 10 A.M. so that the eclipse happened during prime observing hours for my site.

—There was a large sunspot (SESC 5395) on the eastern (celestial direction) limb of the Sun. Such a feature is very helpful to use for focusing. [Besides being photogenic in itself! Ed.]

—I was on spring break from the college at which I work, so I could use my own (and proven) equipment. Also, I could relax and concentrate on the eclipse without having to worry about what was going on at my office.

I had not observed a partial solar eclipse in several years, so my enthusiasm for this one was quite high. The morning was bright and clear; and I conducted my normal observing session for the A.L.P.O. Solar Section, in which I take four full-disk photographs. At about 9 A.M. MST I received a telephone call from the local CBS Television affiliate, who wanted to know if I was going to be doing anything for the eclipse; and, if so, could they come out and do a story for their news about it? Naturally I agreed. Thus, the scene was set. I put up two telescopes; one was my 10-inch that I use for my solar work, while the other was an 8-inch which I could use to project the solar image onto a screen for the television cameras.

The eclipse began right on time. The predicted start for Phoenix was 17h 07m U.T., and I noted the first contact as 17h 06m 58s. As the eclipse progressed, it became obvious to me and my fellow observers just how "mottled" the lunar limb is. We thought that we could see several lunar craters and plains as well as possibly a central peak or two. These were well-shown on the photographs that I was taking at approximate 15-minute intervals. During this time, the CBS cameraman was getting lots of tape, and everything progressed very routinely. Mid-eclipse was noted at about 17h 50m U.T. [The predicted time for Phoenix was 17h 56.4m. Ed.] My remaining hope was that the Moon would cover the large sunspot group (it didn't). [It did from San Francisco, and well worth the sight! Ed.] The cameraman left at about 18h 15m U.T. because he wanted to get his coverage on the noon news because another channel was going to get live coverage during their 11:30 A.M. news. I took several more photographs before the end of the eclipse and caught the live coverage on the other news show, which was shown at about two minutes before the last contact. I made it back to the telescope in time to time the last contact at 18h 47m 44s U.T.

The following week I processed the film and ended up with a very satisfactory nine-photograph sequence, of which one photograph appears on the front cover of this issue and another appears below as *Figure 18*. All the photographs were taken with a 10-inch (25-cm.) Newtonian stopped down to 6 inches (15 cm.), with a single (thicker) layer of Tuthill Solar Skreen. I used an Olympus OM-1 camera and a Wratten 47 (blue) filter, exposing at 1/250 second. (Photographs were taken at the following U.T.'s: 17h 01m, 17h 11m, 17h 26m, 17h 42m, 17h 50m, 18h 06m, 18h 20m, 18h 43m, and 18h 48m.)

All in all, the event was very successfully observed. I made the noon, 5 P.M., 6 P.M., and 10 P.M. news. Now I am gearing up for the next solar eclipse visible from my location, which occurs on July 11, 1991.

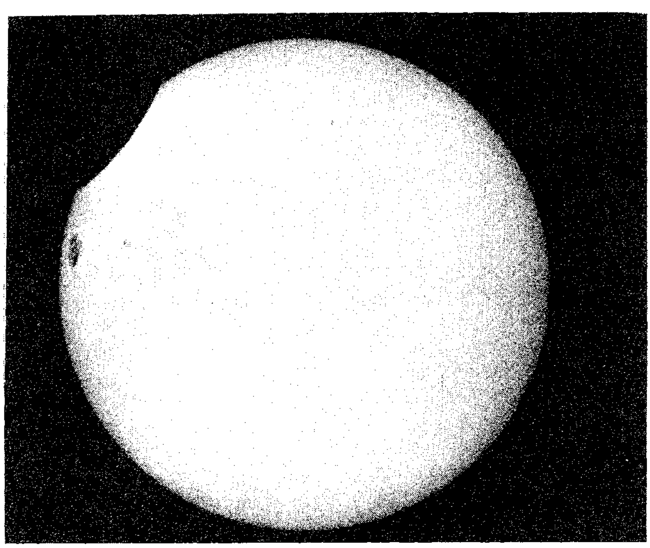

Figure 18. The 1989 MAR 07 partial solar eclipse, photographed from Phoenix, Arizona, by Paul Maxson at 18h 43m U.T., 5 minutes before last contact. North is to the top; the Moon's limb to the upper left. Below the Moon is the major sunspot group SESC 5395. 10-inch (25-cm.) Newtonian, stopped down to 6 inches (15 cm.). Solar Skreen and W47 filter. See also the front cover of this issue.

OBSERVATIONS OF JUPITER IN FEBRUARY, 1989

By: Richard W. Schmude, Jr., Chemistry Department, Texas A&M University, College Station, TX 77843

ABSTRACT

This article presents the results of micrometer measurements of the latitudes of the more distinct belts of Jupiter. In addition, a detailed map of Jupiter's apparent surface, along with a photograph of the planet, is presented. The bulk of the observations used here were made in February, 1989. In addition to the positions of the main belts, other findings discussed are the emergence of a feature similar to the Red Spot Hollow in the South Equatorial Belt, and significant detail within the Equatorial Zone.

INTRODUCTION

Jupiter reached opposition on 1988 NOV 23, and thus was in a favorable position for observing during the last four months of 1988 and the first two of 1989. The bulk of this report concerns observations and measurements made in February, 1989. However, some work was also done in late 1988. Almost all the data presented here were collected with the 35.6-cm. aperture reflector at Texas A&M University Observatory. A 35-mm. camera and Kodak TP-2415 Film were used with Kodak Wratten 25 (red), 47 (blue), and 58 (green) Filters. A microscope micrometer was used in the latitude measurements. It has a micrometer constant with the above telescope of 0.440±0.010 arc-seconds per division; with estimations possible to 0.1 division.

MAPS

Two maps covering the entire apparent surface of Jupiter at a scale of 1:850,000,000 were constructed during this apparition. In each case, this gave a 6×19-inch map. [The map appears to be on the Cylindrical Equal-Area Projection, similar to the appearance of a strip sketch. Ed.] The first map was drawn during a single night on 1988 NOV 23, with an average seeing of 6, on the A.L.P.O. scale that ranges from 0 for worst to 10 for perfect. The second map, shown in somewhat reduced form on p. 125 as *Figure 19*, was drawn between February 21 and 28, 1989, inclusive, with an average seeing of 7.5. [In the subsequent discussion of jovian features, the reader may wish to refer to *Figure 1* on page 50 of the previous issue, which is a nomenclature diagram of Jupiter. Ed.]

The two equatorial belts were large and obvious. A distinct temperate belt existed in each hemisphere; for the sake of convenience, I have chosen to call them the North Temperate Belt (NTB) and the South Temperate Belt (STB). The reader, however, must be aware that the true NTB and STB may have vanished and that the temperate belts seen here may be actually the NNTB (North North Temperate Belt) and the SSTB (South South Temperate Belt); indeed, the latitude measurements of these belts appear to suggest this identification.

On five occasions, I recorded the central meridian transit times for the center and for the preceding and following edges of the Red Spot Hollow (RSH). This feature took 39.0±2.2 minutes to transit; which, assuming a zenocentric latitude of 17°S [and that it follows the System II rotation rate of 870°.27 per day, giving a longitude span of 23°.6±1°.3; Ed.], corresponds to an east-west length of 28100±1500 km. [The zenocentric latitude is the angle, at Jupiter's center, between its equator and the feature. Ed.] From the photograph shown in *Figure 20* (p. 125), the RSH length is 28700±2000 km., which is in good agreement with the length from central meridian transits. I choose a value of 28400±1600 km. for the east-west length of the RSH. The north-south extent of this feature, based on *Figure 20*, is 19000±2000 km. These dimensions imply an area of (4.2±0.7) hundred million square kilometers for the RSH, which is slightly less than the surface area of the Earth.

The North Temperate Belt had numerous irregularities during February, 1989. The dark areas were quite distinct, while the brighter areas were more difficult to observe; apparently this belt had a similar appearance in 1976. [**1**] Like those on the Earth, polar features on Jupiter have a distorted appearance when shown on an equator-centered map. The features shown on *Figure 19* are drawn according to the longitudes they cover and thus are elongated east-west, and compressed north-south, when near the poles. [On this projection, relative areas are shown correctly, however. Ed.]

One surprise during this apparition was the amount of detail visible within the Equatorial Zone (EZ) and the North Equatorial Belt (NEB). Apparently, similar detail was seen by Hargreaves on 1942 FEB 11 [**2**, *Fig. 5*] and by L. Carlino on 1981 JUN 18 [**3**, *Fig. 32*]. The North Equatorial Belt appeared to be about 20 percent greater in north-south extent than the South Equatorial Belt (SEB). Neither of the equatorial belts appeared to be split into two or more belts. Thin rifts were present in both equatorial belts, but in most cases were visible only during moments of excellent seeing. One exception, however, was a large rift in the NEB in late February at the approximate System II longitude 150°. A similar rift was photographed by J. Dragesco on 1981 MAY 19 [**3**; *Fig. 31*].

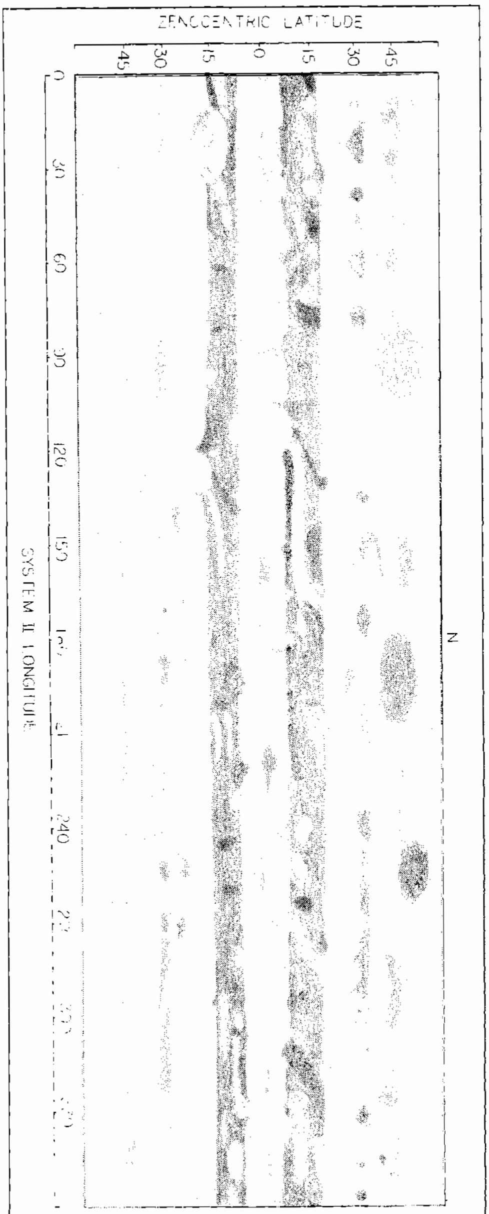

Figure 19. Map of Jupiter during 1989 FEB 21-28 on a Cylindrical Equal-Area Projection. Made by Richard W. Schmude, Jr., in white light with a 35.6-cm. reflector. Note sideways orientation with north to the right; oriented with north at the top, *preceding* is to the right and *following* is to the left. See also text.

There were two distinct rifts on either side of the RSH in November, 1988; however, these features had subsided by February, 1989.

The SEB had an especially distinct oval feature which was visible in both November, 1988, and February, 1989. This feature was at longitude(II) ≈ 120°-130° and shared several characteristics with the RSH, among which were: location at the south edge of the SEB, oval shape, and the small bright patch nearby (the RSH has several bright features near it); see *Figure 19*. Central meridian transit timings of the preceding and following edges of this feature suggest a length of 17300±3600 km., which is about three-fifths of the length of the RSH.

MICROMETER MEASUREMENTS

An extensive set of micrometer measurements of Jupiter's more conspicuous belts was made between January 31 and February 10, 1989. Each feature was measured 10 times and the mean and standard deviation of the zenocentric latitude were computed for each date. The time of each measurement was also recorded, allowing the System II longitude to be computed. The daily zenocentric latitude means, standard deviations, and System II longitudes are all given in *Table 1* (p. 126). The zenographic latitudes for these belts were found using the formulae given in Peek and Moore's *The Planet Jupiter* [**4**] and data from the 1989 *Astronomical Almanac* [**5**]. The latitudes of the equatorial belts are close to those found in previous years. However, the NTB and STB are approximately 5 degrees closer to the poles than given in other recent sources, but are within 2 degrees of the quoted latitudes of the NNTB and SSTB. [**4, 6, 7**]

One must be cautious when making micrometer measurements because irregularities within the belts can have an effect on the re-

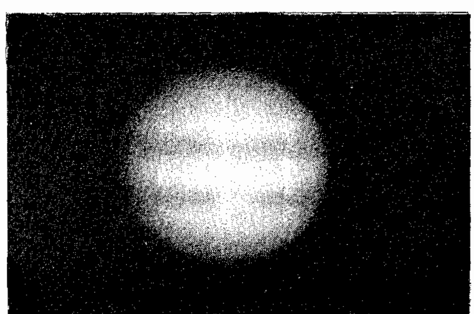

Figure 20. Photograph of Jupiter by Richard W. Schmude, Jr. 1989 FEB 24, 01h 22m U.T. CM(I) = 055°.3; CM(II) = 032°.7. 35.6-cm. reflector, 17-mm eyepiece. 2-second exposure on Kodak TP2415 Film with Wratten 58 (green) Filter. Seeing 7, Transparency 5 (the last on the A.L.P.O. scale ranging from 0 for worst to 5 for best). North at top.

sults or on their interpretation. For example, one can see in *Figure 19* that the NEB is thicker at longitude(II) = 120° than at surrounding longitudes. Any measurement made at this longitude, therefore, would not represent the position of the entire belt. As a second example, a micrometer measurement made at longitude(II) = 320° of the temperate belt that is closest to the NEB may correspond to the NNTB instead of the NTB because the NTB had a large gap at this longitude in late February, 1989. It is for these reasons that I present both a map and micrometer measures in this report.

The zenographic and zenocentric latitudes of the equatorial belts and the North Temperate Belt were also computed from their positions in the photograph in *Figure 20* and are listed in *Table 2* (p. 127). [The zenographic latitude is the angle between the local surface normal and Jupiter's equatorial plane. Ed.] In *Table 2*, each of the latitude measurements in *Table 1* was given a statistical weight which was equal to the seeing divided by the standard deviation of the measurement. For example, the STB measurement made on 1989 JAN 31 was given a weight of 3.53, while that of the same belt on FEB 08 had a weight of 3.48. The weighted mean of all data in *Table 1* is given in *Table 2* under the "micrometer" columns. After analyzing the map in *Figure 19* along with the longitudes of each of the micrometer measurements in *Table 1*, I feel that none of the measurements was made at an abnormal region of a belt. I therefore conclude that the results in *Table 1* and *Table 2* represent the latitudes of the features indicated.

CONCLUSIONS

A large number of irregularities were present at all latitudes on Jupiter during the 1988-89 Apparition. This paper gives a map of Jupiter's apparent surface detail, made in February, 1989. Of particular interest on it are the fine detail within the Equatorial Zone and the Red Spot Hollow [the last is near longitude 030°, latitude -15°. Ed.]. Micrometer-and photograph-based latitudes for several belts are presented here. The combination of an accurate map of Jupiter and the micrometer and photographic latitudes have enabled me firmly to conclude that the latitudes of the features listed in *Table 2* are accurate.

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Table 1. Summary of Zenocentric Latitude Micrometer Measurements.
Measures by Richard W. Schmude, Jr. Each latitude value is the mean of 10 micrometer measurements, followed by its standard deviation Below each latitude is its longitude(II).

1989 U.T. Date and Seeing	Belt						
	NTB	NEBn	NEBs	EB	SEBn	SEBs	STB
	° °	° °	° °		° °	° °	° °
JAN 31 (6)	+32.9±3.5 ≈036°	+15.9±1.8 ≈036°	+07.8±1.5 ≈036°	---	-06.8±1.4 ≈036°	-16.6±1.6 ≈036°	-36.6±1.7 ≈036°
FEB 01 (7)	38.1±5.9 ≈153°	15.9±2.4 ≈153°	08.4±1.3 ≈153°	---	08.4±1.2 ≈153°	15.5±3.1 ≈153°	34.6±3.7 ≈153°
FEB 01 (7.5)	29.3±2.4 201°	14.5±2.1 191°	05.5±2.0 196°	---	09.7±2.0 212°	17.0±2.2 215°	35.6±3.3 226°
FEB 02 (8)	31.7±1.2 012°	17.8±1.0 003°	07.8±1.4 359°	---	07.8±1.9 348°	16.4±2.0 344°	---
FEB 08 (8)	---	16.0±2.0 118°	07.7±3.4 130°	+00.6±2.0 084° [CM(I)]	06.5±1.6 157°	14.5±1.9 172°	32.9±2.3 150°
FEB 09 (4.5)	---	17.7±3.1 293°	08.5±2.4 299°	---	09.8±2.2 303°	16.1±2.5 309°	33.8±2.3 318°
FEB 10 (6)	35.6±4.0 103°	18.0±3.5 074°	07.8±2.4 080°	---	07.2±1.7 084°	15.8±2.4 088°	32.5±2.1 117°

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Table 2. Summary of Micrometric and Photographic Jovian Latitude Measurements.

	Micrometric Latitude Measurements		Photographic Latitude Measurements	
Feature	Zenocentric	Zenographic	Zenocentric	Zenographic
	°	°	°	°
NTB	+33.5±3.4	+37.2±3.9	+35.1±2.1	+38.9±2.4
NEBn	+16.5±2.3	+18.8±2.6	+19.4±1.8	+22.0±2.1
NEBs	+07.6±2.1	+08.7±2.4	+06.9±1.7	+07.9±2.0
EB	+00.6±2.0	+00.7±2.3	---	---
SEBn	-08.0±1.7	-09.2±2.0	-08.8±1.7	-10.0±2.0
SEBs	-16.0±2.2	-18.2±2.5	-18.3±1.8	-20.8±2.1
STB	-34.3±2.6	-38.1±3.0	---	---

A.L.P.O. SOLAR SECTION OBSERVATIONS FOR ROTATIONS 1803-1807 (1988 JUN 05 TO 1988 OCT 19)

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

ABSTRACT

A.L.P.O. Solar Section observations for Rotations 1803-1807 (1988 JUN 05-OCT 19) are summarized, particularly in terms of the morphology and development of sunspot groups. Fourteen observers in four nations contributed visual drawings and photographs in both integrated and Hydrogen-α light. Solar activity continued to increase during this period, reaching a record height during Rotation 1807 (September-October, 1988).

The increase in solar activity during this five-rotation reporting period was accompanied by the largest number of observations and the greatest number of data contributors for any similar period in our Section's history. Most of these observers had contributed to previous rotational reports and are thus becoming regular Section observers. Participating observers are listed in *Table 1* (p. 128). For the most part, these observations were of the highest quality yet submitted to the Section. For example, many of the photographs showed much penumbral detail and granulation! Good work!

For this reporting period, the mean International Sunspot Number (**RI**) was 114.6, and the mean American Sunspot Number (**RA**) was 115.3. These values are remarkably similar, and are over 70 percent greater than the corresponding values for the previous period (Rotations 1798-1802). The highest daily **RI** was 190, and the highest **RA**, 176; both on SEP 23 (Rotation 1807). The lowest **RI**, 22, fell on AUG 22 (Rotation 1805); the lowest **RA**, 24, fell on the same date. These values were in sharp contrast to the previous period. [**1-7**] [Note that activity means did not vary much during Rotations 1803-1805, but increased sharply for Rotations 1806-1807. Ed.] *Figure 21* (p. 128) graphs both forms of Sunspot Numbers during this reporting period.

As usual, all times used in this report will be in Universal Time (U.T.) unless otherwise specified. Angles will be expressed in heliocentric arc. Directions will be heliographic and abbreviated; e.g., N, SW, and so forth. The word "group" refers to a white-light collection of sunspots that are magnetically associated, while "region" will be used to refer to such an object in all wavelengths. Regions and groups will be named by their SESC numbers, which are assigned by the Space Environmental Services Center (SESC) of the National Oceanic and Atmospheric Administration (NOAA) in Boulder, Colorado. Other terms used here are defined in either *The Handbook for the White Light Observation of Solar Phenomena* (available from this Recorder for $US 6.00), *The A.L.P.O.S.S. Monochromatic Handbook* by Co-Recorder Randy Tatum, or in the article "A Three-Dimensional Sunspot Classification System" (*J.A.L.P.O.*, *33*, Nos. 1-3 [January, 1989], pp. 10-13).

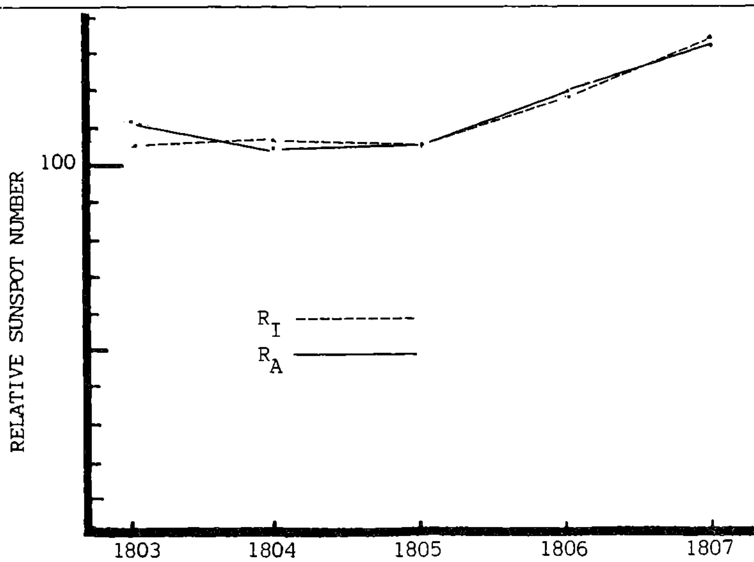

Figure 21. Graph of means of **RI** (International Sunspot Number) and **RA** (American Sunspot Number) for Solar Rotations 1803-1807.

Table 1. Observers Contributing to This Report.

Observer	Telescope cm.	f/	Type	Location
Celestian, S.	20	10	S.-C.	Arizona, USA
Garcia, G.	20	10	S.-C.	Illinois, USA
Gelinas, M.	20	10	Refr.	Quebec, Can.
Graham, F.	18	8	Refr.	Ohio, USA
Hill, R.	6	11.5	Refr.	Arizona, USA
Maxson, P.	15	10	New.	Arizona, USA
	20	8	New.	
Morris, R.	5	30	Refr.	Colorado, USA
Morris, W.	15	5	New.	New Jersey, USA
Rousom, J.	8	5	Refr.	Ontario, Can.
	13	10	New.	
Tao, Fan-Lin	13	?	Refr.	Yuan-Shan, Rep. of China
Tatum, R.	18	15	Refr.	Virginia, USA
Timerson, B.	15	8.5	New.	New York, USA
VanHoose, D.	11	8	New.	Virginia, USA
Vargas, A.G.	20	8	New.	Bolivia

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

Rotation 1803
(1988 JUN 05.04 to 1988 JUL 02.24)

Sunspot Number	Mean	Maximum (Date)	Minimum (Date)
RI	104.9	173 (JUN 09)	53 (JUN 14)
RA	111.1	169 (JUN 08)	52 (JUN 13)

This rotation saw much excitement when flares in two regions (**SESC 5047** and **5060**) gave rise to auroral displays across the northern latitudes. Because of extensive coverage in many publications (e.g., *Astronomy*, Oct., 1988, pp. 99-100); *J.A.L.P.O.*, *32*, Nos. 11-12, Oct., 1988, pp. 260-262) these two regions will not be reviewed here. Instead, other regions, that under normal conditions would be impressive in their own right, will be discussed.

Our report opens with a region that came onto the disk already well-developed and died only two days before it would have passed around the W limb. This was **SESC 5036**, first seen on JUN 05 by Garcia, Rousom, and VanHoose as four spots with penumbrae and bright faculae between them. When the region had come into full view the next day, it was seen as a very complex group, consisting of six collections of spots in penumbrae with a number of umbral spots surrounding them. The total length of the group was about 10 degrees. Four of these collections were in an E-W line, with two more N of the last following spot. On JUN 09 there were fewer spots with penumbrae and the group was more chaotic. In the lead were three spots with penumbrae; arranged such that two of the spots were in an E-W line with the third to the N. Following these were two spots in a N-S line. All around these were small umbral spots. Although this group still had two days until its central meridian passage, it was beginning to decay. By the next day, only one lead spot had a penumbra; there were three follower spots with penumbrae, but they were smaller and there were fewer of the small umbral spots. In H-α, R. Morris saw the region to be fairly quiet with a distinct filament dividing it between the leader and the follower spots. This feature was probably delineating the magnetic polarities. On JUN 11, this region was on the central meridian and the leader spot was the only one with a proper penumbra. Following it were a few umbral spots with rudimentary penumbrae. From this time on, the region dramatically shrank in area and in number of spots until, by JUN 17, there was nothing left in white light.

The other notable region in this very active rotation was **SESC 5062**. In some ways it was more interesting than SESC 5060, which was on the disk to the S. However, no observers made any regional drawings or photographs of SESC 5062 because of their interest in SESC 5060. In other circumstances, SESC 5062 would have been more impressive.

SESC 5062 was first seen as one spot with a penumbra, followed by a collection of umbral spots. H-α whole-disk photographs showed SESC 5060 as large and bright, dominating the disk. However, SESC 5062, although smaller, was equally bright. H-α views on JUN 30 and JUL 01 showed SESC 5062 as a complex region with a clear division between its magnetic polarities. For some distance around the region, fibrils [short-lived dark strands of gas. Ed.] were strongly aligned radially. On JUL 02 the region consisted of one large leader spot with four to six umbrae in one penumbra, followed by six more spots with penumbrae and many umbral spots; all arranged in an E-W line, as shown in *Figure 22* below. This type of configuration is an excellent source for flares; Patrick McIntosh of SESC/NOAA calls this type of formation "a linear accelerator." There were also many thin bright light bridges in the leader spot.

As a personal note, I was testing a new telescope designed to detect white-light flares (WLFs) and managed to see some in the leader spot on JUN 30 and JUL 01. While I was visiting Co-Recorder Paul Maxson in Phoenix, Arizona, we saw bright points in one of the light bridges that later turned out to be a subflare. This light bridge also observed by

Figure 22. Solar Regions SESC 5060 (top) and SESC 5062 (bottom), drawn by John Rousom on 1988 JUL 02, 13h40m-14h00m. 13-cm. reflector, 5 cm.stop, 50X. North at top, celestial west to left (reversed image). Reduced to about 12 cm. to the solar diameter.

my wife, who is not an experienced solar observer, but who has observed other objects.

Also on JUL 02, a white-light photograph by Gelinas showed a bright spot in the penumbra of the leader spot of SESC 5062. The next day saw the maximum area for this region, when an excellent photograph by Paul Maxson showed the leader spot to be fairly round, followed by a line of seven collections of umbral spots with penumbrae! This E-W line of spots was nearly 20 degrees long with virtually no free umbral spots involved. In H-α, R. Morris showed a plage [bright patch; Ed.] following the leader spot and surrounding the following spots. By then, both SESC 5060 and SESC 5062 were visible to the naked eye! By JUL 04, SESC 5062 had decayed dramatically and was no longer visible to the naked eye. The leader spot was still round, but had only two spots with penumbrae following. These were followed by many umbral spots. SESC 5062 now decayed rapidly.

Rotation 1804
(1988 JUL 02.24 to 1988 JUL 29.44)

Sunspot Number	Mean	Maximum (Date)	Minimum (Dates)
RI	107.4	157 (JUL 29)	76 (JUL 25&26)
RA	104.5	151 (JUL 29)	82 (JUL 25)

The first week of this rotation was dominated by the decline of SESC 5062. Otherwise, Rotation 1804 was characterized by smaller groups with many umbral spots, giving the high spot counts and means.

One group, **SESC 5075**, became naked-eye during this period. It was first seen by Section observers on JUL 12 as a huge group consisting of a large leader spot followed by several big spots; all with extensive penumbrae and surrounded by about a half-dozen umbral spots. A H-α photograph on JUL 13 showed the leader and follower spots separated by a plage running N-S. Preceding the leader spot was a lone round spot, designated **SESC 5074**. On a drawing by Rousom and a photograph by Maxson on JUL 15, the penumbra of the leader spot was seen as quite complex on the following side. The penumbral material there was disorganized; with many enclaved bright spots and umbrae, some bordering directly on the photosphere. By then, the following spot was the only one with a penumbra, and the N edge of its umbra touched the photosphere. Between the leader and the follower was a jumble of umbral spots with rudimentary penumbrae. The next day, JUL 16, saw little change, with more detached rudimentary penumbrae between the leader and the follower spots. On that date, R. Morris caught a 1F-class flare in a H-α whole-disk photograph, shown in *Figure 23* on p. 130. [A 1F flare is faint and occupies 100-250 millionths of the visible hemisphere. Ed.] The flare was actually in **SESC 5076**, which appeared on this date as a small collection of umbral spots on the N edge of SESC 5075. Color photographs by Garcia on JUL 17 showed remarkable spiral penumbral appendages radiating from the leader spot and spiraling in a clockwise (E to N) direction. This pattern even was evident in H-α and in the chromospheric fibrils! This was to be the last hurrah for this region, because by JUL 18 its complexity and area were reduced. Many of the appendages had by then detached to the N and E. There were now three other regions that had formed within a 10-degree radius of SESC 5075; SESC numbers **5074**, **5076**, and **5079**. These made a confusing sight in white light. It can often be difficult for the amateur observer to determine what is a true group (i.e., magnetically associated spots) and what is not. But when features become so crowded, this decision is simply impossible in white light. For JUL 20 and 21, we received only H-α photographs, which showed a large N-S filament that had formed to the E of this area, promising a nice limb prominence to come. By JUL 22, the groups were nearing the limb. The filament was now large and 20 degrees in length. In white light the groups were now much reduced, with many faculae. Part of the penumbra of the leader spot was detached to the N; otherwise it was fairly symmetrical. There was little change in the group as it passed behind the limb. The filament broke up on the last day of visibility, JUL 23, never producing a prominence of consequence.

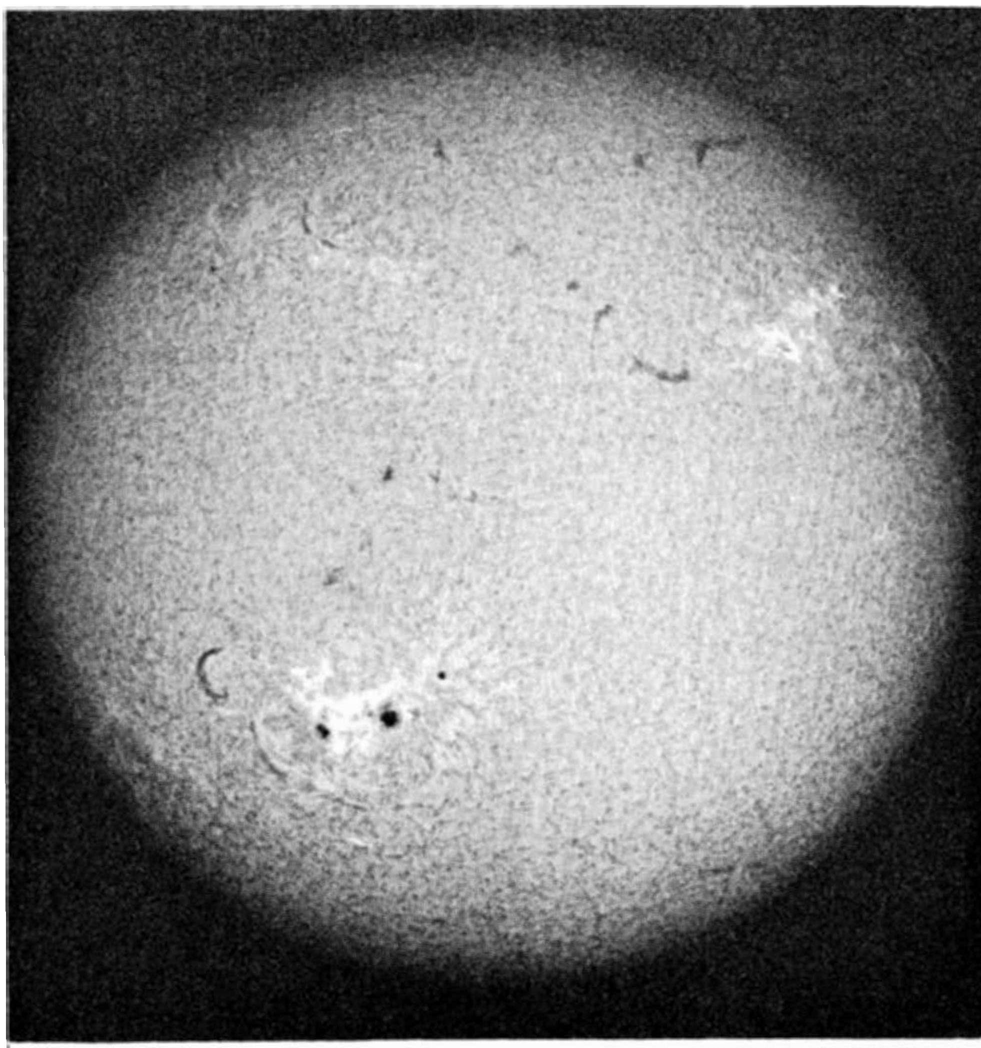

Figure 23. Hydrogen-α photograph of the Sun by Robert Morris on 1988 JUL 16, 16h27m. 5-cm. refractor at f/30; 1/250-second on Kodak TP2415 Film. SESC 5075 includes the two large spots to the lower left; a small flare is located in SESC 5076, just above SESC 5075. North at top, celestial west to the right, in this unreversed view.

Rotation 1805
(1988 JUL 29.44 to 1988 AUG 25.68)

Sunspot Number	Mean	Maximum (Date)	Minimum (Date)
RI	106.7	171 (AUG 09)	22 (AUG 22)
RA	106.4	171 (AUG 09)	24 (AUG 22)

In this rotation the highs were higher, and the lows lower, than in Rotation 1804. This was due to activity's being concentrated more in one longitudinal hemisphere than the other. On average, the regions were larger in area than before; but the largest ones were smaller than the largest of the previous rotation. The lows of this rotation were the lowest for this entire reporting period. However, there were two noteworthy centers of activity in this rotation. The first was **SESC 5092**; and the second consisted of the "Siamese Twins," **SESC 5105** and **SESC 5106**.

SESC 5092 was complex as it came onto the disk on JUL 28. It had a leader that consisted of two spots in a N-S line, but elongated E-W with umbrae bordering on the photosphere between them. Their latitude was 25°N, but faculae extended for some 10 degrees N and S of them. Following these were three main spots aligned N-S with their penumbrae rather large in terms of their umbrae. Faculae lay close to these spots and, in H-α , a bright plage could be seen around the follower spots. On JUL 29, in white light, a thin penumbral bridge was seen, extending from the N of the E leader spot (which had been the S leader spot) to the S of the W leader spot. There was little change in the following spots. In H-α there was less plage area but many small bright points around the follower spots. These points were very bright and very small. By JUL 30 the leader spots were coalescing. The easternmost one was now the largest, with at least a half-dozen umbrae. There were faculae visible all around the region, extending some 30 degrees into the disk. The S following spot was now decreasing in area. The middle one was the largest of the three, and becoming more nearly round. The northernmost spot had taken on a "L" shape and was comprised mostly of penumbral material. H-α views now showed the plage to be large, extending from the E leader spot to the NE through all three follower spots and even slightly beyond them. By the next day there was little change, and H-α photographs showed the region as being followed by a large E-W filament.

August opened with the W leader spot having moved N of the E leader spot, with the penumbral connections still intact. Only two follower spots remained as the earlier S one had decayed. Overall, the region had taken on the appearance of an elongated rectangle with its corners marked by four main spots. This rectangle was elongated E-W some 15 degrees, being just 5 degrees N-S. On AUG 02, the W leader spot was again moving back to the E to the N of the E leader spot. Both leader spots were becoming more nearly round. The umbrae of both spots again had their interior sides bordering directly onto the photosphere. The N follower spot was chaotic, with a rudimentary penumbra and detached penumbrae surrounding it. The S follower was little changed. However, a day later, the S leader spot was starting to break up and its penumbra was then rudimentary. The N leader spot (the former W leader) was becoming more nearly round and symmetrical. The follower spots were much as before. On AUG 04, there were three follower spots again. While the S one was unchanged, the N one had split into E and W portions. There were a number of umbral spots around all the followers. Two days later, as SESC 5092 was nearing the limb, the leader spots had been reduced to small spots with rudimentary penumbrae. Following them were three quite round main spots with penumbrae, surrounded by umbral spots and detached penumbrae. As the region left the disk on AUG 07, the leaders were reduced to only a few umbral spots. The following spots were a jumble of umbral spots in rudimentary penumbrae, all elongated E-W. In H-α there was a bright crack running E-W through the middle of the jumble. Such an area is a good place to search for flares. On the last day of visibility, AUG 08, the leaders had already left the disk. The follower spots, all with penumbrae, now numbered five, arranged as a rectangle with a dot in the middle. The region was accompanied by many faculae.

SESC 5105 and **SESC 5106** came onto the disk on AUG 07, as SESC 5092 was leaving, located at latitude 20°N in the position of the old region SESC 5082. AUG 08 was the first day on which we had good observations of this area. Both regions had a leader spot with a penumbra, followed by an E-W oriented collection of umbral spots. SESC 5105 had a projection extending NE from the leader spot; other than that, the two groups appeared startlingly alike, even their faculae being similar. For this reason, the two regions were nicknamed the "Siamese Twins." When I received the first photographs of these regions, I suspected double exposures! However, a detailed look set things right, and they were easy to tell apart several days later. By AUG 10, SESC 5105 comprised a leader spot that itself was a N-S collection of a half-dozen spots in one penumbra with a bright light bridge cutting through it. Following this was an E-W collection of umbrae in rudimentary penumbrae. Meanwhile, SESC 5106 consisted of two leader spots and two follower spots. The foremost leader was round and symmetrical; with a radial penumbra that was followed closely by a few umbral spots in a rudimentary penumbra. The follower spots both had developed into umbrae with penumbrae that touched without merging. Clearly, these two groups were no longer twins! The appearance of the Sun on 1988 AUG 10 is shown below in *Figure 24*.

On the next day, SESC 5105 had rotated some 60 degrees counterclockwise and had coalesced into one elongated spot. Its follower spots were unchanged through all of this. SESC 5106's first spot was unchanged, but the second leader spot was now a group of umbrae strung out in a line, with rudimentary penumbrae that trailed out to the S of the follower spots. The changes were quite dramatic. The twin appearance returned on AUG 12, when SESC 5105 had both a leader and a follower spot that were elongated E-W due to the further rotation of the leader, mocking the appearance of SESC 5106. The latter region had lost the line of spots it had before and now had simply an E-W elongated leader and follower. From this point on, the spots decayed uniformly. By AUG 16, they had lost their penumbrae, and they left the disk on AUG 20 as two similar groups of umbral spots.

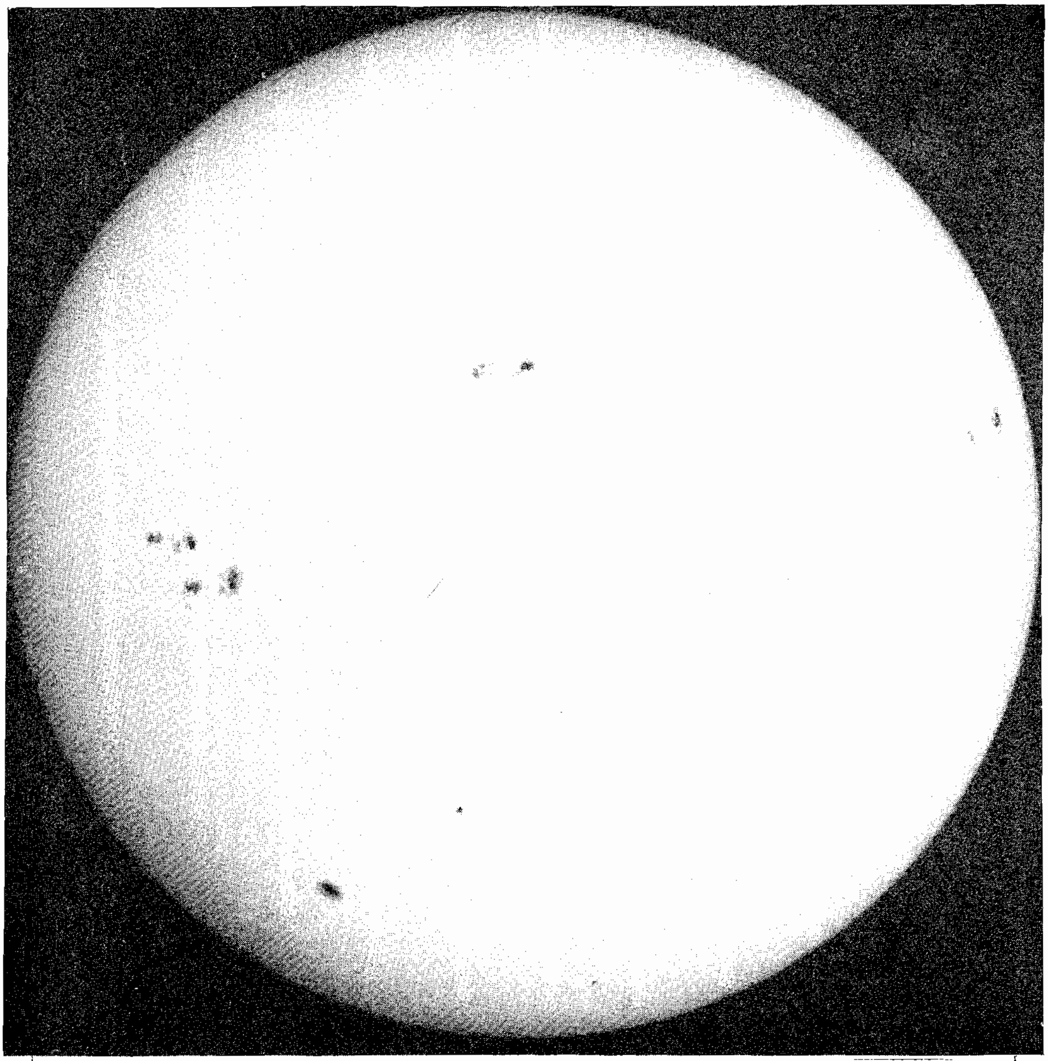

Figure 24. Whole-disk solar photograph by Paul Maxson on 1988 AUG 10, 15h 45m. Taken with a 15-cm. (6-in.) f/10 Newtonian reflector on Kodak TP2415 Film, 1/250 second with a Wratten 47 (blue) filter. Sky conditions fair; 1-3 arc-second seeing. North at top; celestial east is to the left in this unreversed view. To to center left are SESC 5105 (lower) and SESC 5106. (These are the only spot groups in this photograph that are discussed in the text.)

Rotation 1806
(1988 AUG 25.68 to 1988 SEP 21.94)

Sunspot Number	Mean	Maximum (Date)	Minimum (Date)
RI	118.8	168 (SEP 21)	74 (SEP 09)
RA	120.4	170 (SEP 21)	80 (SEP 09)

This rotation saw a notable increase in activity, with **SESC 5129** and **SESC 5131** the largest and best-observed regions of this rotation, attaining naked-eye visibility when at their best.

SESC 5129 came onto the disk on AUG 26 at latitude 18°S, followed the next day by **SESC 5131** at 20°S; thus, SESC 5129 was to the NW of SESC 5131. When on the limb, they were noted by Hill, Maxson, and R. Morris (the last in H-α) as four spots with penumbrae, arranged in a SE-NW rectangle, and some umbral spots. There was a large filament dividing the two regions. When they came into better view on AUG 28, it could be seen that SESC 5129, consisting of two spots with penumbrae, was substantially smaller in area than SESC 5131. In the vicinity of the umbrae, these penumbrae attained almost the brightness of the photosphere. There was only a small amount of facular material.

SESC 5131 had a large leader spot with a well-developed penumbra and a small detached portion following. Following this was a collection of at least three spots with penumbrae. In H-α, a bright region S of SESC 5131 could be seen, while the former filament was much reduced in size. By AUG 29, the leader spot in SESC 5131 was elongated N-S with a half dozen umbrae in one penumbra. A middle spot had formed from the detached leader material and consisted of a line of umbrae in a rudimentary penumbra. The follower spot was much larger, in one penumbra with a large hole in the center. It appeared that one of the former three spots had formed an arc to the N with its ends attaching to the other two spots, which were now merged, at the E and W.

By AUG 30, SESC 5129 was decaying rapidly, but SESC 5131 was visible to the naked eye and very complex in structure. The latter region's leader was a large collection of spots with penumbra on the preceding or W side only. The middle spots were actually two parallel rows of spots with rudimentary penumbrae almost touching the leader spot. There was a gap between the middle and the following spots. The following spots were composed of the N arc, already mentioned, which was beginning to separate on the E side from the massive semicircular spot to the S. In H-α there was a small but bright plage around the W side of the follower spots. A N-S filament now cut the group in half between the middle and follower spots; right through the gap, which probably delineated the polarities of the region. Excellent photographs by Celestian on AUG 31 showed the leader and middle spots to have merged. There were many bright thin light bridges within the new spot; these light bridges are good places to watch for flares. Following this spot, the N arc had continued separating from the large spot, but still had a bridge of penumbra connecting the spots. Between the leader and follower was a string of umbral spots with rudimentary penumbrae. On SEP 01, SESC 5131 was still visible to the naked eye. The appearance of the disk on this date is well shown on a photograph by Celestian, reproduced on p. 134 as *Figure 25*. The leader was one large spot, cut SW-NE by a thin light bridge. The arc had finally separated from the main body of the follower spot and was decaying. By then, SESC 5131 was only a collection of umbral spots with a rudimentary penumbra to the N. There were still some umbral spots between the leader and the follower. As this region reached the central meridian, all its spots were decaying. Also, SESC 5129 was only one spot with a penumbra, and there were two umbral spots to the NW of SESC 5131. The leader of SESC 5131 was in several pieces, each becoming more nearly round with some detached pieces decaying. Following the group, the arc was still decaying, while the S spot was becoming more rounded with a few umbral spots to its W. From this point on, the spots continued decaying by becoming more nearly round and smaller. SESC 5131 was no longer a naked-eye group. When its neared the limb on SEP 07, Rousom noted "complex faculae."

Rotation 1807
(1988 SEP 21.94 to 1988 OCT 19.22)

Sunspot Number	Mean	Maximum (Date)	Minimum (Dates)
RI	135.4	190 (SEP 23)	109 (OCT 01&15)
RA	134.2	176 (SEP 23)	109 (SEP 29&30)

In this rotation, we witnessed the highest levels of activity ever seen in the seven-year history of the A.L.P.O. Solar Section (which was established at the 1982 A.L.P.O. Convention). The groups tended to be less well-developed than those of the previous rotation, and consisted mostly of many umbral spots. However, one region, **SESC 5175**, did reach respectable size, although even this was nothing like the previous SESC 5047 or SESC 5060!

As **SESC 5175** came onto the disk on OCT 02 at latitude 20°S, it was preceded by a large prominence at 40°S. White-light drawings by Hill and VanHoose, and excellent large-scale photography by Maxson, showed three major spots in a row with penumbrae but few faculae. One of R. Morris' numerous H-α observations showed a plage among the spots.

The next day, a filament formed to the S, and a weaker one to the N. Two days later, the S filament was gone and the group was reduced to two spots. The follower spot was decaying, while the leader was becoming more round. On OCT 06, the lead spot, while being more nearly round, was larger and had attained naked-eye visibility, with an area of about 600-700 millionths of the solar disk. There were a few umbral spots to its S, with a small penumbral tail to its E. The follower spot consisted of a collection of small umbral spots in a penumbra elongated E-W. The H-α plage was decaying. The maximum area of the group occurred the next day, with over 90 percent of the area in the leader spot, which was still a naked-eye spot. Also, some rapid activity was recorded by Maxson in white light. At 15h 50m, there were two small spots S of the lead spot. One was directly S, with two good-sized umbral spots and penumbra to the W. To the SW were several small umbral spots in a rudimentary penumbra. The follower spot had penumbra on all sides, and was followed by a half-dozen umbral spots. Four and one-half hours later, the penumbra to the S of the lead spot was very disturbed. The small spot directly S was surrounded by detached penumbra from the lead spot. The other spot was by then only an umbral spot with a thin penumbral bridge connecting it to the W side of the leader spot. Between them, there was an island of detached penumbra. The follower had lost its penumbra and half of its umbral spots. *Figure 26* (p. 135) shows this spot's appearance in a drawing by Rousom at 21h 36m.

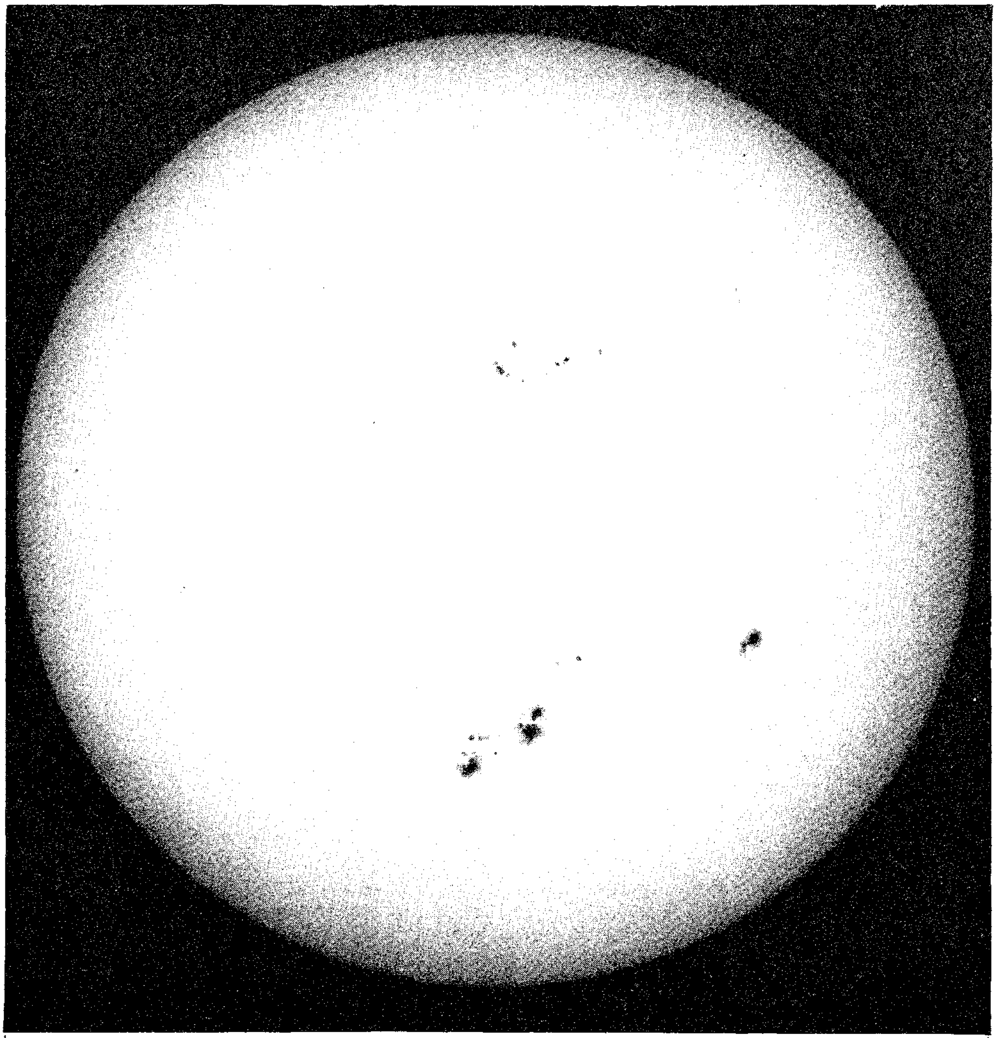

Figure 25. White-light solar photograph by Stan Celestian on 1988 SEP 01, 19h 15m . 8-inch (20-cm.) Schmidt-Cassegrain at f/10, using Kodak TP2415 Film at 1/500 second. North at the top; unreversed view with celestial west to the right. Group SESC 5131 is below the center, with SESC 5129 to its right.

Quite rapid changes indeed! This points out our need for meeting the goal of having photographs and/or drawings for every degree of solar rotation, or approximately every 2 hours. By the next day, all spots were decreasing in area. The follower once again had a penumbra, and the penumbral island S of the lead spot was gone. Classical decay continued through OCT 09, when the spots S of the leader merged with that spot as the entire spot became smaller and more nearly round. Following that spot were two small collections of spots in penumbrae. The middle spot, which was the former follower, was becoming quite round. As this region headed toward the limb, all its spots continued to decrease in area and to become less complex. In H-α, the region developed some bright points S of the leader and N of the middle spot. Beyond this, little else transpired.

CONCLUSION

The impressive activity detailed in this report is minor compared to that being experienced now (July, 1989). This solar cycle is living up to predictions and is likely to be the most active ever. Don't let time slip by. We need your observations of our nearest star. However, if you do decide to observe the Sun, please use the standardized forms found in the Section Handbook (cited on p.127). For example, several good photographs which we received could not be credited because incomplete data accompanied them.

At present, it takes the writer several weeks of intense effort to produce one of these reports. Because no comments are ever received, we do not know if this effort is appreciated. If there are parts of this report that are useful to you, or items that you think could be improved, a postcard would be welcome! What is it about any given rotation or activity region that you find interesting? Write your ideas down and send them in. After all, I can't change things if I don't know what it is that needs changing!

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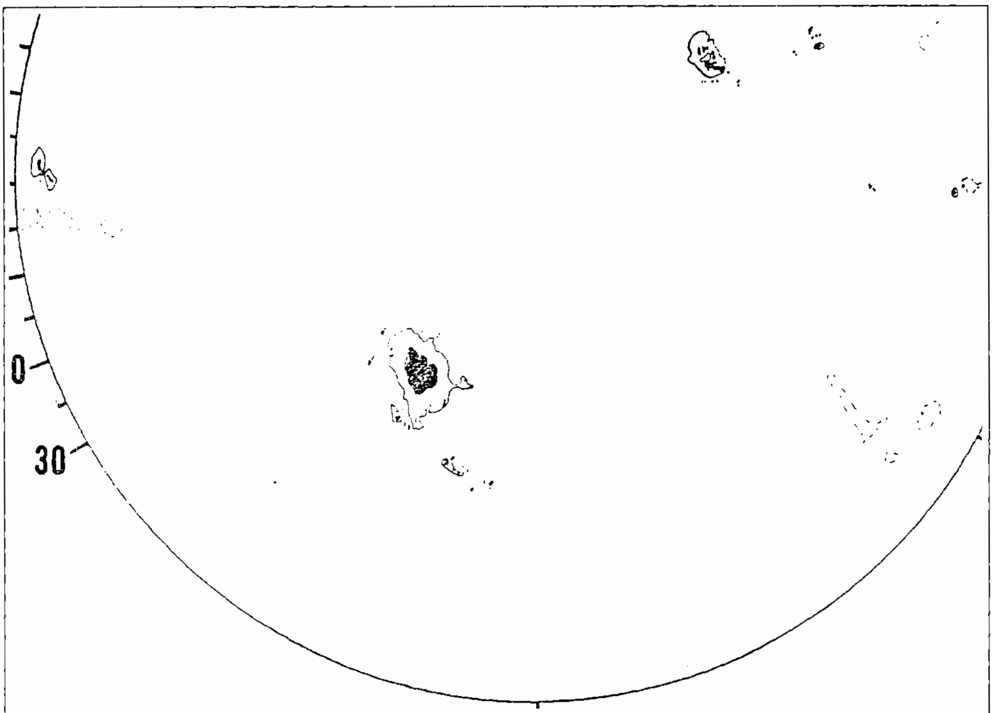

Figure 26. Equatorial section of a whole-disk white-light drawing by John Rousom on 1988 OCT 07, 21h 36m. 8-cm. refractor at 80X with a full-aperture filter. Seeing excellent. Reversed view, with north to the top and celestial west (preceding) to the left. SESC 5175 is slightly below and left of the center.

COMING SOLAR SYSTEM EVENTS: AUGUST-OCTOBER, 1989

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

PLANETARY VISIBILITY

Mercury offers us two apparitions this season. Using our previous criterion of at least a 15° elongation from the Sun, the first apparition lasts from August 2nd through September 17th, with the greatest elongation of 27°.3 east occurring on August 29th. This apparition is in the evening sky and favors our Southern Hemisphere. The second apparition, running from October 5th through 19th, peaks on October 10th with an elongation of only 18°.0 west; it's a morning apparition and, although not favorable, is best seen in our Northern Hemisphere.

Venus gradually pulls away from the Sun, with its elongation increasing from 31°east to 47°east during these three months. Nonetheless, it is moving south and will be rather low in the western sky after sunset for the Northern Hemisphere. Its disk increases in size from 12 to 23 arc-seconds diameter, with a corresponding phase change dropping from 84 percent to 53 percent illuminated.

As for **Mars**, only true enthusiasts will be watching it because it is in conjunction with the Sun on September 29th. Even at the beginning of August, the Red Planet is only 19° from the Sun and only 3.6 arc-seconds across. However, we do advise watching Mars on August 5th, even if you must locate it in the daytime sky. At 21.9h U.T. on that date, Mercury passes just 47 arc-seconds north of Mars. Their magnitudes are -0.5 and +1.8, respectively, and they are just 18° east of the Sun at this time.

On the other hand, **Jupiter** is becoming easier to observe in the morning sky as it draws away from the Sun; by October it is rising about midnight; by November it is at magnitude -2.5, 43 arc-seconds in diameter; and, at declination +22°.8, very high in the sky for northern observers.

We are left with **Saturn** as the one planet that will be easy to find and comfortable to watch in the evening sky throughout the current period. For northerners, the one disadvantage is that the Ringed Planet is still at declination -23° in Sagittarius. With its North Pole tilted 26° toward us, however, this is a good time to study the northern face of the Rings and the Northern Hemisphere of the Ball. Note the "White Oval Watch" for Saturn that is described on p. 138.

Uranus and **Neptune** are not far from Saturn in Sagittarius, meaning that they also are well south of the celestial equator, yet conveniently placed in the evening sky.

Pluto is undoubtedly undergoing a heat wave as, on September 5th, it reaches its closest point to the Sun for 248 years! We cannot watch it to advantage, though, because it is moving closer to its conjunction with the Sun on November 7th.

The above covers the major planets; but there will also be seven minor planets that will be brighter than 10th magnitude in the August-October period:

	Opposition Data		
Minor Planet	1989 Date	Magnitude	Declination
16 Psyche	AUG 04	+9.5	16°S
9 Metis	AUG 11	+9.4	24°S
15 Eunomia	AUG 27	+8.1	2°N
12 Victoria	AUG 30	+8.9	7°N
11 Parthenope	SEP 12	+9.1	9°S
2 Pallas	SEP 30	+8.2	11°S
30 Urania	OCT 10	+9.8	10°N

(Ten-day ephemerides of the above minor planets are published in *The A.L.P.O. Solar System Ephemeris: 1989.*)

Note also that the minor planet **1917 Cuyo** passes closest to the Earth—21 million kilometers—on October 10th, when it will be at magnitude +12.9. An ephemeris of this body was published in our last issue (April, 1989, pp. 91-92).

THE MOON

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

New Moon	First Quarter	Full Moon	Last Quarter
AUG 01.7	AUG 09.7	AUG 17.1	AUG 23.8
AUG 31.2	SEP 08.4	SEP 15.5	SEP 22.1
SEP 29.9	OCT 08.0	OCT 14.9	OCT 21.6
OCT 29.6	NOV 06.6	NOV 13.2	NOV 20.2

During this season, the Last Quarter Moon will be the lunar phase that is the highest in the sky for Northern Hemisphere observers, and the First Quarter Moon will be the phase that is the lowest; the opposite is true for southern observers. The other significant lunar visibility condition is the Moon's

librations, or E-W and N-S tilts in relation to the Earth. Extreme librations occur on the following dates in August-October, 1989:

North	West	South	East
AUG 10	AUG 14	AUG 23	AUG 27
SEP 07	SEP 11	SEP 20	SEP 23
OCT 04	OCT 09	OCT 17	OCT 21
OCT 31	NOV 06	NOV 13	NOV 18

The lunar east and west directions above follow the International Astronomical Union usage, with Mare Crisium near the *east* limb.

ECLIPSES

Two eclipses occur in August. The first is a **total eclipse of the Moon** on August 17th, which was discussed in an article in the previous issue (pp. 89-90). In summary, the umbral magnitude is 1.604; the penumbral phase begins at 00h 23m U.T., totality lasts from 02h 20m to 03h 56m, and the penumbral phase ends at 05h 53m. Thus, the entire eclipse will be visible from eastern North America, all of South America, and westernmost Europe and Africa. The later phases only will be visible from the rest of North America, while the earlier phases only can be seen from the remainder of Europe and Africa; and from western, central, and southern Asia.

Two weeks later, on August 31st, is a **partial eclipse of the Sun** of maximum magnitude 0.635 (relative coverage of the Sun by the Moon, with 1.000 or above being total); in the southern Indian Ocean. The only land points where this event will be visible are in southern Africa, Madagascar, and Antarctica.

OCCULTATIONS

The only bright planet occulted by the Moon during this period is **Mercury**, which us blocked by the Moon on September 2nd, at about 15h U.T., as seen from most of South America. At this time, the planet is at magnitude +0.4, 27° east of the Sun. The portions of the Earth where this event will be visible are shown in *Figure 27* below.

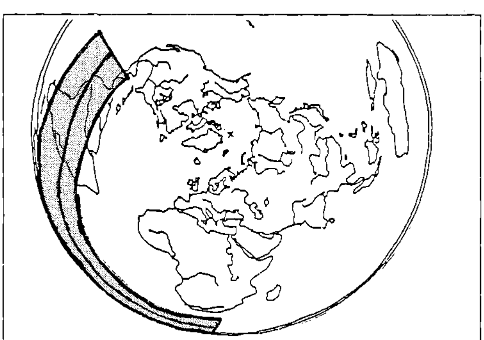

Figure 27. Areas on Earth where the 1989 SEP 02 occultation of Mercury by the Moon will be visible.

The **Pleiades passages** of the Moon continue, with the star cluster (M45) being occulted on August 23rd, 17h, by a 51-percent sunlit Moon as seen from the northern Soviet Union. On September 19th, 23h, a 73-percent illuminated Moon will occult the Pleiades as seen from Europe. Finally, the October 19th passage, with a 91-percent sunlit Moon, will be visible from Canada and the northern United States.

Beehive passages (M44) also occur. A 6-percent sunlit Moon occults this star cluster on August 28th, 18h, as seen from Hokkaido. A similar event, with a 21-percent phase, happens on September 24th, 23h, visible from the western Soviet Union. Then, on October 22nd, 05h, the 43-percent sunlit Moon occults this cluster from the eastern United States.

The Moon also continues with the series of occultations of **Regulus** (Mag. +1.3) and **Antares** (Mag. +1.2) as follows (note that cardinal directions are abbreviated and that the elongation of the Moon from the Sun is given in parentheses):

Regulus—

AUG 03, 07h (19°E)	SE Africa, Madagascar, Indian Ocean, Antarctica.
AUG 30, 14h (8°W)	SE Pacific Ocean, S. America, S Atlantic Ocean, Antarctica.
SEP 26, 20h (34°W)	E Australia, New Zealand, SW Pacific Ocean, Antarctica.
OCT 24, 01h (61°W)	S Indian Ocean, part of Antarctica.

Antares—

AUG 11, 14h (111°E)	SE Atlantic Ocean, S Africa, SE Australia, New Zealand, Antarctica.
SEP 07, 22h (84°E)	S Pacific Ocean, S S. America, S Atlantic Ocean, Antarctica.
OCT 05, 05h (58°E)	E Indian Ocean, Australia, New Zealand, S Pacific Ocean

COMETS AND METEORS

Two known **comets** that will be visible in this three-month period, Schwassmann-Wachmann 1 and Brorsen-Metcalf, have already been described in this issue (pp. 118-121). We refer readers to *The A.L.P.O. Solar System Ephemeris: 1989* for information on three other comets now in the skies: Periodic Comet Gunn, Comet Shoemaker-Holt-Rodriquez, and Periodic Comet Pons-Winnecke.

This period contains two major **meteor showers**, but there are lunar problems. The **Perseids** peak on AUG 12 when there is a 10-day Moon, meaning after-midnight observing is recommended. In the wee hours a zenithal rate of 40-100 Perseids per hour may be expected. Then on OCT 21.1, the brief **Orionids** peak. Unfortunately the Moon is 21 days old then Last Quarter), brightening the sky after midnight, when meteor viewing is normally the best.

There are also seven recognized minor meteor showers in this period, but only two of these peak when moonlight is not a problem; the South Iota Aquarids (AUG 03, 2-day Moon, 1-5 per hour; from JUL 13-AUG 23) and the Annual Andromedids (OCT 03, 3-day Moon; lasting SEP 25-NOV 12).

FEEDBACK FROM READERS

Do you find this column, "Coming Solar System Events" helpful? Do you feel that we should say more about some things, or perhaps less about others? Please drop the Editor a note with your opinions about this feature, so that he can tailor it more to your needs.

A WHITE OVAL WATCH ON SATURN?

By: Frank J. Melillo

Year after year, many observers strive to see any unusual markings or features on Saturn. White spots and ovals are very common on Jupiter, and they are visible most of the time throughout each apparition. The Globe of Saturn is lacking in features when compared with Jupiter, due mainly to two factors: Saturn is about twice Jupiter's distance from the Sun and from us and Saturn's atmosphere is much hazier than Jupiter's.

However, there have been past reports of some large white ovals. In each of the years 1876, 1903, 1933, and 1960, a large white oval was discovered in the planet's Northern Hemisphere. Most of these discoveries were made by amateurs! If you look carefully at the dates above, you will see that they are roughly 27-30 years apart. [Note that Saturn's sidereal period equals 29.4 Earth years. Ed.] By 1989, 29 years have passed without any white oval or ovals being reported. As of now, the Northern Hemisphere of Saturn, which is visible to us, perhaps is more sensitive to the maximum intensity of solar insolation than is the Southern Hemisphere. [Note, however, that Saturn is near *aphelion* when its Northern Hemisphere is tilted toward the Sun. Ed.] Most of these white ovals were seen anywhere from the equatorial region to the North North Temperate Belt (NNTeB).

Right now, Saturn is entering the ecliptical longitude range of 290°-315°, where the white ovals have been observed in the past. [Saturn is in this range between May, 1990, and July, 1992. Ed.] During the next few years, I think it is a good idea to keep a close watch for outbreaks on Saturn's Northern Hemisphere. Perhaps there is a 27-30 year cycle for a white oval to appear when Saturn is in this particular area in the sky.

Without our knowing what to expect, Saturn may surprise us again and therefore we should be monitoring the planet for white ovals.

[Note added by Saturn Recorder, Julius L. Benton, Jr.] Observers are encouraged to contact the A.L.P.O. Solar Section regarding observational procedures and methods; observing forms with instructions are available. Observations should be sent to the Saturn Recorder at the address noted inside the back cover of this *Journal*.

[Editorial note. For data on past white ovals of Saturn, see: A.F.O'D. Alexander, *The Planet Saturn* (London: Faber and Faber, 1962), where there are numerous references listed under "Spots on Saturn" in the index. Besides the dates cited above, white ovals or "spots" were reported in other latitudes in 1891-94, 1941, and 1946.]

IN APPRECIATION OF THE SERVICES OF J. RUSSELL SMITH

By: Walter H. Haas, A.L.P.O. Founder

Mr. J. Russell Smith has resigned his A.L.P.O. staff positions as Secretary and Book Review Editor, because of increasing age. (If you do not yet understand the vexations peculiar to old age, be patient—you will!) He had served as Book Review Editor since 1962 and as Secretary since 1974, when he replaced the late David P. Barcroft, our first Secretary.

Mr. Smith's efforts on our volunteer staff are the kind of dedicated services which have made possible over 42 years the existence of the A.L.P.O. and its contribution to astronomy. Those who have been involved with reviewing books will appreciate how hard it is to find qualified book reviewers and how often their performance falls short of their promises and good intentions. It was J. Russell's idea to use the shorter "New Books Received" review format on many of the books sent to us by publishers. His correspondence as Secretary involved many kinds of letters; among others, requests from enthusiastic children wanting everything free about astronomy and space, requests from students for information to be used in Science Fair projects, inquiries about careers in astronomy, correspondence with subscription agencies (naturally always confused and unhappy with our erratic publication schedule), and responses to a variety of questions about membership and our journal from both domestic and foreign colleagues. Mr. Smith paid out of his own pocket most of the substantial mailing expenses which this work involved. He also mailed extra copies of each issue to book reviewers, publishers, and authors.

One of the founding members of the A.L.P.O. in 1947, our retiring Secretary was a major contributor of visual and photographic Solar System observations for several decades. He presently still possesses a well-equipped private observatory with a 16-inch reflector at a favorable rural site near Waco, Texas. (It is for sale; address inquiries to: J. Russell Smith, 8930 Raven Drive, Waco, TX 76712.)

Let us then join with J. Russell Smith's numerous friends in the astronomical community in saying: "Many thanks for jobs extremely well done."

The present Director here adds his great appreciation for the many services of J. Russell Smith to the A.L.P.O. From his own experience he realizes the demands made by the necessary correspondence of our organization. Also, the book review editing services of Mr. Smith have been invaluable in keeping our readers up-to-date in astronomy.

With Mr. Smith's resignation, the office of Secretary is discontinued, at least for the time being. Many of its functions are now part of the duties of the Membership Secretary.

However, there is no doubt that we continue to need a Book Review Editor. Mr. José Olivarez has kindly volunteered to accept the Acting position of Book Review Editor, effective immediately. We must note here that José also fills two other staff positions—Director of the Lunar and Planetary Training Program, and Jupiter Recorder. Thus, Mr. Smith's resignation makes it clear that too few staff people volunteer for our many functions

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NEW BOOKS RECEIVED

Notes by J. Russell Smith

Comet Predictions for 1988-89. By Charles Townsend, John Rogers, and Chris Spratt. Available from Charles Townsend, 3521 San Juan Avenue, Oxnard, CA 93033. 1987. 38 pages. Price $7.00 postpaid within the continental U.S.A. and $9.00 postpaid outside. Make your check or money order payable to Charles Townsend.

For those interested in comets, this book's chief value is the right ascension and declination positions of comets that it lists, covering Periodic Comets: Reinmuth 1 (1928 I), Finley (1986 VII), Temple 2 (1873 II), Longmore (1974 XIV), du Toit (1944 III), Temple 1 (1867 II), d'Arrest (1851 II), Perrine-Mrkos (1896 VII), Temple-Swift (1869 III), Churymov-Gerasimenko (1969 IV), Pons-Winnecke (1819 III), Gunn (1969 II), Brorsen-Metcalf (1847 V), Lovas (1980 V), du Toit-Neujmin-Delporte (1941 VII), Schwassmann-Wachmann 1 (1925 II), Gehrels 2 (1973 XI), and Clark (1973 V).

Einstein's Legacy. By Julian Schwinger. Scientific American Books. W.H. Freeman and Co., 41 Madison Avenue, New York, NY 10010. 1987. 250 pages, illustrations, index. Price $32.95 cloth (ISBN 0-7167-50911-2).

This book contains the following chapters: "A Conflict Brought to Light," "Marking Time," "$E = mc^2$," "A Matter of Gravity," "Geometry and Physics," and "At the Frontier." Preceding the index is "Sources of Illustrations." This is an excellent book for the advanced student. There are some advanced mathematical equations throughout the book, but one does not have to be a mathematician in order to enjoy it.

Meditations at Sunset: A Scientist Looks at the Sky. By James Trefil. Charles Scribner's Sons, Front & Brown Streets, Riverside, NJ 08075. 1987. 208 pages. Illustrations, index. Price $16.95 cloth (ISBN 0-684-18787-6).

The chapters in this book are: "Meditations at Sunset," "Of Clocks and Calendars," "Spots on the Sun," "When the Sunspots Disappeared," "Clouds," "When Clouds Go Bad," "Whatever Happened to Hurricane Zelda?," "When the Water Won't Boil," "Colors in the Sky," "Roses are Red, But What About Geraniums?," "The Scale of Things, or Why You Can't Get a Suntan Through a Window," "Lightning Bolts and Life," "Lightning Rods and the Research Pipeline," "Ball Lightning," and "UFO's and Other Strange Things in the Sky."

Nebulae—The Birth and Death of Stars. By Necia H. Apfel. Lothrop, Lee and Shepard Books, 105 Madison Avenue, New York, NY 10016. 1988. 48 pages. Illustrations, index, reading list. Price $13.95 paper (ISBN 0-688-07228-3), (cloth ISBN 0-688-07229-1).

I recommend this book, which is well-illustrated in color, for the youngster or the beginner.

In Darkness Born: The Story of Star Formation. By Martin Cohen. Cambridge University Press, 510 North Avenue, New Rochelle, NY 10801. 1988. 220 pages. Illustrations, index. Price $19.95 cloth (ISBN 0-521-26270-4).

The contents of this book are: "Preface," "What Does Astronomy Tell Us?," "What is a Star?," "Our Galaxy," "Where are Stars Born?," "How to Recognize the Youngest Stars," "Nature's Womb," "How and Why Clouds Collapse," "Towards a More Sedate Life," "High Mass Stars and Triggering Mechanisms," "Planets," and "Epilogue."

Gravity's Lens, Views of the New Cosmology. By Nathan Cohen. John Wiley and Sons, Inc., 605 Third Avenue, New York, NY 10158. 237 pages. Illustrations, glossary, index. Price $19.95 cloth (ISBN 0-471-63282-1).

This book's chapters are: "Unveiling the Universe," "After Hubble—Quasars, CBR, and the Standard Cosmological Model," Cosmological Tests and the Cosmic Questions," "The Radio Universe," "Galaxies," "Quasars and the Evolution Revolution," "Micromegas–Inflationary Universe and the Particle Zoo," "Gravity's Lens–The Cosmic Mirage," "Swiss Cheese Universe—Bubbles, Voids, Streaming, and Clusters," " Dark Matter–What and Where is It," "Frontiers—Breakthroughs and Tomorrow's Cosmology," and "Cosmological Conclusions."

The Symbiotic Universe: An Unorthodox Look at the Origin of the Cosmos and the Development of Life. By George Greenstein. William Morrow and Company; order from: Wilmer Warehouse, 39 Plymouth Street, Fairfield, NJ 07006. 1988. 271 pages. Illustrations, glossary, index. Price $18.95 cloth (ISBN 0-688-07604-1).

This book is arranged into a "Prologue: The Second Sun," "Part One: Life," "Part Two: Mind;" and an Appendix, "List of Coincidences." Part One is divided into the chapters: "The Red Giants," "The Anthropic Principle," "Balance," "Blue-White Planet," "Seeds of Life," "Rules of the Game," "The Light of the World," "Space," "The Watchmaker," "The Moment of Creation," and "Grand Unification and the Inflationary Universe." Part Two continues with "The Watchmaker (Reprise)," "Experimental Metaphysics," "Schrodinger's Cat," and "Epilogue: Ocean Voyage." I heartily recommend this well-written book by a Yale scholar.

Universe. By William J. Kaufmann, III. W.H. Freeman and Company, 41 Madison Avenue, New York, NY 10010. 1988. 634 pages. Illustrations, appendices, glossary, Answers to Selected Questions, index. Price $36.95 cloth (ISBN 0-7167-1927-4).

This is an outstanding textbook suited to a one- or two-semester course. The first part covers introductory material and the Solar System; while the second part deals with stars, galaxies, and cosmology. In all, there are twenty-nine chapters.

Race to Mars. The Mars Flight Atlas. General Editors, Frank Miles and Nicolas Booth. Harper and Row Publishers, 10 East 53rd Street, New York, NY 10022. 1988. 192 pages. Illustrations, acknowledgements, index. Price $19.95 cloth (ISBN 0-06-016005-5).

I recommend this book, which is arranged into six Sections: "The Missions," "The Human Factor," "Journey and Arrival," "Mysterious Planet," "Exploring," and "The Future."

The Peterson First Guide to Astronomy. By Jay M. Pasachoff. Houghton Mifflin Co., Wayside Road, Burlington, MA 01803. 1988. 128 pages. Color illustrations, index. Price $3.95 paper (ISBN 0-395-46790-X).

The sections of this book are: "Introducing Astronomy," "Observing the Stars," "Estimating Distances Across the Sky," "The Constellations," "The Milky Way," "Telling the Stars from the Planets," "How to Use the Maps," "Meet the Constellations," "Life Cycles of the Stars," "Stars and Clusters," "White Dwarfs and Supernovae," "Pulsars and Black Holes," "Galaxies," "The Past and Future of the Universe," "Planets and the Solar System," "The Moon," "The Sun," "Tips on Observing," and "Time and Calendars." In my many years of astronomy, I have never seen so much astronomy in such a small book. I recommend it for anyone interested in this field.

Nearby Galaxies Catalog. By R. Brent Tulley. Cambridge University Press, 510 North Avenue, New Rochelle, NY 10801. 1988. 214 pages. References. Price $49.50 (ISBN 0-521-352299-1).

An Introduction is followed by "Table I–A Catalog of Galaxies Within 40 Megaparsecs," "Table II–Reordering of the Catalog by Group Affiliations," and "Table III–The Affiliation of Rich Clusters in Supercluster Complexes." This catalog gives information on 2,367 galaxies. I recommend it for observatories and for the advanced student.

A.L.P.O./W.A.A. Convention.—Don't forget the upcoming W.A.A./A.L.P.O. Convention at the Pasadena Convention Center in Pasadena, California, on August 22-26. Details on this, our 39th Convention, were given in the April issue. In summary: A.L.P.O. and W.A.A. papers will be given on Thursday and Friday, August 24 and 25. The all-night Voyager 2-Neptune Flyby session occurs Thursday night. To date, nine A.L.P.O. papers have been confirmed, and more promised, so we may have two full paper sessions. The A.L.P.O. Business Meeting will be held Saturday morning, August 26. This will be a particularly important Business Meeting because we plan to have Articles of Incorporation for the A.L.P.O. available for inspection and discussion. Following the Business Meeting will be an A.L.P.O. Workshop on Video Imaging of Solar System Objects. To preregister, write: Margaret Matlack, 13617 E. Bailey, Whittier, CA 90601.

Minor Planet 3853 Haas.—The Founder of our organization. Walter H. Haas, was honored recently by having Minor Planet 3853 (1981 WG1) named for him. Minor Planet Haas was discovered on 1981 NOV 24 by E. Bowell at the Anderson Mesa Station of the Lowell Observatory. Our congratulations to Professor Haas on this celestial distinction!

More A.L.P.O. Supporters.—In the last issue we listed our group's present Sponsors and Sustaining Members. Unfortunately, that list was incomplete and we list here those who were omitted. To the list of *Sponsors*, who contribute at least $40 per year, the following should be added: **Dr. Julius L. Benton, Jr.**; **Paul H. Bock, Jr.**; **Kenneth Schneller**; and **Richard J. Wessling**. To the *Sustaining Members* list of those who have contributed $20, we add: **Harvey Herman**; **Lee Morrow**; **Jim Phillips, M.D.**; the **Richmond Astronomical Society**; **Takeshi Sato, Peter C. Scott**; **Don Spain**; **William A. Vance**; and **Dr. Gary K. Walker, M.D.** Generous people like those above are necessary to keep the A.L.P.O. financially afloat, and we express our gratitude to them here.

A.L.P.O. Staff Changes.—As stated above (pp. 138-139), J. Russell Smith has resigned from the positions of **Secretary** and of **Book Review Editor**. The position of Secretary has not been refilled and is discontinued because its functions have been largely replaced by the position of Membership Secretary. We certainly continue to need an Acting Book Review Editor, and José Olivarez has kindly volunteered to fill that post; his address is: 1469 Valleyview Court, Wichita, Kansas 67212.

We also regretfully announce that **Acting Meteors Recorder** John W. Griesé, III, has resigned this post because of time demands. We thank Mr. Griesé for helping out with our Meteors Section this last year. Fortunately, Robert D. Lunsford, an active meteors observer for many years, has agreed to take on this duty. Mr. Lunsford's address is: 161 Vance Street, Chula Vista, California 92010.

Mars Section Changes.—Snowed under by over 6,800 observations that they have received of the 1987-89 Mars Apparition, our Mars Recorders have rearranged their workload by making each responsible for observations received from contributors in a specific geographic area. Also, observers should now write directly to the appropriate Recor-der, rather than to the previous post office box. The Mars Recorders' names, addresses, and regions of responsibility (states are abbreviated) are: **J.D. Beish**, 9460 Toni Dr., Miami, Florida 33157—AL, AR, FL, GA, HA, KY, MS, NC, SC, TN, and VA; **Harry Cralle**, 3902 E. 29th St. (J-4), Bryan, Texas 77802—AZ, CA, CO, KS, LA, MO, NV, NM, OK, TX, UT, and WY; **Carlos Hernandez**, 2714 Plaza Dr., Woodbridge, New Jersey 07095—AK, CT, DC, DE, MA, MD, ME, NH, NJ, NY, PA, RI, and VT; **Don C. Parker**, 12911 Lerida St., Coral Gables, Florida 33156—U.S. territories and possessions and all areas outside the U.S.; and **Dan Troiani**, 629 Verona Ct., Schaumberg, Illinois 60193—IA, ID, IL, IN, MI, MN, MT, ND, NE, OH, OR, SD, WA, WI, and WV.

Thanks to David H. Levy.—From 1985 to the present the A.L.P.O. has been conferring the annual Walter H. Haas Award on some amateur astronomer selected for outstanding contributions to observational astronomy. The past recipients are the late "Chick" Capen (1985), Dr. Donald Parker (1986), Dr. Jean Dragesco (1987), and Dr. John Westfall (1988). The plaque for the award with its inscription has been provided each year at his own expense by Mr. David Levy, writer, observer, and former head of the A.L.P.O. Comets and Meteors Section. He continues to serve us as Assistant Meteors Recorder. We much appreciate Mr. Levy's help in enabling us to recognize excellent work in observational amateur astronomy.

Astronomy and Astrophysics Abstracts.– Many of our readers may not know that the contents of each issue of *The Strolling Astronomer* are cited in *Astronomy and Astrophysics Abstracts*, the standard bibliographic reference in those fields. This series (the "AAA") appears twice each year. If an article is published with an abstract, this series reproduces the abstract. Thus, for all submitted articles that are more than about two pages in length, we strongly recommend that they be preceded by a 75-150 word abstract. Also, we recommend to our Section Recorders that they submit their more substantial publications, such as handbooks, to the AAA so that they may be cited as well. Simply send a sample copy of each publication to: Astronomy and Astrophysics Abstracts, Astronomisches Rechen-Institut, Moenchhofstrasse 12-14, D 6900 Heidelberg 1, F.R. Germany.

New Newsletter.—A new quarterly publication, *The Practical Observer*, is planned and should interest many A.L.P.O. members. The subscription rate is $10 per year, but you may request a free copy of the premier issue by writing: The Practical Observer, 313 Raphael Avenue, Middlesex, NJ 08846-1224.

1990 Astronomical Society of the Pacific Meeting.—The Astronomical Society of the Pacific is venturing its furthest afield yet and is planning its 102nd Annual Meeting for Boston University, Boston, Massachusetts, on July 14-18, 1990. They will meet with the IAPPP (International Amateur-Professional Photoelectric Photometry) and possibly other amateur groups. The A.L.P.O. is one of the groups that has been invited to participate, and we will discuss this option at our 1989 Business Meeting on Saturday morning, August 26, in Pasadena.

1990 JUL 22 Total Eclipse of the Sun.– Just four days after the above Convention the first total solar eclipse in over two years occurs in Finland, the Soviet Arctic, and the Bering Sea. In Helsinki, totality lasts 1m 34s, with the solar altitude just 1°.1. Those interested in viewing this event in Finland should start making their plans now. An international amateur meeting is being planned in eastern Finland after the eclipse date. Travel and lodging arrangements should be made through travel agents or through groups. For information about the eclipse in Finland, the area, and the international conference, write: URSA Astronomical Association, Laivanvarustajankatu 3, SF-00140 Helsinki, Finland.

1991 International Amateur Conference and Total Solar Eclipse.—On 1991 JUL 11 will occur one of the longest-duration total solar eclipses of our century. To coincide with this eclipse, a conference, "Research Amateur Astronomy Symposium," will be held in La Paz, Baja California Sur, Mexico, on July 8-12. This is a symposium, not an eclipse tour, but those in the La Paz area to see the eclipse are welcome to attend the symposium. Beside the symposium session, there will be eclipse viewing from a convenient site in La Paz, a post-eclipse banquet, and an optional historical field trip on July 12 to the viewing site for the 1769 transit of Venus. Attendance is limited, so if you are interested write soon for information to: Corporation for Research Amateur Astronomy, P.O. Box 16542, San Francisco, California 94116, USA.

PUBLICATIONS OF THE ASSOCIATION OF LUNAR AND PLANETARY OBSERVERS

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Association Staff

Director/Editor
John E. Westfall
P.O. Box 16131
San Francisco, California
94116

Founder/Director Emeritus
Walter H. Haas
2225 Thomas Drive
Las Cruces, New Mexico
88001

Membership Secretary
Harry D. Jamieson
P.O. Box 143
Heber Springs, Arkansas
72543

Book Review Editor
José Olivarez
1469 Valleyview Court
Wichita, Kansas 67212

Lunar and Planetary Training Program
José Olivarez
(See address immediately above)

-------Solar Section-------

Richard Hill
(Recorder, General)
4632 E. 14th Street
Tucson, Arizona 85711

Paul Maxson
(Recorder, White Light)
8839 N. 30th Avenue
Phoenix, Arizona 85051

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P.O. Box 209
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(See address of Director/Editor)

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200 Rojo Drive
Sedona, Arizona 86336

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(Recorder, Lunar Dome Survey)
101 Bull Street
Charleston, South Carolina
29401

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Chester CH3 5QA, England

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Recorder
(See address under Lunar Section.)

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(Recorder)
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Miami, Florida 33157

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(See address under Book Review Editor)

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(Assistant Recorder)
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San Jose, California 95124

James V. Scotti
(Assistant Recorder)
Lunar and Planetary Laboratory
University of Arizona
Tucson, Arizona 85721

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(Acting Recorder)
161 Vance Street
Chula Vista, California 92010

David H. Levy
(Assistant Recorder)
(Address care of Acting Recorder)

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(Assistant Recorder)
(See address under Comets Section.)