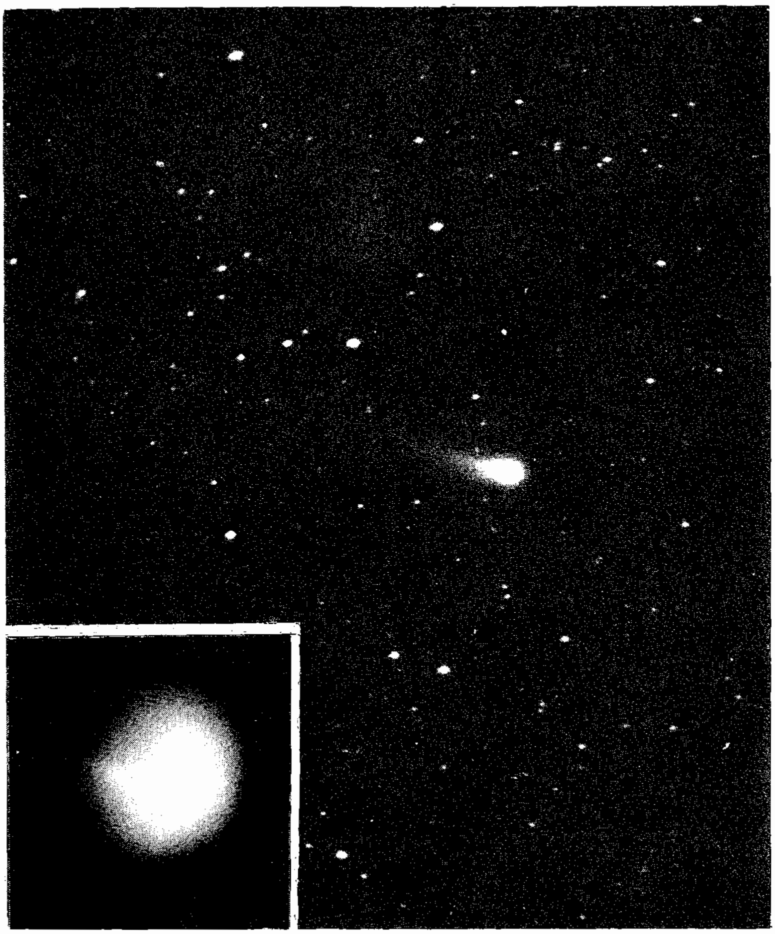
ISSN 0039-2502

The Journal Of The Association Of Lunar And Planetary Observers

The Strolling Astronomer

Volume 31, Numbers 7-8

Published April, 1986



Two contrasting views of Comet P/Halley. The larger view is by Philip Glaser, taken on January 13, 1986, at 03 hr. U.T., with a 200-mm f/8 lens, using hypersensitized Kodak 2415 Film, guided on the comet's coma. This photograph covers 2.4 x 3.0 degrees, in the constellation Aquarius, with north at the top, and shows a 0.8-degree tail to the left of the coma. The inset at the lower left is a CCD red-light view with the 61-in. Catalina Observatory reflector, taken by Stephen Larson and David Levy, University of Arizona, on January 6, 1986, at 02 hr. U.T. In the left portion of the coma is a bright tailward dust jet, the first observed in the current apparition.

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Founded In 1947

IN THIS ISSUE

CALCULATING MARTIAN POLAR CAP LATITUDES

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Introduction

In order to understand a planet's geology and climate, we must obtain precise positions of its surface and atmospheric features. These positions are usually expressed in degrees of latitude and longitude. For over 150 years the filar micrometer has been used for these measurements. More recently, earth-based and spacecraft photographs have been measured with measuring engines. In addition, longitudes may be determined accurately by means of central meridian timings. These methods are described in detail in references [1], [5], and [6].

Old Methods

The authors recently demonstrated that the rate and amount of shrinking of Mars' North Polar Cap (NPC) varies from one apparition to the next [4]. This may be a key indicator of local meteorological variations on Mars as well as of global climatic changes. The NPC regression curves plot the areocentric latitude of the south edge of this cap against the position of the planet in its orbit (measured in terms of L(S), the areocentric longitude of the Sun, or "Martian Date"). Therefore, a study of Martian NPC changes requires that the latitude of its south edge be determined.

Classically, latitude determinations of a planetary feature are done by measuring the distance of the feature from the north limb ("N") and then from the south limb ("S"). [Directions are in terms of the planet's axis. Ed.] The angle, theta, that the feature makes with the apparent center of the disk, is:

$$\text{theta} = \arcsin\,[(S - N)/(S + N)]. \qquad (1)$$

Taking into account the planet's oblateness and the tilt of its axis with respect to the Earth, one can then calculate the planetocentric or planetographic latitude of the feature [5].*

This is the technique employed when the latitude of the Martian NPC south edge is measured from photographs. However, as work by Capen and Capen has shown, using a filar micrometer at the telescope provides a more internally-consistent method for measuring the Martian cap [2]. There are a number of reasons for this, not the least of which is that the human eye can often penetrate thin arctic hazes while the photographic emulsion often blends these into the boundaries of the NPC. These hazes have even caused problems in NPC-boundary measurements from Viking Orbiter imagery [3]!

Unfortunately, when one attempts to determine the latitude of Mars' NPC by measuring its apparent north-south extent, one encounters problems. The cap's edge is at a high latitude, and thus the cap appears extremely foreshortened, so that very small changes in the north-south measurement will result in significant differences in the resulting latitude of the NPC edge. Also, the NPC-regression phase that we are particularly interested in occurs in Martian Northern Hemisphere late spring and early mid-summer, when the cap is quite small, and its apparent north-south extent even smaller. Indeed, many of the reports in which the cap was measured in this manner contain large latitude variations, indicating systematic errors. In order to avoid, or at least to minimize, these difficulties, we measure the Martian Polar Caps across their maximum east-west extents, whch is shown as <u>BC</u> in Figure 1 (p. 138). Ignoring Mars' slight oblateness (1/193), the <u>areocentric latitude</u> of the cap's edge, <u>B</u> , can be directly calculated from the relation:

$$B = \arccos\,(BC/D), \qquad (2)$$

where <u>D</u> is the planet's apparent polar diameter, either obtained directly or derived from the ephemeris diameter and the micrometer screw constant.

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*The planetocentric latitude is measured from the center of the planet; planetographic latitude is the angle between the surface normal (local vertical) and the planet's equator and is affected by oblateness. Note also that this paper assumes that the Polar Cap is centered on the Martian Pole. [Ed.]

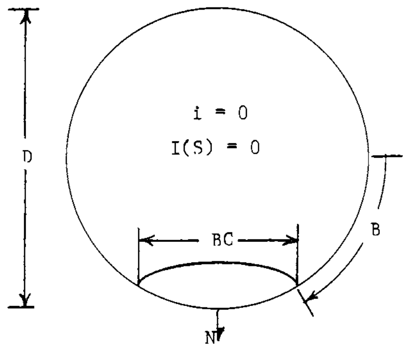

Figure 1. Mars with zero phase defect.

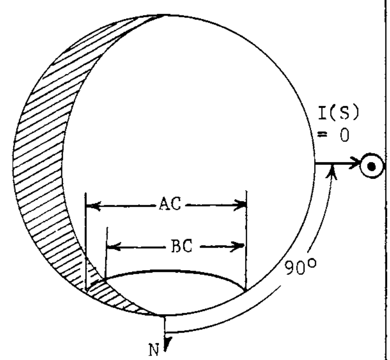

Figure 2. Zero I(S) with phase defect.

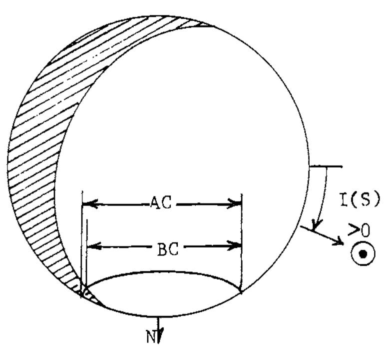

Figure 3. Positive I(S) with phase defect.

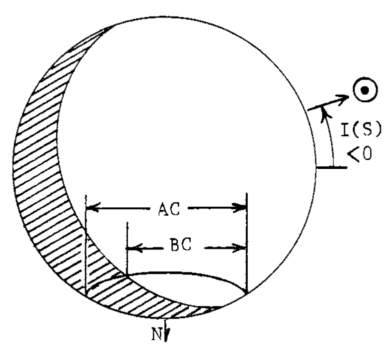

Figure 4. Negative I(S) with phase defect.

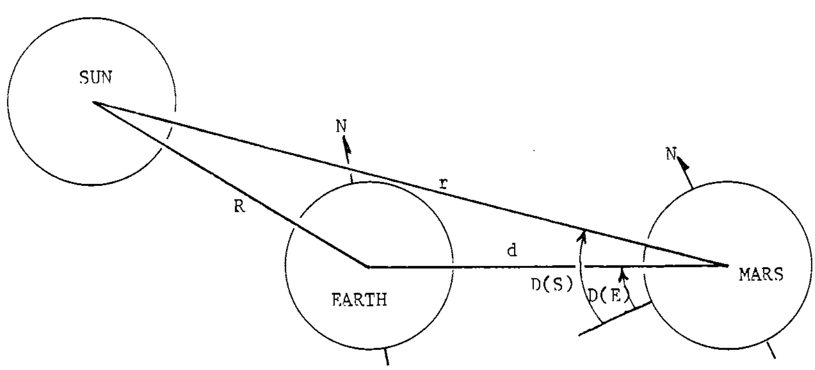

Figure 5. Diagram of Sun-Mars-Earth geometry with areocentric declination of Sun, D(S), and Earth, D(E).

There remains one problem, however; the Martian phase. The Red Planet can have a significant phase defect. Near quadrature, earthbased observers will see less than 85 percent of the disk illuminated. Thus, if we measure BC at such times, what we actually measure will be only 0.85 or less of the total cap width. This is called the phase, k (see Figure 2 above). To correct for this, we simply divide BC by the phase, calling our corrected cap width AC :

$$AC = BC/k, \text{ and,} \tag{3}$$

$$B = \arccos (AC/D). \tag{4}$$

This procedure is fairly straightforward and for many years has been the standard practice for explorers of the Martian arctic. However, for the past few years the authors have been troubled by the fact that equations (2) - (4) apply only when the incidence angle of the Sun as measured from the east-west points on the Martian limb, I(S), is 0. This angle is derived as follows:

$$I(S) = 270^{\circ} - [PA(D) - PA(A)], \text{ (before opposition), or} \tag{5a}$$

$$I(S) = 90^{\circ} - [PA(D) - PA(A)], \text{ (after opposition),} \tag{5b}$$

where: PA(D) is the Position Angle of the Defect, and,
PA(A) is the Position Angle of the Axis.

Examination of Figures 3 and 4 (p. 138) reveals that, if I(S) is positive, less of the cap will be invisible and, if I(S) is negative, more of the cap will be hidden by the phase defect, than would be calculated from equation (3).

Another problem leading to systematic errors in polar cap measurement is the fact that the cap may be wholly illuminated. Also, Mars may be tilted sufficiently toward the Earth that less of the cap is on the unilluminated hemisphere of Mars, making equation (3) less accurate.

While the authors realize that the phase effects described in the previous two paragraphs are minor and have little effect on their previous NPC measurements, they feel that, under some circumstances, these phase effects can cause significant errors. For this reason, and for the sake of mathematical precision, they have attempted to condense the process of Martian NPC latitude determination into one mathematical model.

In addition to the incidence angle of the Sun, I(S), it was initially thought that the declination of the Earth as seen from Mars, D(E) (Figure 5), was a significant variable. After careful analysis of the problem, it is now evident that only the declination of the Sun in the Martian sky (D(S)), and therefore the angle of the Sun with respect to the Martian equator, enters into the complex equations which derive the formulae for position angles. Corrections are independent of D(E) because the cap's relation to the terminator is not affected by the relative positions of the Earth and Mars. These planets' relative orbital positions and the axial tilt of Mars do determine which pole and how much phase we see.

Phase Angle Equations

Ignoring oblateness, the phase, k, is the ratio of the minimum apparent diameter to the geometrical diameter. The equation for phase is:

$$k = 0.5\,(1 + \cos i), \tag{6}$$

where i is the Sun-Mars-Earth angle (phase angle), as derived from Figure 5 (p. 138) and the following equation:

$$i = \arccos\,(r^2 + d^2 - R^2)/(2dR), \tag{7}$$

where: r is the radius vector of Mars,
d is the distance of Mars from the Earth, and
R is the radius vector of the Earth (all usually expressed in astronomical units).

The phase angle, i, can also be obtained from the *Astronomical Almanac* or from the *A.L.P.O. Solar System Ephemeris*. Once this value and the incidence angle, I(S), are known (equation 5), one can calculate the corrected phase, k':

Before Opposition:

$$k' = (1 + \cos i)/[1 + \cos I(S)], \text{ if } I(S) > 0, \tag{8}$$

$$k' = \{[1 + \cos i][1 + \cos I(S)]\}/4, \text{ if } I(S) < 0, \tag{9}$$

After Opposition:

$$k' = \{[1 + \cos i][1 + \cos I(S)]\}/4, \text{ if } I(S) > 0, \qquad (10)$$

$$k' = (1 + \cos i)/[(1 + \cos I(S)], \text{ if } I(S) < 0. \qquad (11)$$

Note that, shortly before or after opposition, the phase defect becomes undetectable as the phase approaches 100 percent. Phase corrections for polar cap measurements are unnecessary for phases of approximately 0.99 or more.

Now that the portion of the phase defect which affects the cap has been determined ($\underline{k'}$), we can rewrite equation (3) to give the correct cap width, AC:

$$AC = BC/k', \qquad (12)$$

and, finally, use equation (4) to yield the areocentric latitude ($\underline{B}$) of the edge of the Polar Cap:

$$B = \arccos (AC/D). \qquad (13).$$

Example

Universal Time (U.T.): 1982 JAN 03, 00 hr. 00 min.

Average Cap Measurement = 0.195 mm; Disk Diameter = 0.654 mm.

Mars is before opposition (which occurred on 1982 MAR 31).

$PA(A) = 30^{\circ}.48$, $PA(D) = 293^{\circ}.03$, $k = 0.904$, $i = 36^{\circ}.06$.

$$I(S) = 270^{\circ} - (293^{\circ}.03 + 30^{\circ}.48) = +7^{\circ}.45$$

$I(S) > 0$, so:

$$k' = (1 + \cos i)/[1 + \cos I(S)] = (1 + \cos 36^{\circ}.06)/(1 + \cos 7^{\circ}.45)$$

$$= 1.80840/1.99156 = 0.90803$$

$$AC = BC/K' = 0.195/0.90803 = 0.2148$$

Areocentric Latitude $\underline{B} = \arccos (0.2148/0.654) = \arccos (0.3284)$

$$\underline{B} = +70^{\circ}.83 .$$

In this example, the uncorrected latitude would be + 72.65 degrees, giving a small difference of 1.82 degrees. This may appear to be a small error, but much larger differences may be encountered near quadrature. The effects of systematic errors in the resulting regression curves bear this out, and a 3- to 6-degree error can result during some Martian apparitions.

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EVIDENCE FOR RECENT LUNAR VOLCANISM

By: Michael T. Kitt

Introduction

It is generally believed that the lunar *maria* were filled with basaltic lavas during a period of extensive volcanism which occurred some 3.1 to 3.9 billion years ago, a geologic age referred to as the Imbrian Era. The basis for this conclusion is radiometric dating performed on lava samples returned by the American Apollo and Soviet Luna missions to the Moon. Although minor levels of volcanism are accepted to have occurred just prior to, and after this period, the vast majority of extruded lavas are assumed to have been produced during the Imbrian Era.

However, this paper presents evidence suggesting that lunar volcanism may have continued at significant levels well after the end of the Imbrian Era. The basis for this hypothesis is the anomalous distributions observed for large, fresh lunar craters. In a previous study of the nearside of the Moon it was demonstrated that fresh craters with diameters over 60 kilometers are not randomly distributed, as none of this size is situated on the *maria*. [2] The probability that this observed distribution is the result of a random impact process, calculated on the basis of the binomial probability distribution, was only .00114, an extremely low value. In contrast, the same study showed that fresh craters in the 40-60 kilometer diameter range are uniformly distributed across both the lunar highlands and the *maria*.

This paper presents data for fresh craters located on the lunar farside, and confirms the findings of the nearside study. In addition, the distribution of fresh craters within the *maria* themselves has been investigated and is demonstrated to be non-random. These data can be interpreted as evidence for recent (post-Imbrian) volcanism.

Distribution of Fresh Farside Craters

Using the methods described in the nearside study [2], available Lunar Orbiter photography was used to determine the state of preservation of farside craters having diameters of 40 kilometers or more. [1] A group of nearside highland craters that were unequivocally classified as post-mare (e.g., Tycho, Cavalerius), because their ejecta overlie mare lava flows, were used as reference standards in evaluating the preservation of candidate craters. The following criteria were used for determining whether a specific crater was fresh:

a.	Crater Rims:	Sharply-defined, terracing and slumping details well preserved.
b.	Central Peaks:	Crater must have one or more central peaks.
c.	Crater Floor:	Must show no evidence of flooding with lava or infilling with ejecta.

Photography of the lunar farside was not as systematic as that obtained for the nearside. In addition, the quality of farside photographs is significantly poorer, and only a small fraction of the lunar farside has been photographed at resolutions equivalent to those for the nearside. Large areas were covered using the Lunar Orbiter medium-resolution camera only, which provided full-disk photographs. Lastly, several farside regions were not photographed at the low Sun angles required to bring out the finest detail. As a result, crater ejecta blankets were rarely detectable (even for craters shown to have prominent ejecta blankets from Apollo photographs), and this criterion could not be used for crater classification. A reassessment of the previously-referenced nearside study showed that the degrees of preservation of only crater rims, terraces, floors, and central peaks are effective criteria for discriminating between pre-mare and post-mare craters.

The excellent farside charts prepared by Antonín Rükl were crucial to the success of this study and, with their accompanying instructions, were used for the measurement of farside crater diameters (here usually rounded to the nearest 5 km). [4] The interpretive cartography of Rükl proved an excellent basis for developing a list of over 120 candidate farside craters to be photographically evaluated. Later, these maps were invaluable for establishing the orientation of individual photographs and for making crater identifications in the jumbled crater fields typical of the Moon's farside. The result of this evaluation was a list of 54 farside craters classified as post-mare, ranging in diameter from 40 to 180 km., as listed in Table 1 below.

Table 1. Post-Mare Farside Craters.

Crater	Diam. (km)	Crater	Diam. (km)	Crater	Diam. (km)	Crater	Diam. (km)
Tsiolkovsky	180	Millikan	85	Birkeland	65	Valier	55
Compton	175	Olcott	85	O'Day	65	Kidinnu	50
Hausen	167	Daedalus	80	Bhabha	60	Kirkwood	50
Poynting	120	Robertson	80	Gavrilov	60	Moiseev	50
Sklodowska	115	Langmuir	80	Morse	60	Artem'ev	50
Kovalevskaya	110	Lobachevsky	80	Bridgman	60	Siedentopf	50
Plaskett	105	Hale	80	Maunder	55	De Forest	50
Numerov	100	King	80	Eijkman	55	Krasovsky	45
Lyman	100	Cantor	80	Lowell	55	Dryden	45
Petzval	100	Green	75	Ohm	55	Crookes	40
Vavilov	90	Von Neumann	75	Dante	55	Bjerknes	40
Vestine	90	Coulomb	75	Lucretius	55	Ramsay	40
Scaliger	85	Joffe	70	Sharonov	55		
Berkner	85	Marconi	70	Störmer	55		

The craters listed in Table 1 are plotted on an equal-area projection in Figure 6 (p. 143). They are randomly distributed across the farside of the Moon. Each quadrant contains approximately the same number of craters, and there are no empty or deficient regions. The Mare Orientale locale, strongly depleted in older craters due to the thick overlying ejecta blanket from the Orientale impact, contains roughly the same density of fresh craters as does the remainder of the farside. These observations are consistent with the fact that the lunar farside is essentially composed of highland terrain and should therefore display a uniform density of fresh craters.

The global distribution of large, fresh lunar craters has been tabulated using data from this and the previously-cited nearside survey. Table 2, below, gives crater densities calculated for three broad areas: the nearside *maria*, the nearside highlands, and the farside of the Moon. These densities are expressed in units of craters per million square kilometers. As in the previous study, craters are divided into two diameter ranges: those with diameters of 40-60 kilometers, and those larger than 60 kilometers. The only modification to the previous nearside data is the inclusion below of three libration-zone craters (Hahn, La Pérouse, and Schlüter), whch were classified as fresh but were not included in the original survey.

Table 2. Densities of Fresh Craters.

(Areas and densities are in units of millions of square kilometers.)

Region	Area	Diameter 40 - 60 km. Craters	Diameter 40 - 60 km. Density	Diameter over 60 km. Craters	Diameter over 60 km. Density
Maria	5.7	9	1.58	0	0.00
Nearside Highland	13.3	18	1.35	22	1.65
Farside Highland	19.0	24	1.26	30	1.58

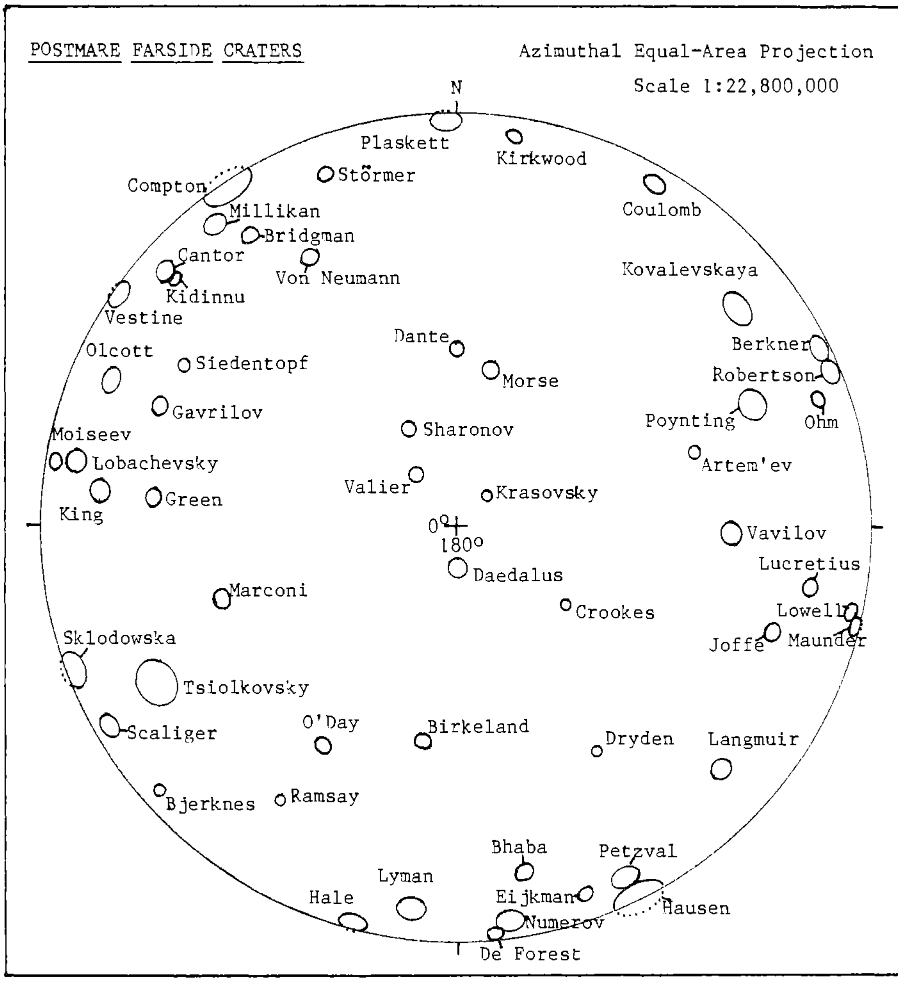

Figure 6. Post-mare lunar farside craters 40 km. in diameter or larger, as listed in Table 1 on p. 142, plotted on an azimuthal equal-area projection, centered on the center of the lunar farside. [Map constructed by Editor.]

It is readily apparent from Table 2 (p. 142) that the density of fresh craters is almost identical for the nearside and the farside highlands, with an average density of 2.9 craters per million square kilometers for all highlands for all craters 40 kilometers in diameter or larger. The proportion of craters in the two size ranges is likewise in excellent agreement for both sides of the Moon. Turning to the maria, we note that the density of craters with diameters of 40-60 kilometers is approximately equivalent to that observed for the highlands. However, none of the 52 fresh lunar craters with diameters over 60 kilometers is located on the *maria* . Using binomial probabilty theory, the likelihood of such a distribution resulting from a random process is only .0002.

To this point, we have demonstrated a significant distribution anomaly for large, fresh lunar craters, which strongly suggests that some non-random process has acted on the *maria* , resulting in a complete lack of large, fresh craters on 15 percent of the Moon's total area. The next step in this investigation involved an analysis of the distribution of craters within the *maria* themselves.

Distribution of Fresh Craters Located on the Maria

Table 2 (p. 142) indicated that there are nine fresh craters in the diameter range of 40 - 60 kilometers that are located on the maria ; these are the craters Aristillus, Autolycus, Bullialdus, Bürg, Cardanus, Harpalus, Lansberg, Plinius, and Seleucus. Every one of these is located near the edges of its respective mare . In fact, no large craters are found within the central regions of any of the circular maria . This basic observation prompted a statistical survey of fresh craters located on the maria . Table 3, below, gives a listing of the 40 fresh craters with diameters of 15 kilometers or greater that are located on the maria ; their diameters are taken from Rükl. [5]

Table 3. Fresh Craters Located on Maria.

Crater	Diam. (km)	Crater	Diam. (km)	Crater	Diam. (km)	Crater	Diam. (km)
Bullialdus	59	Timocharis	35	Theatetus	25	Galle	21
Aristillus	55	Archytas	32	Delisle	25	Le Verrier	21
Cardanus	50	Reiner	30	Helicon	25	Pytheas	20
Seleucus	43	Lambert	30	Sheepshanks	24	Diophantus	19
Plinius	43	Euler	28	Maskelyne	24	Peirce	19
Lansberg	40	Triesnecker	26	Schiaparelli	24	Dawes	18
Harpalus	40	Mösting	26	Lalande	24	Birt	17
Bürg	40	Arago	26	Picard	23	Bessel	16
Autolycus	40	Lavoisier A	26	Protagoras	22	Galilaei	16
Briggs	39	Ross	26	Lichtenberg	21	Nicollet	15

The positions of each of these craters were measured to determine whether they were located within the central 50 percent of their respective maria , or whether they were near the highland margins of the maria , in the outer 50 percent. Only 11 craters, or 27.5 percent of the total, were found to lie within the central portions of the maria . Again using binomial probability theory, the probability of this observed distribution being the result of a random process is .002.

Interpretation of Results

It has been shown that the maria are statistically deficient in large, fresh craters relative to the Moon as a whole. Furthermore, the maria themselves appear to have a non-random crater distribution, with their central regions strongly deficient in medium-to-large craters. Based on the impact theory of crater formation, which specifies that crater density is directly related to the age of the geological strata, a possible explanation for this crater distribution is that the central regions of the maria are much younger than is currently assumed. On this basis, many fresh impacts which occurred after the Imbrian Era ended would have been obliterated in the mare units by subsequent volcanic activity.

Although most basaltic samples returned from the Moon were dated to the Imbrian Era, it must be remembered that all the sampling sites were confined to the extreme edges of the maria . No basaltic samples that are known to have originated from the central regions of the maria have been dated. Accordingly, a younger age for the central portions of the maria is not precluded by field data. An Apollo program finding that supports this hypothesis involves the stratigraphy of the Mare Serenitatis region. The dark annulus girdling this circular mare was long thought from earthbased studies to represent the final stages of lava production in that region. Careful study of the Apollo orbital photography has in fact demonstrated that the dark material represents the older unit, which was later encroached upon by the lighter-color basalts erupting from the central portions of Mare Serenitatis. [3] Although other maria do not show the contrasting lava coloration of Mare Serenitatis, it is possibe that the typical sequence of basin infill has followed the pattern now established for Mare Serenitatis. If so, this would provide an adequate explanation of the anomalous distribution of fresh post-mare lunar craters.

Another point requiring consideration involves the mechanics of crater formation. The highland regions are covered with a layer of rubble which may be two or more kilometers deep. The _maria_ , being much younger and having form- ed after the accretion of the Moon was complete, have a layer of rubble only 5- 20 meters deep. It is probable that a projectile of a given mass and impact velocity, which would result in a very large crater if it impacted in the highly fractured highlands, might result in a substantially smaller crater in the more resistant basalts of the _maria_ . Furthermore, post-impact slumping, which is known to enlarge crater diameters, would be expected to be more pronounced in the highland environment. These factors could provide a reasonable explanation for the complete absence of large craters in the _maria_ .

Conclusion

Based on samples returned from Maria Imbrium, Serenitatis, Fecunditatis, Tranquillitatis, and Crisium and from Oceanus Procellarum, it is currently thought that the _mare_ basins were substantially filled with basaltic lavas by 3.1 billion years ago. Thereafter, all volcanism is believed to have ended except in a few isolated areas (notably in the western regions of Mare Imbrium and Oceanus Procellarum) where crater counts suggest limited lava flows for perhaps another 700 million years. However, all the Apollo and Soviet samples on which these conclusions are based were obtained from the peripheries of the _maria_ , as these were the favored landing sites.

The anomalously-low density of fresh craters within the central regions of the _maria_ is best explained if it is assumed that significant lava production occurred in these areas for 300-700 million years longer than is currently accepted. Impacts occurring during this period within the central portions of the _maria_ would have been obliterated by lava flows, or the resulting craters would have been so degraded as no longer to have a fresh morphology (for example, the crater Marius in Oceanus Procellarum). The complete absence of large (over 60-km. diameter) craters within the _maria_ is further explained if it is assumed that the size of a crater formed by a projectile is in part controlled by the composition and structure of the material in the impact area.

This study demonstrates the need for continued exploration of the Moon. Sampling and radiometric dating of basalts from the central regions of the _maria_ will probably be the only way conclusively to demonstrate the validity of the above hypothesis. Indeed, this is only one of several significant unanswered questions regarding the formation and subsequent geological evolution of the Moon. The need to provide an acceptable margin of safety during the early Apollo missions and the cancellation of several advanced program missions unfortunately resulted in a much too homogeneous selection of exploration sites. As a result, the data from the Apollo missions, while of incalculable value, have left us with a rather incomplete and somewhat oversimplified view of the Moon. Those of us who have gazed in awe at the Moon and have tried to unlock just one more of her many secrets can only hope that the grand mission of her exploration will be resumed within our lifetimes.

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LUNAR ECLIPSES RETURN: APRIL 24, 1986

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

The Circumstances

The last total eclipse of the Moon that was visible from the Americas happened on December 30, 1982 and it is certainly time for another. The total lunar eclipse of April 24, 1986, will be observable in the central and western Americas, the Pacific Basin, and East and South Asia. In the United States, the West Coast and particularly Hawaii will have the most complete view.

Totality will last 65 minutes, with the umbral magnitude 1.208 (1.000 or greater is total). The Moon passes south of the umbral center, with the first umbral contact at position angle 094.°4 and the last at 316.°4. The times of the eclipse's phases are given in Table 1 below.

Table 1. Universal and Local Times of Lunar Eclipse Phases, April 24, 1986.

Event	U.T.	EST	CST	MST	PST	A-HST
Moon enters Penumbra. . . .	10:04.7	05:04.7c	04:04.7a	03:04.7d	02:04.7d	00:04.7d/a
Moon enters Umbra	11:02.8	-------	05:02.8c	04:02.8a	03:02.8d	01:02.8d/a
Moon enters Totality. . . .	12:10.3	-------	-------	05:10.3c	04:10.3a	02:10.3d/a
Middle of the Eclipse	12:42.6	-------	-------	-------	04:42.6n	02:42.6d/n
Moon leaves Totality. . . .	13:14.9	-------	-------	-------	05:14.9c	03:14.9d/n
Moon leaves Umbra	14:22.3	-------	-------	-------	-------	04:22.3a/-
Moon leaves Penumbra. . . .	15:20.4	-------	-------	-------	-------	05:20.4a/-

Key to Conditions:
- \- After moonset/sunrise.
- c Civil Twilight (Sun 0-6° below horizon).
- n Nautical Twilight (Sun 6-12° below horizon).
- a Astronomical Twilight (Sun 12-18° below horizon).
- d Dark Sky (Sun more than 18° below horizon).

(In the last column, the first condition indicates Hawaii, and the second indicates Alaska.)

Making Observations

There are several types of useful observations that one can make with a small telescope, binoculars, or even the naked eye:

1. Notes, drawings, or photographs depicting the general tone, color, and form of the penumbra and umbra.
2. Timings of occultations of faint stars which would not otherwise be visible at this phase of the Moon.
3. Investigations of selected lunar areas for possible eclipse-induced LTP (Lunar Transient Phenomena).
4. Danjon-scale estimates of the luminosity of the Moon at mid-eclipse.
5. Umbral contact times for the Moon's limb and selected craters.
6. Photometry of the whole disk or of selected lunar areas.

Detailed instructions for making such observations can be found in the A.L.P.O. Lunar Eclipse Handbook , available from the writer for $1.50. Below is some information for making the last three types of observations.

Danjon-Scale Luminosity. --Assign the Moon's mid-eclipse appearance to one of the following categories:

0 . . Very dark eclipse; Moon almost invisible, especially at mid-eclipse.
1 . . Dark eclipse; gray or brownish coloration; details distinguishable only with difficulty.
2 . . Deep red or rust-colored eclipse, with a very dark central umbra and the outer edge of the umbra relatively bright.
3 . . Brick-red eclipse; usually with a bright or yellow rim to the umbra.
4 . . Very bright copper-red or orange eclipse; with a bluish very bright shadow rim.

In cases of doubt, make a fractional estimate of luminosity, such as "2.7" or "3-1/2".

Umbral Contact Times. --The diameter of the Moon's umbra is enlarged by a variable amount due to the Earth's atmosphere, and its true size can be found by timing umbral contacts to 0.1-minute accuracy. First, there are four contacts of the Moon's limb with the umbral edge, whose predicted times were given in Table 1 above. Somewhat more accurate results are obtained by timing when the edge of the umbra crosses selected craters. This is best done by timing when the umbral edge first reaches the crater rim, and then when it leaves the crater, recording the mean of the two times. If possible, this should be done both before and after totality. The predicted times of umbral contact for the craters that we recommend are given in Table 2 below.

Table 2. Predicted Umbral Contact Times for Recommended Craters.

(All times are U.T. 24 APR 1986, in the form umbral ingress/umbral egress.)

Grimaldi. . .	11:09/13:26	Plato. . . .	11:26/14:00	Tycho. . . .	11:45/13:32
Aristarchus .	11:12/13:40	Aristoteles.	11:35/14:08	Abulfeda E .	11:46/13:51
Kepler. . . .	11:16/13:39	Eudoxus. . .	11:35/14:08	Proclus. . .	11:53/14:16
Pytheas . . .	11:22/13:50	Manilius . .	11:38/14:01	Taruntius. .	11:56/14:14
Gassendi. . .	11:22/13:30	Birt	11:38/13:41	Nicolai A. .	11:58/13:44
Copernicus. .	11:24/13:47	Menelaus . .	11:40/14:05	Stevinus A .	12:06/13:58
Timocharis. .	11:25/13:54	Plinius. . .	11:44/14:08		

Eclipse Photometry. --Because the umbra is the zone of the Earth's shadow whose brightness varies the most between different eclipses, photometry is most useful for the umbral and total phases. Whole-disk photometry can be done by several visual methods, depending in part on the brightness of the eclipsed Moon. For bright eclipses, a star can be compared with the Moon's image as seen in a convex reflecting surface, initially calibrated using the uneclipsed Moon (magnitude -12.7). For darker eclipses, a star can be compared with the Moon's image as viewed in reversed binoculars. Nearsighted persons may be able to remove their glasses and compare the out-of-focus image of the Moon to a star.

Figure 7 (p. 148) shows the night sky during the eclipse; more precisely, at the beginning of totality as seen from latitude 35° N, longitude 120° W, with the magnitudes of bright stars and planets shown without decimals. Underlined magnitudes indicate stellar class M , which approximates the color of the eclipsed Moon. If no such star is bright enough, Mars or Saturn (being warm-hued) may also be used. In any case, the Moon-star or Moon-planet comparison should be corrected for differential atmospheric absorption unless the altitude of the Moon is within a few degrees of that of the comparison object.

The second illustration, Figure 8 (p. 149), gives a detailed view of the star field near the eclipsed Moon. The Moon's position is calculated for 35° N, 120° W, and may differ by several tenths of a degree for other locations. Stellar magnitudes are shown as on Figure 7 (except that those precise to .01 magnitude are shown by three digits and those precise to 0.1 magnitude by only two digits), and the chart shows that several stellar occultations will occur during the eclipse. [Text continued on p. 149.]

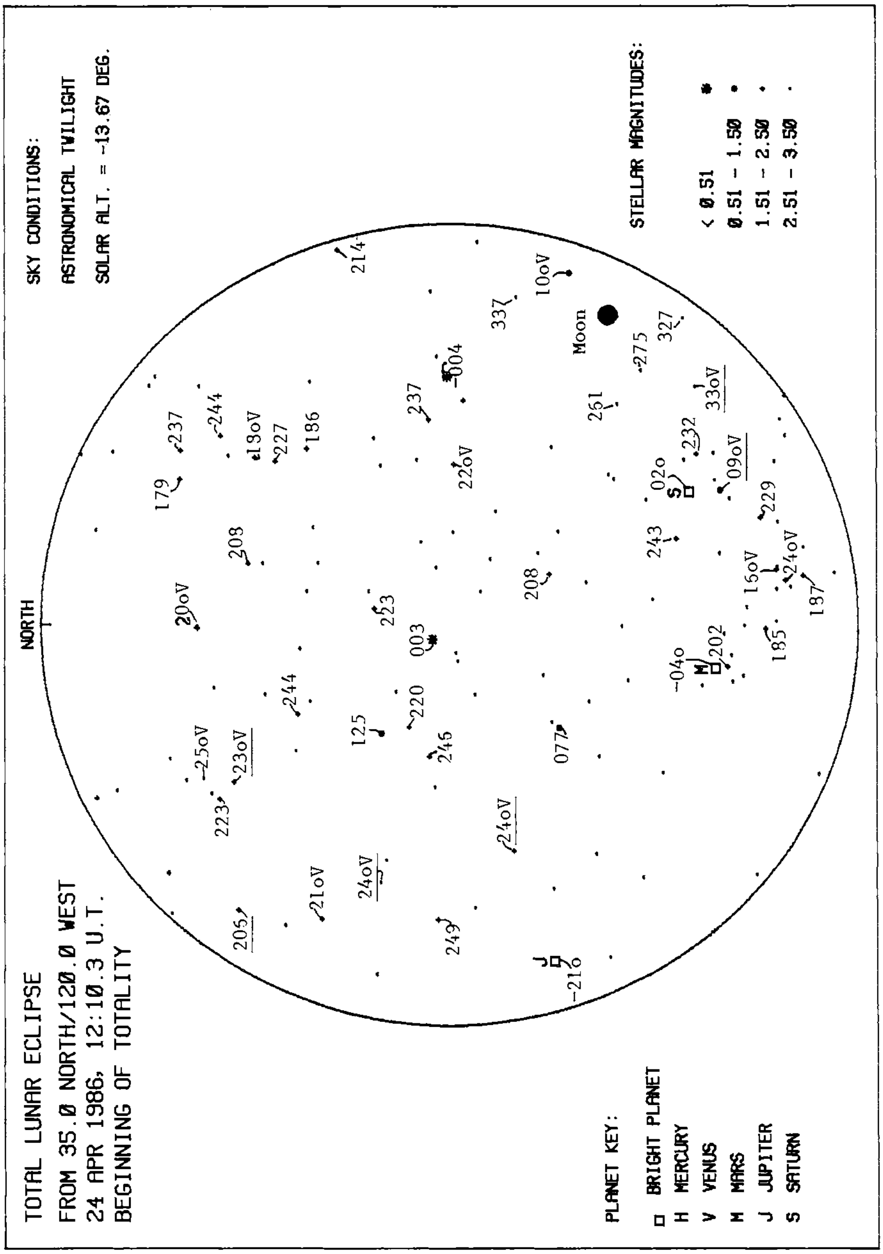


Figure 7. The night sky as seen during the total lunar eclipse of 24 APR 1986, as computed for the beginning of totality (12:10.3 U.T.) at latitude 35° N, longitude 120° W. The visual magnitudes of planets and of all stars brighter than +2.50 magnitude (+ 3.50 near the Moon) are shown without decimals, and are underlined for spectral class M. A "o" as the last magnitude digit indicates 0.1 magnitude precision only, while "V" designates a known variable star.

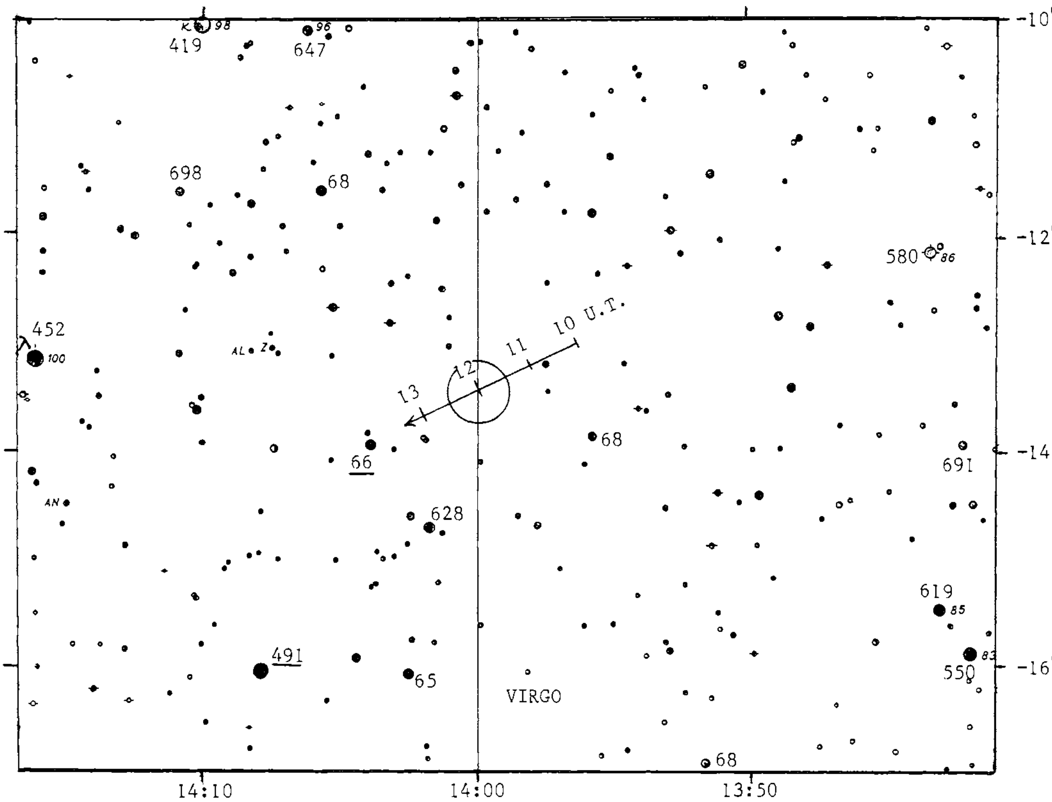


Figure 8. Detailed chart of the vicinity of the eclipsed Moon on 24 APR 1986. This chart is derived from the Atlas Eclipticalis and has a limiting visual magnitude of about + 9. The Moon's disk is drawn to scale, and celestial north is at the top. The Moon's path is shown at 1-hour intervals as seen from 35° N, 120° W, and will differ slightly for other locations. Coordinates are indicated for Epoch 1950.0.

[Text continued from p. 147.]

Photoelectric monitoring of one or more selected lunar areas is a useful method of measuring brightness variations within the umbra and brightmess changes over time. Features should be measured repeatedly throughout the time that they are immersed in the umbra. For details on this form of photometry, see the writer's reports, "Three-Color Photometry: Penumbral Lunar Eclipse, May 15, 1984 U.T." (J.A.L.P.O. 30 , Nos. 9-10, August, 1984, 209-211) and "Photoelectric Photometry of the December 30, 1982 Total Lunar Eclipse" (J.A.L.P.O. 30 , Nos. 1-2, June, 1983, 6-9).

Reporting Observations. --Observations of this lunar eclipse should be sent to the writer at the address given on the inside back cover. Be sure to include data on the atmospheric seeing and transparency, as well as on the telescope type, aperture, and magnification. For photographs, please give the lens focal length and focal ratio, the exposure time, and the type and speed rating of the film used. Given sufficient good observations, we can look forward to a report about this event in a future issue.

THE 1982-83 AND 1983-84 APPARITIONS OF THE PLANET SATURN: VISUAL AND PHOTOGRAPHIC OBSERVATIONS

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

Introduction

A variety of excellent visual and photographic observations of the planet Saturn and its satellites made during the periods 1983 JAN 12 - AUG 03 (1982-83 apparition) and 1983 DEC 29 - 1984 SEP 15 (1983-84 apparition) constitute the basis of this report. Somewhat limited regions of Saturn's Southern Hemisphere remained detectable to observers during these two apparitions, and the Northern Hemisphere of the Globe and the north face of the Rings were increasingly well-presented during each apparition. For the 1982-83 apparition the value of B, the Saturnicentric latitude of the Earth relative to the ring plane, positive when north, varied between + 17°093 (maximum opening, 1983 FEB 07) and + 14°644 (maximum closure, 1983 JUN 27). The corresponding values for the 1983-84 apparition were + 20°912 (1984 FEB 18) and + 18°966 (1984 JUL 07).*

Table 1 (below) gives geocentric data for these two apparitions that will be helpful in interpreting this report.

Table 1. Geocentric Data for the 1982-83 and 1983-84 Saturn Apparitions.

	1982-83 Apparition	1983-84 Apparition
Conjunction	1982 OCT 18, 21^h U.T.	1983 OCT 31, 06^h U.T.
Stationary	1983 FEB 13, 08	1984 FEB 25, 06
Opposition	APR 21, 19	MAY 03, 08
Stationary	JUL 02, 13	JUL 14, 04
Conjunction	OCT 31, 06	NOV 11, 07
Opposition Data:		
Visual Magnitude	+ 0.4	+ 0.1
Globe--Equatorial Diameter	19"01	18"69
--Polar Diameter	17"01	16"91
Rings--Major Axis	42"82	42"40
--Minor Axis	11"62	14"39
B	+ 15°737	+ 19°819

Table 2 (p. 151) lists the dedicated observers who submitted useful data to the A.L.P.O. Saturn Section throughout the 1982-83 and 1983-84 apparitions. This tabulation shows that 116 visual and photographic observations were submitted by 11 individuals for the 1982-83 apparition. The monthly distribution of observations for that apparition is given in the form of a histogram (Figure 9, p.152) from which it can be seen that the majority of observations were made during the months of April through June, 1983 (66.4 percent). On either side of this peak period observational activity showed a progressively marked decline. Also, 29.3 percent of the observations were made before opposition, none on the opposition date, and 70.7 percent were made afterward.

In 1983-84, there were 168 observations amassed by 17 contributors, many of whom had also submitted data for 1982-83. The distribution of these observations by month is also shown as a histogram on Figure 9 (p. 152). Slightly over half of the observations contributed were made during the months of May and June, 1984 (52.3 percent), again with a decline on either side of the peak. Also, 17.9 percent of the observations were made prior to opposition, 0.6 percent on the date of opposition, and 81.5 percent after opposition.

The distribution of the observations before and after opposition was somewhat comparable to preceding apparitions, and it is usually the case that individuals tend to observe Saturn more often when the planet is well-placed in the evening sky after sunset, near to or after the opposition date.

* In this report, longitudes of Globe features in the NEBs, EZ, and SEBn are referred to "System I", with the A.L.P.O. System I used for 1983 (844°0/day) and the I.A.U. System I used for 1984 (844°3/day). The rest of the Globe is referred to the A.L.P.O. "System II" (812°0/day) for both years. [Editor]

Table 2. Participating Observers, 1982-83 and 1983-84 Saturn Apparitions.

Observer and Location	Number of Observations 1982-83	1983-84	Instrument(s) Used*	
Leo Aerts, Heist-op-den-Berg, Belgium	1	1	15.2-cm.(6.0-in.)	RR
Julius L. Benton, Jr., New Hope, PA	2	6	6.0-cm.(2.4-in.)	RR
			8.3-cm.(3.3-in.)	RR
			12.7-cm.(5.0-in.)	RR
			30.5-cm.(12.0-in.)	MAK
Norman J. Boisclair, S. Glens Falls, NY	-	50	15.2-cm.(6.0-in.)	S-C
Mark S. Daniels, Wichita, KS	6	3	20.3-cm.(8.0-in.)	NEW
Donald H. DeKarske, Colorado Springs, CO	-	1	10.2-cm.(4.0-in.)	RR
Thomas A. Dobbins, Lyndhurst, OH	-	5	16.5-cm.(6.5-in.)	RR
Charles L. Evans, Hampton, VA	15	-	25.4-cm.(10.0-in.)	CASS
Marc A. Gelinas, St.-Hubert, Quebec	-	6	20.3-cm.(8.0-in.)	S-C
Walter H. Haas, Las Cruces, NM	6	17	31.8-cm.(12.5-in.)	NEW
Alan W. Heath, Nottingham, England	18	21	30.5-cm.(12.0-in.)	NEW
Daniel Louderback, South Bend, WA	-	1	20.3-cm.(8.0-in.)	NEW
M. Maksymowicz, Moisson, France	6	5	11.4-cm.(4.5-in.)	NEW
			15.2-cm.(6.0-in.)	NEW
			20.3-cm.(8.0-in.)	NEW
Domenec Barbany Martinez, Barcelona, Spain	7	-	20.3-cm.(8.0-in.)	NEW
Gary T. Nowak, Winooski, VT	4	13	7.6-cm.(3.0-in.)	RR
			20.3-cm.(8.0-in.)	S-C
			22.9-cm.(9.0-in.)	RR
			31.8-cm.(12.5-in.)	NEW
Robert Robotham, Springfield, Ontario	37	13	8.3-cm.(3.3-in.)	RR
			15.2-cm.(6.0-in.)	NEW
Kenneth Schneller, Euclid, OH	-	5	16.5-cm.(6.5-in.)	RR
			20.3-cm.(8.0-in.)	NEW
Pablo A. Silveira, Caracas, Venezuela	-	2	20.3-cm.(8.0-in.)	S-C
Michael E. Sweetman, Tucson, AZ	-	5	10.2-cm.(4.0-in.)	RR
Daniel M. Troiani, Chicago, IL	14	14	25.4-cm.(10.0-in.)	NEW
			27.9-cm.(11.0-in.)	S-C
Total Number of Observations	116	168		
Total Number of Observers.	11	17		

* CASS = Cassegrain Reflector, MAK = Maksutov-Cassegrain Catadioptric, NEW = Newtonian Reflector, RR = Refractor, S-C = Schmidt-Cassegrain Catadioptric.

The author gives his most sincere thanks to all the colleagues and friends mentioned in this report for their observational support of our programs. Such systematic, consistent work by dedicated individuals worldwide, novice or otherwise, is vital to our efforts. All potential observers of Saturn are most cordially invited to join us in our endeavors in future apparitions of the planet.

The Globe of Saturn

This descriptive report has been derived from an analytical reduction of the observations of Saturn contributed to the A.L.P.O. Saturn Section throughout the apparitions of 1982-83 and 1983-84. Except where the identities of observers are pertinent to the discussion, their names have been omitted in the interest of brevity. The instruments used during both apparitions ranged in aperture from 6.0 cm. (2.4 in.) to 31.7 cm. (12.5 in.), with most contributions made with intermediate apertures. The use of classical refractors and Newtonian reflectors continued to be popular for our contributors.

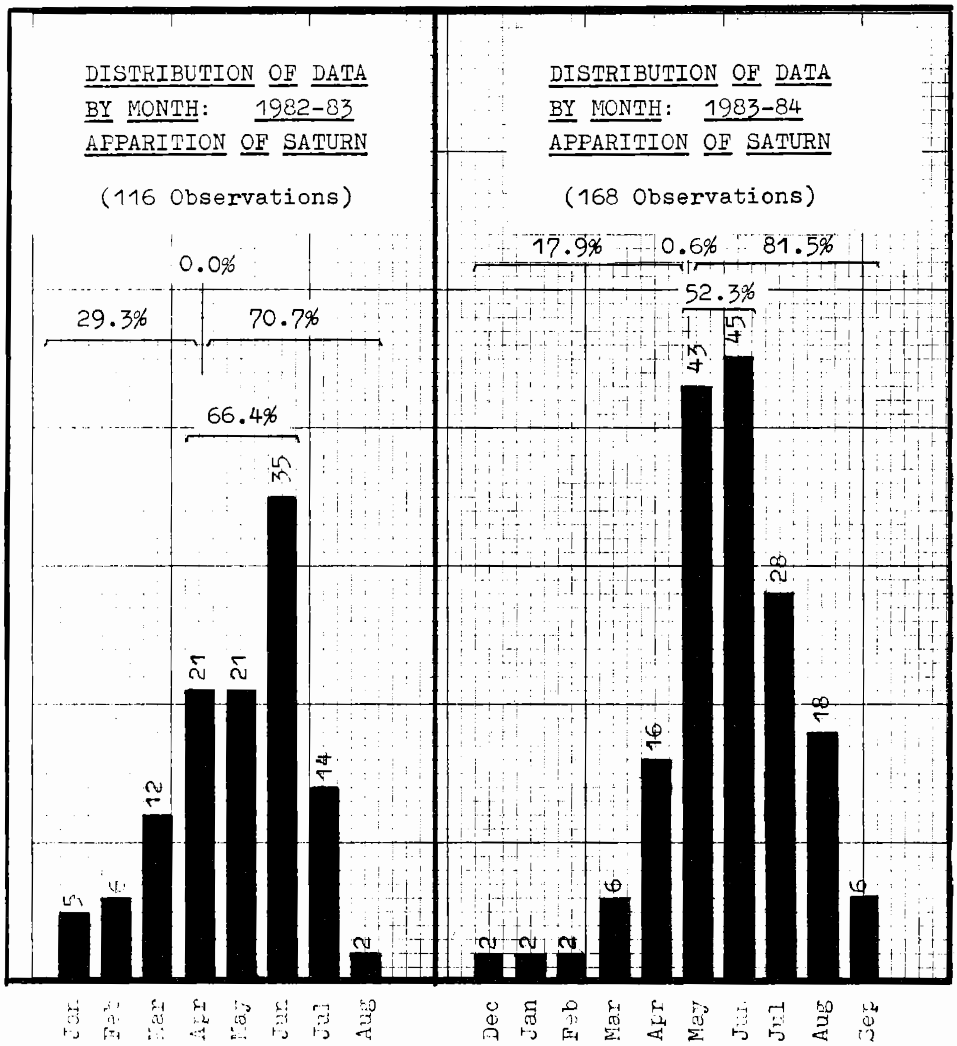


Figure 9. Histograms showing the distribution of observations of Saturn by month for the 1982-83 apparition (left) and the 1983-84 apparition (right).

A representative diagram of Saturn with its ring system (for B = + 17°) is given as Figure 10 (p. 153), along with the standard A.L.P.O. nomenclature for belts, zones, and ring components.

Northern Portions of the Globe. --A fairly low level of activity characterized the Northern Hemisphere of Saturn throughout 1982-83 and 1983-84, a situation similar to that of 1980-81 and 1981-82. Any detail recorded in the north was chiefly elusive and ephemeral, and mostly associated with the EZn, the NEB, the NTeZ, and the NTrZ. The following discussion of Northern Hemisphere features uses comparative data from apparition to apparition, as in previous Saturn Reports, in order to identify suspected subtle changes over time. It is believed that the changing tilt of the axis of Saturn with respect to the Earth and Sun may play a major role in any recorded changes in Belt and Zone intensities. See Tables 3 and 4 (pp. 153-155) for comparative intensities, and Figure 11 (p. 156) for graphs of brightness variations upon the Globe and Rings, based on photographic photometry for three spectral bands. Sample drawings of the general appearance of Saturn during the two apparitions covered by this report are given in Figures 12 - 21 (pp. 159-163). [Text contined on p. 155.]

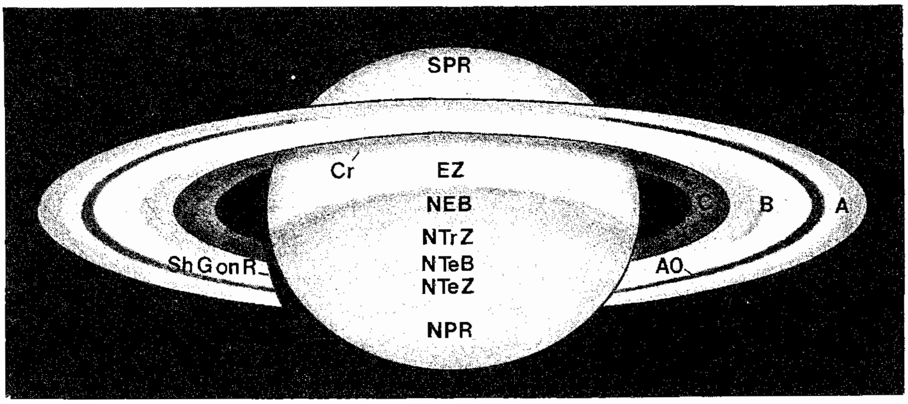


Figure 10. Diagram of the general appearance of Saturn during the 1982-83 and 1983-84 apparitions giving the nomenclature of the belts, zones, and ring features. Adapted from a drawing by Mark S. Daniels. South is at the top, as in the normal astronomical orientation of the planet for an inverting telescope in the Earth's Northern Hemisphere. The globe features, given in order from the south polar limb to the north polar limb, are: SPR , South Polar Region; EZ , Equatorial Zone (often subdivided south-to-north into the EZs , EB [Equatorial Band or Belt]), and EZn); NEB , North Equatorial Belt (often subdivided south-to-north into the NEBs , NEB Z [NEB Zone], and NEBn); NTrZ , North Tropical Zone; NTeB , North Temperate Belt; NTeZ , North Temperate Zone; and NPR , North Polar Region. Less-often seen globe features not specified in the above diagram are the: NNTeB , North North Temperate Belt (immediately north of the NTeZ); NNTeZ , North North Temperate Zone (immediately north of the NNTeB); NPB , North Polar Belt (encircling the NPR); and the NPC , North Polar Cap (near the North Pole). The ring features, listed in order from the outer edge to the inner edge, are: A , Ring A; AO , Cassini's Division (separating Ring A from Ring B; also called B10); B , Ring B; and C , Ring C. Cr denotes the Crape Band (Ring C projected on the Globe), and Sh G on R is the shadow of the Globe on the Rings. It is important to note that, in this orientation, globe features move across Saturn from right to left. In the IAU convention, East is to the left, and the direction of rotation is West-to-East. Thus the shadow of the Globe on the Rings is shown here to the East, as occurs before opposition. In some instances when the shadow of the Rings appears on the Globe, the Crape Band may then appear darker than usual due to this cause. Seeing the Globe through Cassini's Division may also affect the intensity of the latter feature, and it is assumed that observers will estimate AO's intensity at its ansae (the points apparently farthest from the Globe).

Table 3. Visual Numerical Relative Intensity Estimates of Major Globe and Ring Features of Saturn for the 1982-83 and 1983-84 Apparitions, With Absolute Color Estimates.

Globe or Ring Feature	Relative Intensity: Number of Estimates 1982-83	1983-84	Mean Intensity and Standard Deviation 1982-83	1983-84	Derived Absolute Color
Zones:					
NPC	11	11	5.77 ± .46	5.56 ± .28	Dusky-Yellow to Yellow-Grey
NPR	28	28	4.93 ± .18	5.43 ± .55	Dusky Yellowish-Grey
NNTeZ	1	6	6.00 ± ---	6.23 ± .26	Yellow-White
NTeZ	29	20	6.49 ± .10	6.22 ± .29	Yellow-White
NTrZ	28	18	6.95 ± .14	6.28 ± .83	Yellow-White
NEB Z	20	11	3.71 ± .55	3.67 ± .84	Very Dark Yellow-Grey

Table 3--Continued.

Globe or Ring Feature	Relative Intensity: Number of Estimates 1982-83	1983-84	Mean Intensity and Standard Deviation 1982-83	1983-84	Derived Absolute Color
(Zones--Continued)					
EZn	35	46	7.18 ± .26	6.86 ± .79	Pale Yellow-White
Globe North of Rings	8	21	5.50 ± .49	5.09 ± .17	Dusky Yellow-Grey
Globe South of Rings	34	18	4.61 ± .65	5.02 ± .18	Dusky Yellow-Grey
Belts:					
NPB	5	8	3.18 ± .27	3.79 ± .15	Very Dark Greyish-Yellow
NNTeB	-	5	---------	5.68 ± .18	Yellow-Grey
NTeB	14	14	3.89 ± .41	4.66 ± .92	Dark Yellow-Grey
NEBn	33	15	3.24 ± .28	3.50 ± .68	Dark Greyish-Brown
NEBs	34	15	2.82 ± .27	3.19 ± .60	Dark Greyish-Brown
NEB	4	33	4.53 ± .93	3.87 ± .65	Greyish to Brownish
Rings:					
Ring A: Outer half	2	3	5.45 ± .95	6.57 ± .42	Dusky-White
Inner half	2	3	6.85 ± .85	6.83 ± .46	Pale Dusky-White
Whole	37	31	5.89 ± .39	6.12 ± .33	Greyish Yellow-White
Cassini's Division (A0/B10)	8	18	1.49 ± .70	1.08 ± .58	Very Dark Greyish-Black
Ring B: Outer 1/3	----[Standard of Intensity Scale = 8.00]----				White
Inner 2/3	8	25	6.51 ± .28	7.13 ± .15	Yellow-White
Ring C (Ansae)	6	22	0.48 ± .12	1.14 ± .56	Very Dark Grey
Crape Band	31	30	2.61 ± .94	2.63 ± .64	Dark Grey
Shadow:					
Rings on Globe	18	17	0.98 ± .40	0.72 ± .34	Greyish-Black
Globe on Rings	33	28	0.90 ± 46	0.70 ± .43	Greyish-Black
Terby White Spot	-	6	---------	7.50 ± .62	White

NOTE: Visual numerical relative intensity estimates (visual surface photometry) are based on the A.L.P.O. Intensity Scale, where 0.0 denotes complete black (shadow) and 10.0 is the greatest possible brilliancy (maximum Solar System reflectivity). The adopted scale as used for Saturn employs a reference standard of 8.0 ("Standard of Intensity Scale") for the outer third of Ring B, which appears to be stable in overall intensity over time at most ring inclinations. All other globe and ring features are systematically estimated relative to this reference standard. Details about the procedures for conducting such visual estimates are given in the literature issued by the A.L.P.O. Saturn Section.

Table 4. Comparative Mean Intensities for Saturn's Globe and Ring Features.

Globe or Ring Feature	Mean Intensity Values 1981-82	1982-83	1983-84	Mean Intensity Change* 1981-82 to 1982-83	1982-83 to 1983-84
Northern Hemisphere--Zones					
NPR	4.8	4.9	5.4	+0.1	+0.5
NTeZ	6.6	6.5	6.2	-0.1	-0.3
NTrZ	6.9	7.0	6.3	+0.1	-0.7
NEB Z	3.4	3.7	3.7	+0.3	0.0
EZn	7.3	7.2	6.9	-0.1	-0.3
Northern Hemisphere--Belts					
NTeB	3.8	3.9	4.7	+0.1	+0.8
NEBn	3.1	3.2	3.5	+0.1	+0.3
NEBs	2.8	2.8	3.2	0.0	+0.4
NEB	3.3	4.5	3.9	+1.2	-0.6
Ring System--North Face					
Ring A (Whole)	5.8	5.9	6.1	+0.1	+0.2
Cassini's Division (A0/B10)	0.7	1.5	1.1	+0.8	-0.4
Ring B: Outer 1/3	[Standard of Intensity Scale]			---	---
Ring B: Inner 2/3	6.9	6.5	7.1	-0.4	+0.6
Ring C: Ansae	1.8	0.5	1.1	-1.3	+0.6
Ring C: Crape Band	1.9	2.6	2.6	+0.7	0.0
Shadows: Globe on Rings	1.1	0.9	0.7	-0.2	-0.2
Shadows: Rings on Globe	1.6	1.0	0.7	-0.6	-0.3

* Positive for intensity increase, negative for decrease, and 0.0 if stable.

[Text continued from p. 152.]

The following sections give synoptic descriptions of particular features on the Globe, in north-to-south order.

North Polar Region (NPR). --Compared with 1981-82, the NPR showed only an insignificant brightness increase for 1982-83 (mean intensity change = +0.1), while in 1983-84 the increase in overall brightness since the previous apparition was more obvious (+0.5). In both apparitions covered, most contributors described the NPR as a dusky yellow-grey region of uniform intensity, with the exception of a definite dusky-yellow North Polar Cap (NPC) in the extreme north. For both apparitions, the NPC was consistently lighter than the surrounding NPR, particularly in 1982-83. In both apparitions a definite, rather linear North Polar Belt (NPB) encircled the NPR, described by observers as having a very dark greyish-yellow hue.

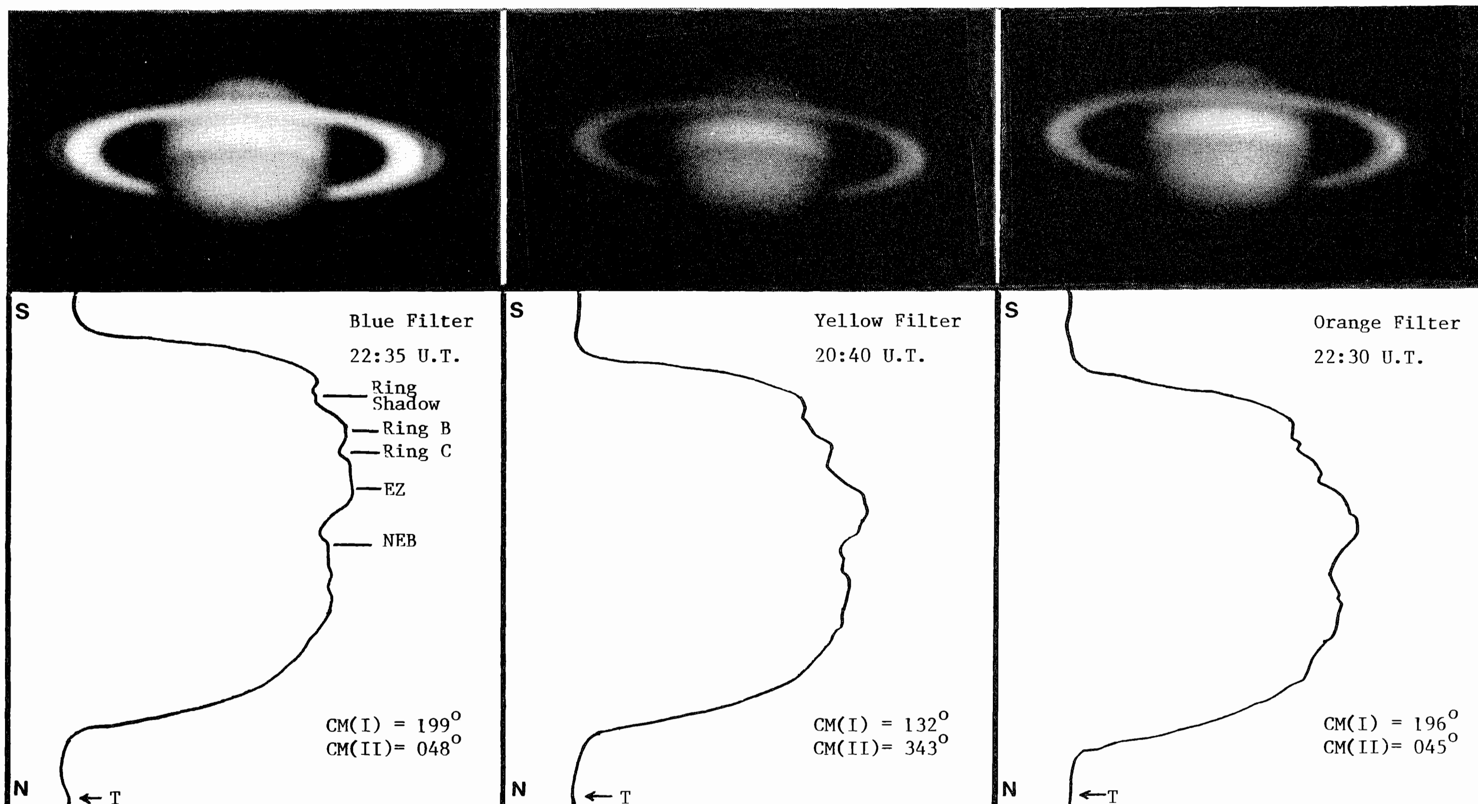
North North Temperate Zone (NNTeZ). --Only scattered reports of any NNTeZ were forthcoming for either apparition. When seen, in 1983-84, this feature was most often perceived as a yellowish-white, narrow zone north of the NTeZ, about equal in brightness to the NTeZ and the NTrZ.

North North Temperate Belt (NNTeB). --No reports of a definite NNTeB were submitted for 1982-83, but there were rare sightings of this narrow belt in 1983-84. When seen, this feature was described as an elusive, diffuse, yellow-grey region and as the lightest belt then on the planet.

North Temperate Zone (NTeZ). --The NTeZ was practically unchanged in intensity (a -0.1 difference) in 1982-83 compared with 1981-82. The 1982-83 to 1983-84 darkening trend was more pronounced (-0.3). During both apparitions covered here, the NTeZ was yellow-white, fairly uniform in intensity from limb to limb, and showed possible (unconfirmed) whitish spot activity in 1982-83 only. The NTeZ was somewhat darker than the NTrZ in 1982-83, but by 1983-84 there was no more than a ± 0.1 intensity difference among the NTeZ, NTrZ, and NNTeZ. [Text continued on p. 157.]

Figure 11.

Saturn in three spectral ranges. Photographs taken by A. Sanchez Lavega and J.A. Quesada with the 1.23-meter telescope of Calar Alto Observatory. Also shown are North-South scans along the central meridian with a Jarrell-Ash photometer. T is transmission. Taken on 1983 MAY 02, U.T., with B = +15°.44, B' = +16°.13.



[Text continued from p. 155.]

North Temperate Belt (NTeB). --The NTeB was easier to see in both 1982-83 and 1983-84 than in the 1981-82 apparition despite an increase in its brightness. From 1981-82 to 1982-83 there was an insignificant increase in NTeB brightness (+0.1), but from 1982-83 to 1983- 84 the increase in intensity was far more pronounced (+0.8). In the two latter apparitions, the NTeB was reported as a rather diffuse, roughly-linear, dark yellow-grey belt, uniform in intensity from limb to limb.

North Tropical Zone (NTrZ). --In both 1982-83 and 1983-84, the NTrZ was second in brightness only to the EZn, and these two zones were almost equal in 1982-83. The brightness of the NTrZ increased by only +0.1 between 1981-82 and 1982-83, but darkened by -0.7 by 1983-84. In both latter apparitions, this zone's color was reported as yellow-white, its intensity as uniform from one limb to the other; and the only activity reported was vague whitish spots.

North Equatorial Belt (NEB). --The dark greyish-brown NEB was differentiated into components in both 1982-83 and 1983-84: the NEBn, NEBs, and the NEB Z between them. This multiple nature was more evident in 1982-83 than in 1983-84. Taken as a whole, the greyish-to-brownish NEB was significantly brighter in 1982-83 than it had been in 1981-82 (by +1.2), but darkened by 1983-84 (by -0.6). The NEB as a whole was far more diffuse in 1983-84 than in 1982-83, which is consistent with its being reported as a single feature only rarely in 1982- 83. Perhaps we might consider the overall intensity data for the NEB as a whole more reliable for the 1983-84 apparition due to the rarity of sightings of the NEB as single in 1982-83.

The dark greyish-brown NEBs was the darkest belt on the Globe of Saturn in 1982-83 and in 1983-84, showed no change in intensity from 1981-82 to 1982-83, but became +0.4 intensity units brighter by 1983-84. Amorphous dark areas were reported in the diffuse NEBs during both apparitions discussed here, although this detail did not persist long enough to enable central meridian transit timings. The NEBs and NPB had nearly equal intensities during 1982-83.

The NEBn, with a greyish-brown to dark greyish-brown color, changed little in intensity (brightening by +0.1) between 1981-82 and 1982-83. The increase in brightness was more pronounced (by +0.3) between 1982-83 and 1983-84. The rather diffuse NEBn was second only to the NEBs in being the darkest belt on the Globe in 1983-84. As with the NEBs, there were ephemeral mottlings and elusive dark features in the NEBn during both apparitions discussed here, but no detail persisted long enough to permit central meridian transit timings.

The NEB Z was very dark yellowish-grey in hue during both 1982-83 and 1983-84. From 1981-82 to 1982-83 the NEB Z underwent a small brightness increase (+0.3), but did not vary in mean intensity between 1982-83 and 1983-84. In the two latter apparitions the NEB Z was a very indistinct zone between the NEBs and the NEBn, with those NEB components grading into a lighter intensity in the NEB Z.

Equatorial Zone (chiefly EZn). --Exhibiting only a very minor intensity decrease between 1981-82 and 1982-83 (-0.1), but darkening more significantly from 1982-83 to 1983-84 (-0.3), the pale yellow-white EZn was the brightest zone on the Globe for the latter two apparitions. Very minor detail was seen in the EZn aside from occasional vaguely-suspected whitish features. The Equatorial Band or Belt (EB) was seldom reported in either apparition but, when suspected, was roughly linear, greyish-brown, and very difficult to perceive.

Shadow of the Rings on the Globe. --The projected shadow of the Rings on the Globe was reported during 1982-83 and 1983-84 as a rather uniform greyish-black to black feature, of regular geometric form, and was best seen in late April, 1983, and early May, 1984. Poor seeing, inadequate aperture and thus resolution, and other optical problems all conspire to cause this shadow to appear something other than a true black.

Shadow of the Globe on the Rings. --The shadow of the Globe of Saturn upon its Ring system was noted in both apparitions as a very dark greyish-black feature of regular geometric form. Any deviation from a truly black appearance may be ascribed to the factors noted in the previous paragraph.

Southern Portions of the Globe. --In each apparition since 1980, Saturn's Southern Hemisphere has been tilted increasingly away from our line of sight. As a consequence, in 1982-83 and 1983-84 practically no zones or belts of the Southern Hemisphere of the planet were easily visible. Because of this limited visibility, only a general intensity was assigned to the perceptible southern regions as a whole for these two apparitions. In 1982-83, the Globe south of the Rings was described as being darker than the collective northern portion of Saturn (i.e., between the NEB and the north polar limb), while these two areas were essentialy equal in intensity in 1983-84.

Latitudes of Saturn's Belts and Zones. --Haas was the only observer to submit usable visual latitude estimates for features on the Globe of Saturn during 1982-83 and 1983-84. Employing the technique he developed about 20 years ago, Haas estimated the fraction of the planet's polar semidiameter subtended on the central meridian between the north or south limb and the feature whose latitude was desired. Latitudes computed from these estimates appear in Table 5; below, but one must recognize that it is somewhat presumptuous to try to derive too much from data supplied by a single observer, regardless of how truly accurate his work may have been. This should be a stimulus to other individuals to participate in this type of study, and instructions to do so are available in the literature issued by the Saturn Section.

Table 5. Latitudes of Saturn's Global Features During 1982-83 and 1983-84.*

Feature	1982-83 Apparition, B = +16°			1983-84 Apparition, B = +21°		
	Eccentric (Mean)	Planeto-centric	Planeto-graphic	Eccentric (Mean)	Planeto-centric	Planeto-graphic
	°	°	°	°	°	°
S edge NPR	-----	-----	-----	+74.5	+72.8	+76.1
N edge NPB	-----	-----	-----	+73.6	+71.8	+75.3
S edge NPB	-----	-----	-----	+67.6	+65.3	+69.9
Center NTeB	-----	-----	-----	+35.5	+32.4	+38.5
N edge NEB	+26.5	+23.9	+29.1	+27.4	+24.7	+30.0
S edge NEB	+20.2	+18.1	+22.3	+21.6	+19.4	+23.9

* The planetocentric latitude is the angle, measured from the Globe center, between the feature's radius vector and the equatorial plane; planetographic latitude is the angle between a plane tangent to the Globe at the feature and the polar axis, which thus takes into account the planet's ellipticity; eccentric latitude is simply the mean of the planetocentric and planetographic latitudes. [Editor.]

The Rings of Saturn

The following discussion concerns an analytical reduction of the observations of Saturn's ring system that were contributed during the 1982-83 and 1983-84 apparitions, together with a continuing comparative analysis of mean intensity data in keeping with previous apparition reports. The northern face of the ring system was tilted increasingly toward us in 1982-83 and 1983-84, with the maximum values of B being +17° and +21°, respectively.

Ring A. --Considered as a whole, Ring A was greyish-yellow to dull yellowish-white in hue during 1982-83 and 1983-84, with infrequent reports of intensity differentiation in both apparitions. Ring A's brightness was about the same in 1982-83 as it was in 1981-82 (an increase of only +0.1), and it increased only slightly more by 1983-84 (+0.2). Seen as a whole, Ring A was quite uniform in intensity throughout, for most of 1982-83 and 1983-84, with no indication of a distinct Encke's Division (A5) or any other "intensity minima."

On rare occasions in 1982-83, observers reported that the overall intensity of the outer half of Ring A was darker than its inner half, and a similar impression was reported on a few occasions in 1983-84. When seen as a differentiated component, the inner portion was significantly brighter than the outer in 1982-83, but the two portions were more nearly equal in 1983-84. The color assiged to the inner half of Ring A was pale dusky-white, and the outer portion was described as dusky-white in both 1982-83 and 1983-84.

Ring B. --The outer third of Ring B is the standard of reference adopted for the A.L.P.O. Visual Numerical Relative Intensity Scale for Saturn, with a value of 8.0 assigned. Throughout the 1982-83 and 1983-84 apparitions, the intensity of the outer third of Ring B was consistently stable, with no intensity variations suspected; and Ring B was white in color. It was the brightest portion of both the Globe and Rings during both apparitions.

The inner two-thirds of Ring B in 1982-83 were somewhat darker than in 1981-82 (by -0.4) and also were 0.3 intensity units darker than the inner half of Ring A. From 1982-83 to 1983-84, the inner two-thirds of Ring B brightened by +0.6 intensity units, and were second in brightness only to the outer third of Ring B by 1983-84. In both later apparitions, the inner two-thirds of Ring B were assigned a color of yellowish-white.

Cassini's Division. -- Also referred to as "A0" or "B10", Cassini's Division was generally visible at the ansae, appearing very dark greyish-black, in both 1982-83 and 1983- 84. Only a few observers were able to detect Cassini's Division completely around the Rings during either apparition, reporting only fleeting glimpses of other "intensity minima" in Ring B.

Ring C. --Observers remarked that Ring C was difficult to see, even at the ansae, in 1982-83, but was quite evident in 1983-84. Between 1981-82 and 1982-83 Ring C darkened markedly at the ansae (by -1.3 in mean intensity), perhaps explaining why it was so difficult to see in 1982-83. However, by 1983-84 Ring C's ansae brightened by +0.6 intensity units, and were thus easily detected. For both later apparitions, the color ascribed to Ring C at the ansae was a uniform very dark grey. The Crape Band (Ring C projected on the Globe) had about the same intensity in both 1982-83 and 1983-84, and was dark grey in hue and regular in form. Compared with 1981-82, this feature was +0.7 mean intensity units brighter in both 1982-83 and 1983-84. [These apparent changes may be due to the changing saturnicentric declinations of the Sun and the Earth. Editor]

Other Ring Components. --Although some observers have suspected a Ring D (internal to Ring C) and an elusive Ring E (external to Ring A) in previous apparitions, there were no indications of these real but extremely difficult components in 1982-83 or 1983-84.

Terby White Spot. --Few explicit reports of a Terby White Spot (a brightening of the Rings adjoining the shadow of the Globe) were made in 1982-83, and there were only scattered sightings of this feature in 1983-84.

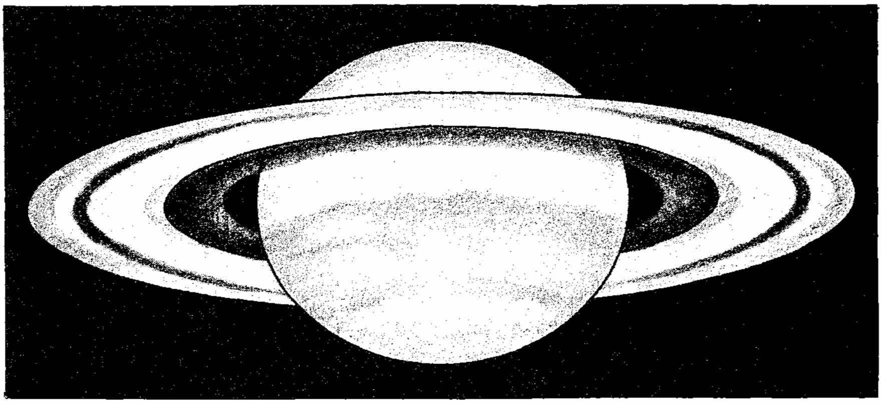


Figure 12. Drawing by M. Daniels, on 1983 MAR 02, at 09:05 U.T., using a 20-cm. reflector at 235X. Seeing = Very Good - Excellent; Transparency = Fair-Poor. CM(I) = 075^{c}; CM(II) = 062°. B = +16.°92; B' = +15.°40. "CM" refers to the longitude of the central meridian; System (I), with a rotation rate of 844.°3/day, is used for the NEBs, EZ, and SEBn; System(II), rotating at a rate of 812.°0/day, is used for the remainder of the Globe.

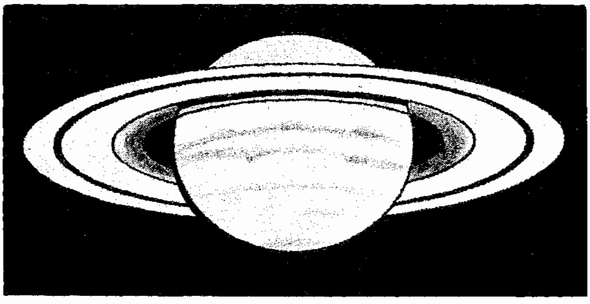


Figure 13. Drawing by D. Troiani. 1983 MAR 12, 09:27-09:41 U.T. 28-cm. S-C, 310X. Seeing = 5-3; Transparency = +6.0. CM(I) = 249-257°; CM(II) = 307-315°. B = + 16.°75; B' = + 15.°52. (Seeing is on a scale of 0-10, while transparency is the naked-eye limiing visual magnitude.)

Bicolored Aspect of the Rings. --Although several observers applied systematic filter techniques to the ansae of Saturn's Rings, looking for their curious bicolored aspect, Haas was the only individual to achieve real differences between the celestial East and celestial West ansae. From 1983 JUN 04 through JUN 19, using a 31.8-cm. (12.5-in.) Newtonian at magnifications of 202X to 303X, Haas reported that on four nights both Ring ansae were equally bright in integrated light (no filter) and red light (W25 filter; where "W" indicates Wratten). However, when blinking (rapidly alternating) with a blue (W47) filter, the west ansa was the brighter on June 4 and June 19. On the two dates of 1983 JUN 26 and JUL 14, Haas also reported no difference when using integrated light and red light (W25 filter), but the east ansa was then the brighter in blue light (W47 filter). In all instances of this bicolored aspect, the observer believed the phenomenon was genuine.

During the 1983-84 apparition, on ten nights from 1984 APR 14 - MAY 31, Haas reported that the ansae were equal in brightness in integrated light and red light (W25 filter), but that the west ansa was the brighter on all ten nights when viewed in blue light (W47 filter). On 1984 JUN 09 the west and east ansae were equal in integrated light, but the west ansa was slightly the brighter in both red and blue light. On 1984 JUN 20, the two ansae were equally bright in integrated, blue, and red light. Finally, on three nights from 1984 AUG 19 - SEP 15, the only anomaly noted was that the west ansa was the brighter in blue light, but the ansae were equal in integrated and red light.

Particularly with respect to observations such as these, the technique of simultaneous observations by independent observers should be employed, and indeed it should be stressed for all Saturn work. We still do not know whether this phenomenon is an illusion produced by atmospheric dispersion or by some other cause, but clearly more simultaneous observations are needed.

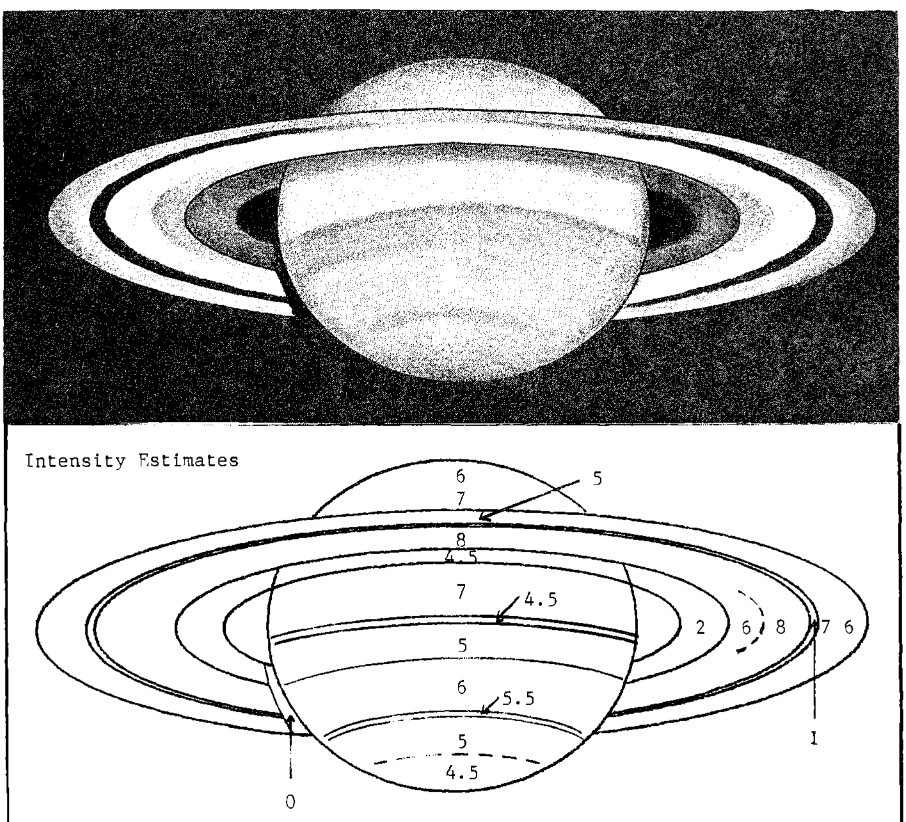


Figure 14. Drawing and intensity diagram by M. Daniels, on 1983 APR 03, at 05:30-07:00 U.T., using a 20-cm. reflector at 235X and 282X. Seeing = 4-6; Transparency = Good. CM(I) = 320-013°; CM(II) = 039-090°. B = $+16^{\circ}.25$; B' = $+15^{\circ}.78$.

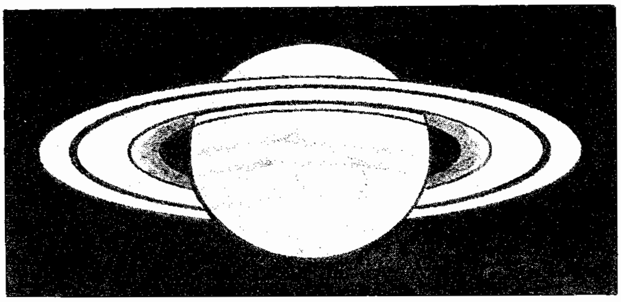


Figure 15. Drawing by D. Troiani. 1983 APR 16, 07:14-07:31 U.T. 25-cm. NEW, 374X. Seeing = 3-4; Transparency = +5.0. CM(I) = 194-204°; CM(II) = 215-225°. B = + 15°.89; B' = + 15°.93.

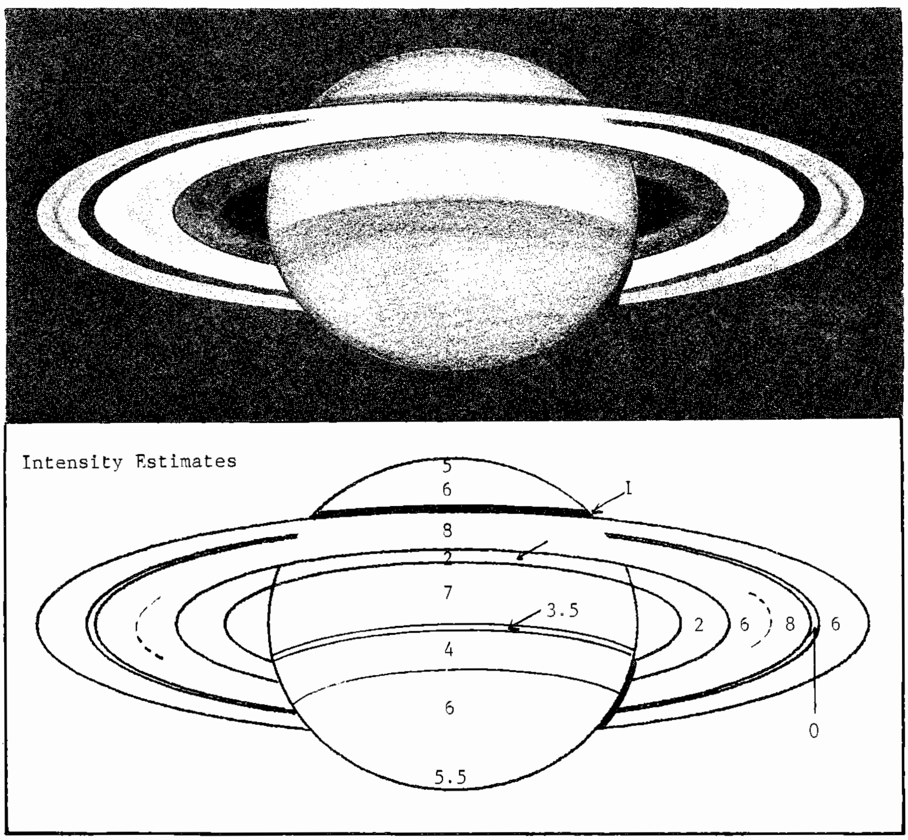


Figure 16. Drawing and intensity diagram by M. Daniels, on 1983 APR 25, at 04:30-05:50 U.T., using a 20-cm. reflector at 235X and 282X. Seeing = 4-9; Transparency = Very Good. CM(I) = 135-182°; CM(II) = 231-276°. B = +15°.64; B' = +16.°04.

The Satellites

Although numerous observers, using various apertures, remarked that several of Saturn's brighter satellites were visible, there were very few visual magnitude estimates. As a result, it was not at all possible to perform a suitable analysis with these very sparse and largely unrelated, subjective data. Observers are encouraged to undertake systematic visual magnitude work on the satellites of Saturn whenever possible, taxing as the procedure may be.

Conclusions

As can be seen from the preceding discussion, our observers quite actively took part in the more general observing program, which included disc drawings, intensity estimates, and photography of the planet Saturn. While these general observations, particularly intensity estimates, certainly are essential to our program, so too are more specialized endeavors, such as latitude estimates and measurements, satellite observations, systematic color-filter observations of the Globe and Rings, and central meridian timings. There is a critical need for more effort on the more specialized areas of Saturn observing, and observers are encouraged to extend their work into these areas as soon as their time and experience allow.

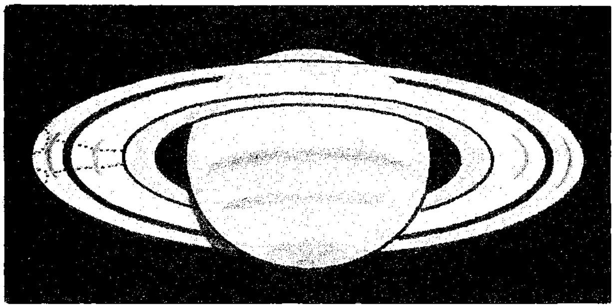


Figure 17. Drawing by T. Dobbins. 1984 MAR 24, 06:05 - 06:24 U.T. 16.5-cm. RR; 221-396X. #11, #82A, and #23A Wratten Filters. Seeing = 5-8; Transparency = 5. CM(I) = 010-022°, CM(II) = 217-228°. B = + 20.°62; B' = + 19.°68.

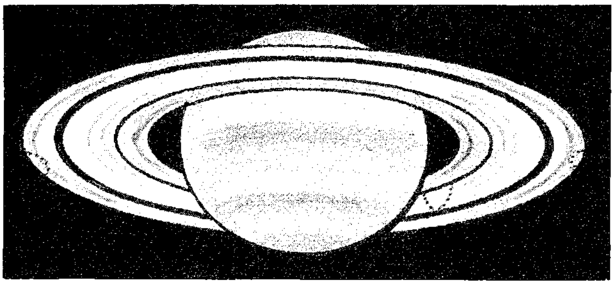


Figure 18. Drawing by T. Dobbins and K. Schneller. 1984 APR 29, 05:50 - 06:35 U.T. 16.5-cm. RR; 236-275X. #21, #11, #80A, and Polarizing Filters. Seeing = 7-9; Transparency = 5+. CM(I) = 149-176°; CM(II) = 284-309°. B = + 19.°91; B' = + 20.°03.

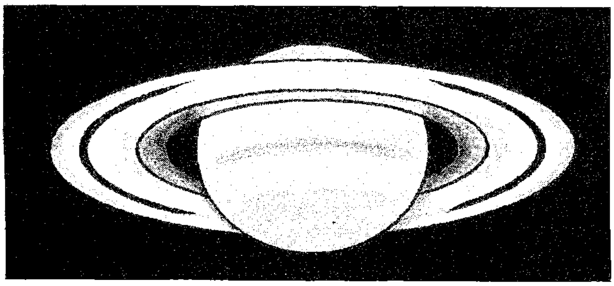


Figure 19. Drawing by A. Heath. 1984 MAY 08, 23:30 U.T. 30-cm. NEW; 190X and 318X. Seeing = 3-2 (Antoniadi scale). CM(I) = 087°; CM(II) = 270°. B = + 19.°70; B' = + 20.°13.

The Recorder is always delighted to assist the novice, as well as the experienced observer, who embarks on a systematic program of study. Readers are encouraged to write to him about their interests, regardless of the size of their telescope or their degree of real experience. There is always room for everyone.

Thanks are expressed again to the faithful observers who made this report possible, and the writer looks forward to continued dedicated efforts by such individuals, worldwide, in the coming years. [Text continued on p. 164.]

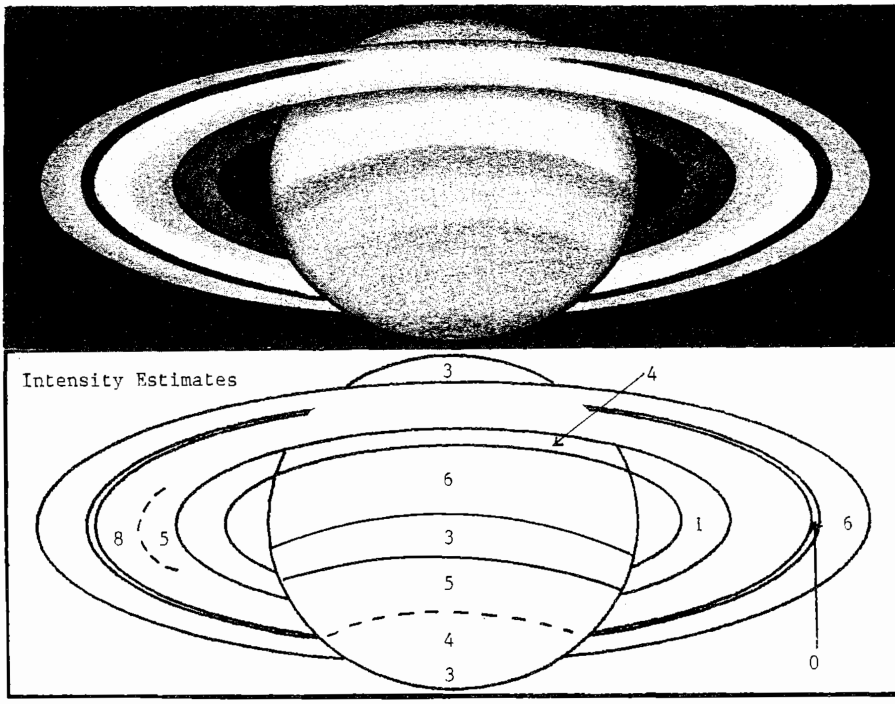


Figure 20. Drawing and intensity diagram by M. Daniels, on 1984 MAY 08, at 04:40 U.T., using a 20-cm. reflector at 190X. Seeing = 5-6, Transparency = Good. CM(I) = 157°; CM(II) = 353°. B = +19.°71; B' = +20.°12.

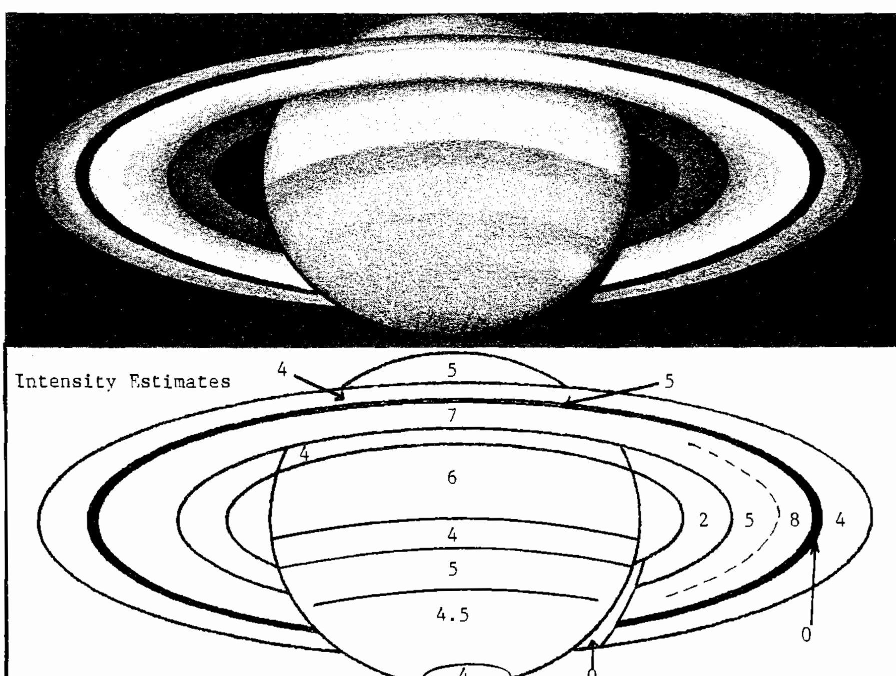


Figure 21. Drawing and intensity diagram by M. Daniels, on 1984 JUN 17, at 03:00-03:30 U.T., using a 20-cm. reflector at 235X. Seeing = 7-8, Transparency = Good. CM(I) = 031-048°; CM(II) = 018-035°. B = +19.°05; B' = +20.°50.

[Text continued from p. 162.]

References

1.) Alexander, A.F.O'D., The Planet Saturn. London: Faber and Faber, 1962.
2.) Benton, Julius L., Jr., The Saturn Handbook. Savannah, GA: Review Publishing Co., Inc., 1981. (3rd revised edition.)
3.) ________, "The 1981-82 Apparition of Saturn: Visual and Photographic Observations," J.A.L.P.O. 30 , Nos. 7-8, pp. 133-141 (April, 1984).
4.) U.S. Naval Observatory, The Astronomical Almanac. Washington: U.S. Goverment Printing Office. (Annual publication; the 1982, 1983, and 1984 issues were used, each published in the immediately preceding year.)

[The above report describes the observations submitted to the A.L.P.O. Saturn Section for the 1982-83 and 1983-84 apparitions of that planet. We have also received a summary of the observations conducted by the Saturn Section of the Unione Astrofili Italiani (U.A.I.) for the 1984 (i.e., 1983-84) apparition. It is very useful to have two independent reports on the same planet for the same time period. The U.A.I. report is presented below and should be compared with the previous A.L.P.O. report. Note that the intensity scale employed by the U.A.I. is the reverse of that used by the A.L.P.O., with the U.A.I. system grading black as 10 and white as 0. Editor.]

VISUAL OBSERVATIONS OF SATURN IN 1984

By: Gianluigi Adamoli, Director, Saturn Section, Unione Astrofili Italiani

Abstract. --This paper describes 80 observations by 16 observers of the planet Saturn in 1984. Saturn was dull and almost colorless in 1984 and no certain spots were detected on the Globe. The latitudes of the northern belts appear to have gradually increased since 1980.

General Remarks

This report describes the results of 80 visual observations of Saturn made by 16 members of the Unione Astrofili Italiani, who used telescopes (mainly reflectors) ranging from 9 to 30 cm. aperture: G. Adamoli (Padova), P. Amoroso (Milan), S. Baroni (Milan), G. Borgonovo (Milan), S. Calì (Palermo), A. Conti (Milan), A. Ferlito (Naples), S. Gargano (Milan), M. Giuntoli (Pistoia), T. Granata (Pavia), A.W. Heath (Long Eaton, England), G. Macario (Salerno), G. Maga (Pavia), P. Marabello (Padova), D. Sarocchi (Florence), and E. Palumbo (Salerno).

These observations were made between 1983 DEC 29 - 1984 AUG 30 inclusive, although most fell in the months of April through June, 1984. Saturn was in opposition on 1984 MAY 03 at declination -13°, with its polar tilt of $+20^{\circ}$ making the Northern Hemisphere well visible.

Statistics

In this report a "weighted mean" is the mean of two or more observers, each given one of three different weights depending upon whether his individual mean is based on 1-2, 3-6, or 7 or more observations. If not so specified, means are unweighted. The error measure used is the standard deviation.

Statistical analysis was based on 931 intensity estimates, 487 color estimates, and 227 latitude measures from drawings. Tables 1, 2, and 3 (pp. 165-166) report, respectively: weighted intensity means, general color estimates, and Saturnicentric latitude means for the centers or edges of atmospheric belts. Most northern latitude estimates have a $\pm 3^{\circ}$ uncertainty, while the SPR value is only a rough estimate.

The Rings

Generally speaking, the Rings had brightened since 1983 and intensity estimates were systematically lower in 1984 by fractions of a point except for Ring B1, which was more or less stable.* Colors were difficult to detect:

* B1 refers to the outer part of Ring B; B2 to the inner portion. [Editor.]

Ring A at its ansae was yellow while the other parts of the Ring system were whitish or greyish. Ring A was uniform to all observers except Heath, who distinguished a duller outer part from a brighter interior and who glimpsed the Encke Division on one occasion of excellent seeing. The Cassini Division was seen by all observers, at least at its ansae, though some judged it somewhat narrow. Ring B was almost uniform, although those who saw B2 judged its width as 1/10 to 2/5 (typically 1/4) of the entire width of Ring B.

Ring C was a very elusive feature and there were large uncertainties as to its brightness among those who did see it. The only definite information about Ring C regards its projection against the Globe, which was easily seen but appeared narrower than it had in 1983. Its width was measured as 0.034 $\pm$ 0.016 polar diameters at the central meridian, taking the mean of 10 observers, while this value had been 0.058 $\pm$ 0.019 in 1983. This difference is remarkable because the axial tilt, $\underline{B}$, was greater in 1984 than in 1983. The ring shadow also looked narrower in 1984 than in 1983, the mean of three observers being 0.020 $\pm$ 0.002 in 1984 as opposed to 0.053 $\pm$ 0.015 in 1983.*

Some observers made intensity estimates for the sky background near Saturn using the 0-10 scale, obtaining a mean value of 8.0 (assuming 10 as perfectly dark, in the absence of city lights). This suggests that the Cassini Division, and the Globe and Ring shadows, all rated 8 to 9.5 in Table 1 (below), were in fact black, as well as one can judge from these estimates.

Table 1. Intensity Estimates for Saturnian Features, 1984.**

Feature	Weighted Mean	Standard Deviation	Number of Observers
Ring A	2.5	$\pm$ 0.9	15
Cassini Division	7.9	1.8	15
Ring B1	1.5	0.7	15
Ring B2	1.8	0.6	6
Ring C	6.9?	2.5	5
Rings A and B projected on Globe	1.6	0.4	9
Ring C projected on Globe	5.8	1.4	13
Ring Shadow on Globe	9.5	0.5	3
Globe Shadow on Ring	8.9	1.2	15
SPR	4.0?	1.4	2
STZ [STeZ]	3.1	1.2	9
EZ	1.5	0.8	13
EB	4.5	0.8	3
NEBs	4.8	0.8	15
NIZ [NEB Z]	2.5	0.7	12
NEBn	4.6	0.8	9
NTZ [NTeZ]	2.5	0.7	12
NTB [NTeB]	3.7	0.9	7
NNTZ [NNTeZ]	2.3	0.2	4
NNTB [NNTeB]	4.0?	1.0	2
NPR	3.8	0.8	11

* Note that the 1983/1984 difference in the central meridian width of RIng C was less than the combined uncertainty. The width of the visible portion of the ring shadow on the Globe depends upon the Saturnicentric solar latitude as well as upon the Earth's latitude. [Editor.]

** For the identifications of features see the previous article, p. 153. There is a strong <u>negative</u> relationship between the U.A.I. and the A.L.P.O. intensity estimates ($\bar{R}$ = -0.965) for the U.A.I. intensity range 1.5 - 6.9, where: (A.L.P.O. Intensity) = (9.2 $\pm$ 0.4) - (1.15 $\pm$ 0.10)(U.A.I. Intensity), with a standard error of $\pm$ 0.53. [Editor.]

The Globe

The increasingly southern declination of Saturn in recent years has, for Europe, resulted in poorer seeing conditions and prevented the visibility of elusive shadings in the belts and zones. Thus, no Italian observers saw spots on Saturn in 1984 with certainty.

The EZ was not very bright and was similar in intensity to Ring B1. Heath's filter observations indicated that it was bright in red light but very dull in blue, so that its color may have been more marked than Table 2 suggests (below). All the other belts and zones were dull with their normal intensity values. Observers who used white light (no filters) detected practically no color on the Globe, except for an occasional brown tint for the NEB. The STZ [STeZ] immediately south of the Rings appeared somewhat dark, possibly a contrast effect. The SPR, near the limb, and belts north of the NTB, were seen only occasionally and uncertainly.

Table 2. General Visual Color Estimates.

Ring A	Yellow-Grey?	STZ [STeZ]	Grey
Ring B1	White-Yellow	EZ	White-Yellow
Ring B2	White-Grey	NEB	Grey-Brown
Rings A and B projected on Globe	White-Yellow	NIZ [NEB Z]	Grey
Ring C projected on Globe	Grey	NTZ [NTeZ]	WHite-Yellow
		NTB [NTeB]	Grey
		NPR	Grey

The latitudes of Northern Hemisphere features, as measured on drawings, show a consistent increase in recent years and the NEB, NTB, and NPR edge appear to have migrated by substantial amounts since 1980, when the Northern Hemisphere came into view. [Adamoli; 1982, 1983, 1984] Similar displacements appear to be common, at least for the polar regions, and may be related to the change in B (Saturnicentric latitude of Earth). [Sassone C., 1982] If so, the latitude changes are seasonal phenomena similar to the recently-discovered long-term changes in intensity. [McKim and Blaxall, 1984] Table 3 (below) compares the 1984 latitude measures with those of 1983. [Because all latitude changes in Table 3 are positive, a systematic error may be present. Editor.]

Table 3. Saturnicentric Latitudes as Measured from Drawings.

Feature	1984 Latitude (°)	1984 Number of Measures	1983 Latitude (°)	1983 Number of Measures
SPR--edge	-40 ?	6	-44 ?	13
EB	+ 5	9	+ 5 ?	7
NEBs--south edge	+17	58	+15	151
NEBs--north edge	+22	24	+21	73
NEBn--south edge	+26	24	+24	73
NEBn--north edge	+31	58	+29	151
NTB	+48	13	+48	27
NPR--edge	+73	34	+70	21

Observations of Titan

Only Heath followed this satellite, making 11 brightness observations from 1984 APR 23 to JUN 12. He compared Titan's visibility in red light (W25 filter) with that in blue (W47), recording apparent variations in the "color index" which were not related to orbital position.

Acknowledgement

The author warmly thanks all the observers who contributed to this report, especially those who were experienced and who have persevered over the years, whose contributions should be recognized as the most useful.

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A.L.P.O.S.S. SOLAR OBSERVATIONS FOR ROTATION 1744

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

General

In terms of complexity, this rotation's activity was the highest yet recorded by the A.L.P.O. Solar Section (A.L.P.O.S.S.). Most activity was confined to two major collections with two or more activity regions each. In some cases the internal activity of a region was so chaotic and complex that completely detailed descriptions cannot be given here.

All dates and times in this report are in Universal Time (U.T.), while ordinate compass directions will be abbreviated (N, E, SW, WNW, etc.) and will be heliographic, unless otherwise noted. Sunspot groups will be referred to by the Space Environmental Services Center Number (SESC) which applies here to features in all wavelengths. [1-4] For explanations and definitions of other terms used in this report, see The Handbook for the White Light Observations of Solar Phenomena , available from the Recorder (for $US 4.00).

Observers who contributed data for this report are:

Observer	Telescope				Location
	Aper.(cm.)	f-ratio	Type	Stop (cm.)	
Blackburn, N.	15	f/15	Refractor	7.5	Missouri, U.S.A.
Dragesco, J.	36	f/10	Sch.-Cas.	12	Bénin, W. Africa
Hill, R.	20	f/10	Sch.-Cas.	10	Arizona, U.S.A.
Maxson, P.	20	f/6	Newtonian	15	Arizona, U.S.A.
Nicolini, J.	13.5	f/15	Refractor	--	Campinas, Brazil
Otero, J.	7.5	f/15	Refractor	--	Caracas, Venezuela
Rhoads, J. & C.	20	f/10	Sch.-Cas.	--	Georgia, U.S.A.
Timerson, B.	30	f/4	Newtonian	11.5	New York, U.S.A.
Truax, J.	15	f/8	Newtonian	--	Michigan, U.S.A.
Young, S.	20	f/10	Sch.-Cas.	--	California, U.S.A.

Rotation 1744 (1984, 01 08.73 - 02 05.07)

Sunspot Number [2,3]*	Mean	Maximum (date)	Minimum(date)
R_I	69.0	118 (01/29)	36 (01/08)
R_A	65.4	111 (01/29)	35 (01/08)

The first collection of activity regions was in the S Hemisphere, consisting of the two regions SESC 4392 and SESC 4393. On 01/10, at 15:45, Truax showed a large spot near the E limb. A photograph by Hill 4 hours later showed a second spot at the same latitude. A second photograph 24 hours after that showed yet another spot at the same latitude. These comprised the main features of the collection, which spanned some 20° of longitude. The leading spot was SESC 4392, which was probably the remains of SESC 4380 from the previous rotation. [5] The region following SESC 4392 was SESC 4393.

The development of these regions was well covered by an excellent series of high-resolution photographs by Dragesco, three of which are given here as Figure 22 (p. 168), an excellent series of drawings by Otero, additional photographs by Hill, Maxson, Rhoads, and Timerson, and drawings by Nicolini and Young. [Text continued on p. 170]

* R_I represents the International Relative Sunspot Number, while R_A is the American Relative Sunspot Number. [Editor.]

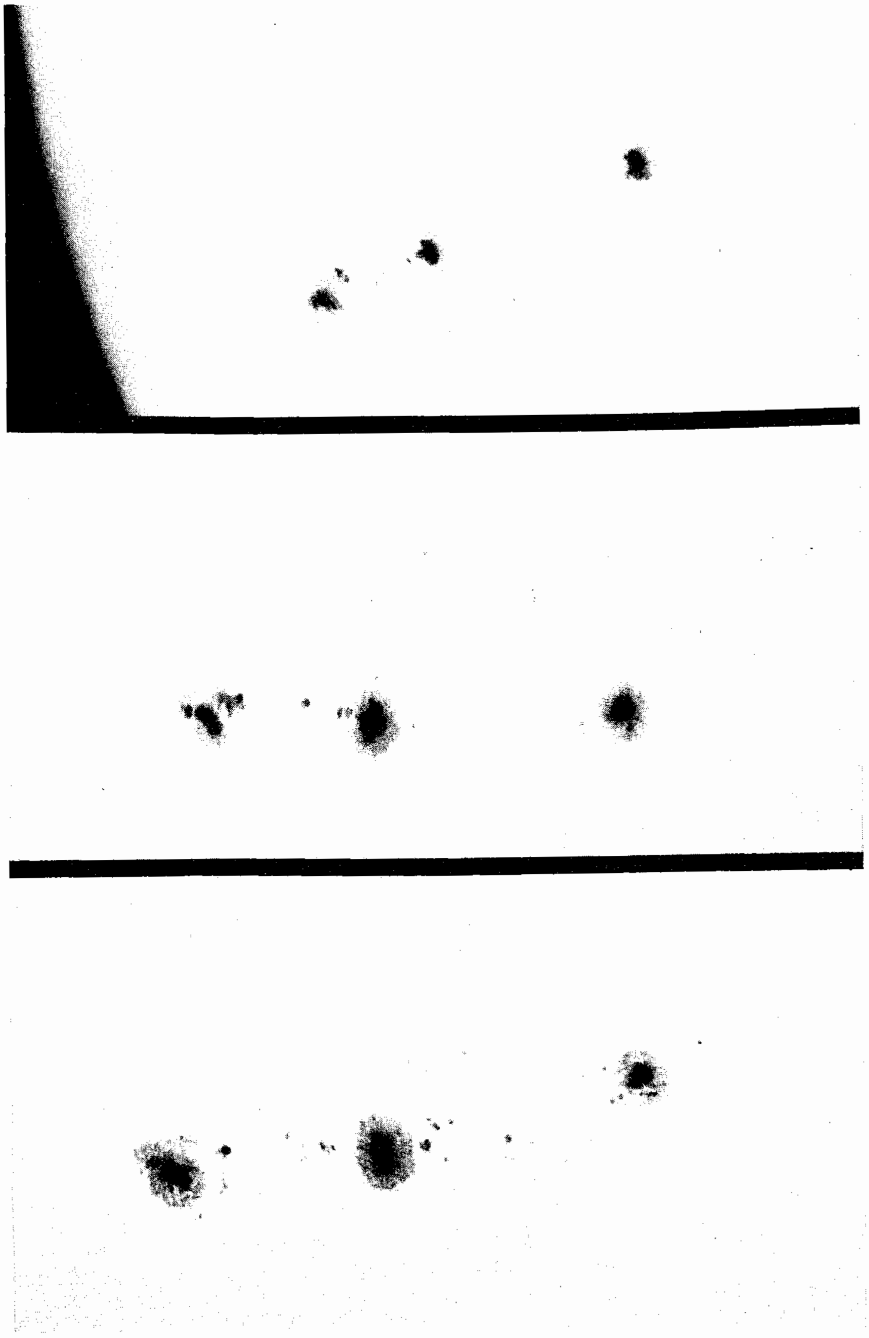

Figure 22. A series of three white-light Solar photographs by Jean Dragesco during Rotation 1744, showing sunspot groups SESC 4392 (right) and 4393 (left). From top to bottom, taken on 1984 JAN 12, 10:52 U.T.; JAN 13, 10:04 U.T.; and JAN 14, 08:48 U.T., all using a 36-cm. Schmidt-Cassegrain with a 12-cm. stop, upon Kodak 2415 Film, developed in HC-110. Note the light bridge in the left-most spot in the center photograph. North at top.

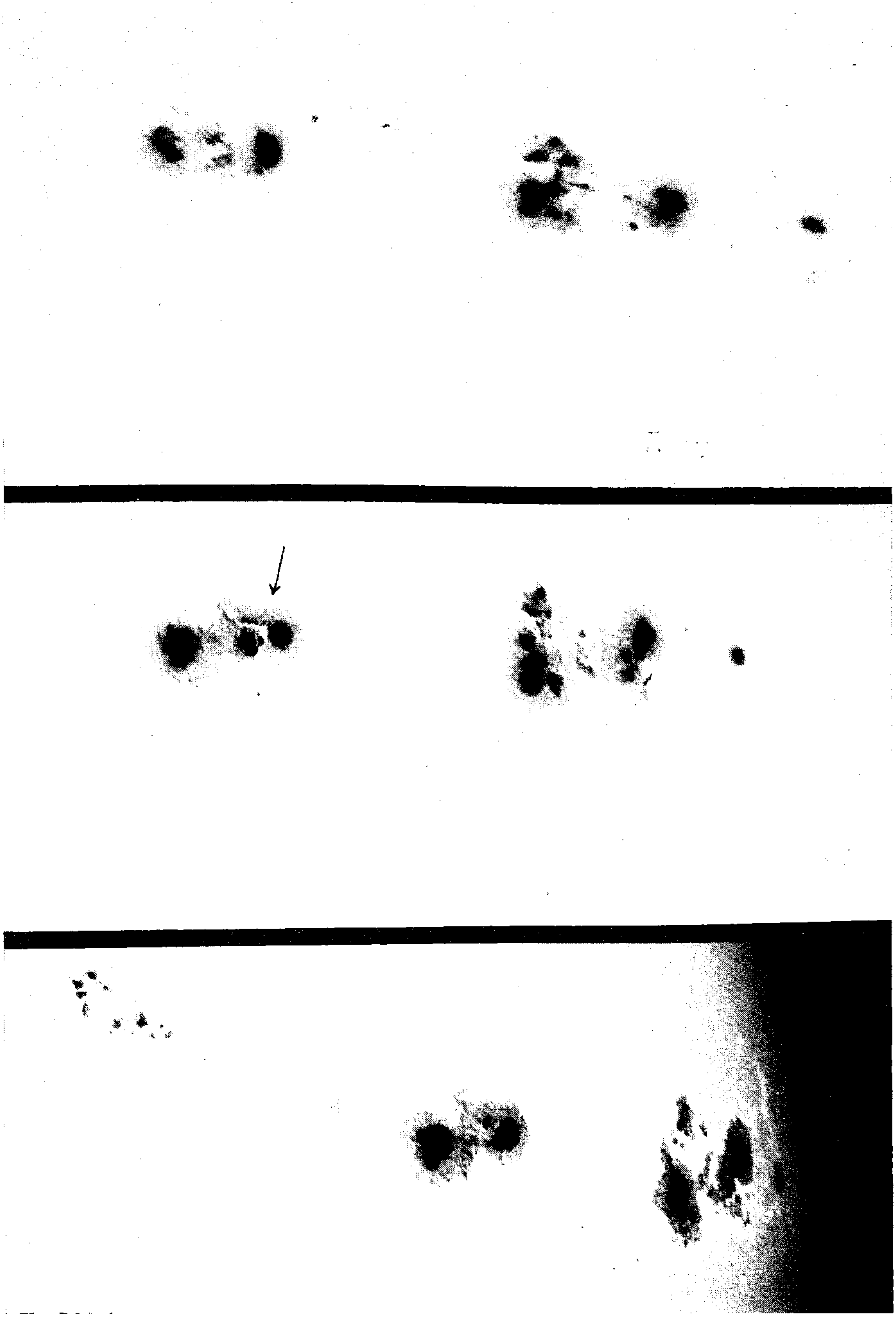

Figure 23. Three white-light Solar photographs by Jean Dragesco showing sunspot groups SESC 4397 (right), 4398 (center), and 4399 (left), during Rotation 1744. From top to botom, taken on 1984 JAN 29, 09:25 U.T.; JAN 31, 08:38 U.T.; and FEB 01, 10:27 U.T., all using a 36-cm. Schmidt-Cassegrain with a 12-cm. stop. The arrow in the center frame points to a rarely-observed white-light flare. North at top.

[Text continued from p. 167]

Throughout its passage across the disk, SESC 4392 remained relatively symmetrical, which is typical for an old decaying region. It decreased in size and was fairly inactive, with only minor pore development taking place twice. By the time SESC 4392 left the disk on 01/20 it was less than half the area it had been on 01/10.

The region following SESC 4392, SESC 4393, was more complex. Its leader spot began as a rather symmetrical main spot with a trail of small umbral spots and pores to the E. These quickly coalesced with the main spot and little activity was seen after 01/16. However, on 01/12 the follower spot began as a spot that was rather symmetrical N-S, with two small umbral spots to its NW, sharing a common penumbra. The next day (shown in Figure 22, p. 168), a light bridge cut off the E quarter of the follower spot, while the two NW spots had developed into no less than six spots and the main spot had lost the portion of its penumbra that had been closest to these spots. By 01/14 half of the small spots to the NW had merged with the follower spot, and the other half had coalesced into a large umbral spot to the NW with a rudimentary penumbra pointing back to the follower. On the next day the follower spot had beoome much more symmetrical except on its E, where the penumbra was poorly formed and the E quarter of the umbra was still detached. The spots to the NW had moved away one full spot diameter and had decayed to pores. It is interesting to note that activity in SESC 4393 and SESC 4392 varied in synchronization with each other. The maximum activity occurred on 01/14 and 01/15. On 01/16 the E quarter of the follower spot of SESC 4393, whose umbra remained cut off but whose penumbral light bridge had faded, had rotated some 40° counterclockwise and had begun to separate from the main spot. At the same time a row of pores and umbral spots with rudimentary penumbrae had formed in a line radiating from the spot toward the W. The next day these pores and spots had separated and had moved slightly S, while their E portion had begun to decay without fully separating from the main spot. The follower spot was now clearly decreasing in area. This decrease continued the next day, 01/18, when the decaying E portion had merged with the main spot and all pores had decayed to invisibility. A dramatic decrease in area took place by 01/20, when the follower had been split into two portions by the formation of a light bridge. The spot now covered only half the area that it had on 01/18. The E portion then rapidly dissolved until, on 01/21, only one small symmetrical round spot remained and the E portion was no more.

The second collection of regions came onto the disk in the N Hemisphere while the first collection left, giving Solar Section members a continuous opportunity to carry on active observing programs. As it came into view on 01/21, the second collection was already quite complex. On 01/25 it spanned over 40° of longitude along a line of latitude and consisted of four active regions: SESC 4397, 4398, 4399, and 4400, although SESC 4400 was slightly S of the other three. Three photographs of Regions 4397-4399 are shown in Figure 23 (p. 169).

The first detailed observations of SESC 4397 began on 01/23. They showed the region to consist of a symmetrical approximately-round spot with attendant pores and umbral spots to the S. During its passage across the disk, maximum development occurred on 01/25. Two days later, it was more nearly round but only half as large. On 01/29, pores formed again to the S but had disappeared by the next day as the main spot continued to decrease in size until it left the disk on 02/01.

SESC 4398 was slightly farther to the E and much more complex than SESC 4397. As SESC 4398 came into view on 01/23, it was a single spot with pores and umbral spots preceding it. This region quickly became more complex. On 01/25 one of the umbral spots began to form into a leader spot. As it did, a trail of small spots connected it with a complex group of spots just N of the follower spot. A thin but bright light bridge had formed in the follower spot by 01/26 but was short lived and exhibited no permanent changes. On the next day the leader and follower spots were directly connected by penumbral material while the smaller spots to the N began to move closer to the follower. SESC 4398's maximum area of over 2,000 millionths of the disk occcurred on 01/29, making it an easy naked-eye group. The subsequent evolution of this region was extremely complicated, with no clear consolidation or expansion evident. However, many complex interactions between its leader and follower spots took place. During the remainder of this region's passage across the disk, the leader and follower spots were never again completely disconnected, and always lay within a single penumbral complex. This feature was probably a delta-configuration, but without magnetic information this assertion is uncertain.

While not so active as SESC 4398, SESC 4399 was still very active. It increased in area throughout its entire passage. The leader spot consolidated twice and then formed a chain of umbral spots within its penumbra, tangent to the N edge of the main umbra and pointing toward the follower. Dragesco photographed this chain on 01/31 during a class 1B white light flare! (See Figure 23, p. 169) Such observations are quite rare. The day afterward, the region's area had suddenly increased by over 10 percent. Many complex and chaotic internal motions were taking place. As with SESC 4398, the leader and follower spots were continually connected by penumbral material throughout the disk passage. Region SESC 4399 left the disk on 02/04 while still increasing in area and complexity.

SESC 4400 was relatively minor, being never more than an umbral spot some 4 or 5 arc-seconds across. It was located to the S of, and between, SESC 4398 and SESC 4399, appearing on 01/25 and gone by 01/27.

As this collection of regions was leaving the disk, a new region, SESC 4403, began to form some 15° of longitude to the E of SESC 4399. This was a quasi-circular patch of umbral spots with rudimentary penumbrae and considerable internal motion. However, this region left the disk before developing leader and follower spots.

Those interested in joining our observing efforts should contact the A.L.P.O.S.S. Recorder, Richard E. Hill, at 4632 E. 14th St., Tucson, AZ 85711.

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Suggestions for Further Reading

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COMET NOTES: VI

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

Why are comets so fascinating? Their long tails punctuating history, these objects receive more attention than the small sizes of their icy, dusty nuclei appear to deserve. Stellar astronomers wonder why comets walk off with so much attention. The answer is really simple; these "primitive bodies" of the Solar System attract us in unscientific ways, bringing out our poetry, our art, and, unfortunately, our competitive nature.

With Comet P/Halley, this nature reached a crescendo with hundreds of people crawling over each other in their drive to be the first on their blocks to recover the comet and to observe it. Competition has in fact become one of the uglier aspects of the current apparition of this magnificient comet, fueled by some magazines as well as by many astronomy clubs. Even the A.L.P.O. offered a special prize, although ours was noncompetitive; we gave a certificate to all the early observers without concern as to who was first. We did find ourselves in the unfortunate role of arbiter in several quarrels and lost friendships over who saw THE comet before someone else. This hardly can be the way to enjoy this privileged time.

I admit to having once been attracted to being first--either first to see the comet, first to photograph it, first to wish upon it, or whatever. Of course, I couldn't actually be the first to see it, because I wasn't around in -239 with the Chinese observers. But then, when the people at Stellafane were tripping over each other to become the "fifth, sixth, and fortieth" to see the comet, and I didn't stand in line, I knew that I was out of luck. Perhaps I could rush back to Arizona and be the first in my home state, but that appeared somewhat academic because observatories all around me had been studying it since 1982. Then an idea struck: Why not be the first to see the comet from my own home, ahead of the cats, who I assumed had other interests? With mounting excitement I sped into the driveway, only to be greeted by a note from our Assistant Comets Recorder, Jim Scotti: "Hi David. Opened your observatory last week; got one possible sighting of P/Halley."

Seriously, being the first to see Halley's Comet, or anything else in the sky, is of value only if one learns something from the observation. As scientifically informed people, we understand the need to observe and study this comet, but we should also understand the illogical ideas that these bodies can create in the general population. Our task is not to become a part of these ideas, but to alter them so that everyone can share in the real joy of comets.

OBSERVING METEORS: VI

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

Why is the night of May 4/5, 1986, different from other nights? This night is special because it offers us the chance to see both parent Comet Halley and her children, the Eta Aquarid Meteors. This May shower will thus be the season's most important, coinciding beautifully in time with the fading comet, which will be located in Hydra at about $10^h 44^m$, $-15^\circ 14'$, forming a triangle with Spica and Regulus.*

The single observer hourly rate for the Eta Aquarid shower averages 20, if one observes from a southern location where the radiant is high in the sky. Throughout most of the United States the rate is about half that optimistic number. At 65 km./sec., these meteors are among the fastest. Although there has been no strong evidence of increased activity near the times of Comet Halley's past perihelion passages, surprises are possible.

Viewing a meteor shower near the time of arrival of the parent comet is not as uncommon an event as one might think. The Orionids of late October also are related to Comet Halley. Again, just last October, some observers enjoyed a substantial Draconid shower in connection with Comet Giacobini-Zinner, which had passed though the plane of the Earth's orbit only three weeks earlier. Then, it seems that a strange asteroid, 1983 TB, wih an orbital period not much greater than the Earth's, may be the parent of the Geminid shower. The Geminids have increased in strength in recent years and are now by far the "best" shower of the year. Finally, early in this decade, the famous Perseid shower began to increase its numbers, seemingly in preparation for the return of its parent comet, Swift-Tuttle (1862 III), which was expected in 1982-84. This comet apprently eluded us, however, and that shower has shown some weakening in more recent years.

In the Spring of 1983, when the Earth had a close encounter with Comet Iras-Araki-Alcock, observers watched in vain for a meteor shower at the moment when the Earth crossed the plane of the comet's orbit. One of these meteor tales had a happier ending: Comet Biela divided into two at its 1846 return, and reappeared as two separate comets in 1852. Although neither comet was ever seen again, some remnants fell earthward in strong meteor showers in 1872, 1885, and 1898. This shower, the Andromedids, has been insignificant ever since.

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* The shower radiant itself will be located opposite Comet Halley in the sky, at $22^h 24^m$, 00°, and will not be above the horizon until the pre-dawn hours, when a waning crescent Moon should only slightly interfere with observation. [Editor.]

LINCOLN LA PAZ (1897 - 1985)

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

Dr. Lincoln La Paz, astronomer, mathematician, and a charter member of the A.L.P.O., died at his home in Albuquerque, New Mexico, on October 19, 1985.

Dr. La Paz was born at Wichita, Kansas on February 12, 1897, and received his formal education at Fairmount College in Wichita (A.B., 1920), Harvard University (A.M., 1922), and the University of Chicago (Ph.D., 1928). After briefly teaching at Harvard University and Dartmouth College, he joined the Mathematics Department of the Ohio State University in 1929, attaining the rank of full Professor in 1942. During World War II he served as Technical Director of the Operations Analysis Section, Headquarters, Second Air Force. He there played am important role in the development of the proximity fuse. In 1945 he became the Chairman of the Department of Mathematics at the University of New Mexico, and continued to teach until 1962.

He became interested in meteors and meteorites early in his career, and his students at Ohio State learned to plot and to count meteors with him on cold winter nights. He founded the Institute of Meteoritics at the University of New Mexico in 1944, serving as its first Director. One of the Institute's major achievements was the discovery and excavation, in 1948, of the Furnas County, Nebraska - Norton County, Kansas aerolite. This is the largest meteorite of this type so far found in the world. Our older readers may remember his frequent contributions to "Meteor Notes" in Popular Astronomy in the 1930's and 1940's. His book that would probably be most familiar to our readers is Space Nomads: Meteorites in Sky, Field, and Laboratory (1961). His daughter, Miss Jean La Paz, was this book's co-author.

Dr. La Paz belonged to many scientific, astronomical, and mathematical societies, more than can be enumerated here; and he was the author of a very large number of papers in technical journals. Perhaps his most valuable contribution to astronomy consisted of the application of mathematics to problems in meteoritics. In pure mathematics his specialities included Number Theory and the Calculus of Variations.

As usual, recitations like the one above tell us little about the man. The writer knew Dr. La Paz as a graduate student in mathematics at the Ohio State University in 1939-41 and then later as a faculty member of the Department of Mathematics at the University of New Mexico in 1946-50. He found this association enjoyable and intellectually stimulating. Dr. La Paz served as Counselor of the A.L.P.O. for many years following its founding in 1947. He was a man of most remarkable physical energy; sometimes it seemed as if he was happiest when dealing with at least six different persons waiting at his office door, each with his or her own set of problems and questions. Yet it is significant that the inevitable complaints then voiced were always made in good humor and that everyone clearly felt that Dr. La Paz was truly concerned, and ever helpful, about his or her particular project, big or small as it might be. That he was so concerned was proven by my last letter from him in August, 1985. It was an encouraging letter, written in quick response to a postcard mailed to inform A.L.P.O. members of my health problems at that time.

His passing must leave me with a sense of loss, tempered by a number of treasured memories. There was the view of the Giacobinid meteor storm on October 9, 1946, from a high-flying B-29, for which Lincoln La Paz had arranged. There were my efforts to explain the development of Waring's Theorem at a classroom blackboard, while teacher La Paz stood by patiently. There were surveys of the earthlit Moon for possible lunar meteors with a portable telescope in the dark and silent New Mexico desert.

I wish to thank Miss Jean La Paz, who kindly supplied much of the information given above.

BOOK REVIEWS

Mars and Its Satellites: A Detailed Comentary on the Nomenclature. By Jürgen Blunck. 2nd Edition, revised. Exposition Press, Inc., Smithtown, NY, 1982. 222 pages, illustrations, Appendix. Price $ 10.00.

Reviewed by C.F. Capen

The first edition of this book was reviewed in J.A.L.P.O. Vol. 27 , Nos. 7-8 (Nov., 1978), p. 169. The second edition has been expanded by 22 pages; additional reference Mars charts have been included and the charts moved forward in the text, while two new appendices have been added.

In the introduction, Dr. Blunck discusses the history and evolution of the Martian nomenclature used to identify the light and dark albedo surface features shown on the wide variety of Mars charts drafted by the classical astronomers of the 19th Century. The complex naming scheme of Schiaparelli, which scientists still use today, is most interestingly explained. Mars and Its Satellites is divided into 30 short chapters, each corresponding to a map section of the U. S. Geological Survey Atlas of Mars . The placenames adopted by the International Astronomical Union in 1958 and the more recent names of the topographic features discovered by the Mariner and Viking space missions are also described. Selected Martian craters have been named after deceased persons who were students of, or influenced by, the Red Planet, and Blunck gives an interesting biography of each individual so honored. The areographic positions given for the albedo features are not necessarily those intended by the classical astronomers who named them. The classical and modern Mars charts were well selected and are well placed for reference, but unfortunately did not reproduce well on the soft paper used by the publisher. However, the price of the book is right.

Dr. Blunck's expertise in ancient history, mythology, and languages is apparent throughout the book. Many ancient geographical names have more than one origin, while others, if traced back far enough, become obscure. In most cases, he succeeds in tracing the etymologies of the Martian feature names.

Following the main text is a "Gazetteer" with the nomenclature and surface charts of the two Martian satellites. "Appendix 1" lists "Names of Mars Researchers Used in the Older Nomenclature," which were introduced by Proctor and added to by Green and Flammarion, and includes Proctor's 1867 map of Mars. "Appendix 2" lists "Rarely-Used Surface Area Designations" of the Graeco-Latin names used on maps by Antoniadi, Avigliano (ALPO), Brenner, Cerulli, Comas Sola, Capen (ALPO), Douglass, Escalante, Fournier, Jonckheere, Lowell, Pickering, Schiaparelli, Sadil, Sharonov, and Vaughn (ALPO), together with five maps of ancient geography that show the terrestrial placenames traditionally used to name features on Mars. "Appendix 3" discusses "Science-Fiction Names and Nicknames." Apparently, Dr. Blunck has waded through most Martian fiction stories and books from the 1930's to the present, and this makes most interesting reading for the Mars observer, historian, and Sci-Fi addict. The listing of titles is largely complete, although two Barsoom publications by Ballantine Press have been missed; the large color Map of Barsoom and A Guide to Barsoom--The Mars of Edgar Rice Burroughs , both by J.F. Roy. The nicknames given to the surface rocks surrounding the Viking-1 and -2 landing sites are described well. It is unfortunate that Dr. Blunck has not been closely acquainted with Mars observers because the affectionate nicknames given to many of the observed disk features by classical and modern planetary astronomers are not given, and they would have been an interesting addition. "Appendix 4. IAU Committees on Martian Nomenclature," gives the names of the members of Martian nomenclature committees operating within Commission 16 of the IAU. Next is a "Short-List of Maps and Globes of Mars," which is really a long listing of major works, and is worth the price of the book to the serious student of Mars. It lists charts from 1858 to 1981. The last item is a complete index of names with the locations of the features they designate.

Mars and Its Satellites is the most complete listing of Martian placenames published to date, and it should be on the reference shelf of the planetary astronomer, historian, and collector of Mars publications.

Rings: Discoveries from Galileo to Voyager. By James Elliot and Richard Kerr. The MIT Press, c/o Uniserv Inc., 525 Great Road (Route 119), Littleton, MA 01460, 1984. 209 pages. Price $ 17.50.

Reviewed by Gary A. Becker

Rings (for short) has a provocative air which might qualify it to be placed conspicuously in a drugstore paperback carrousel. Although the content of Rings would not please a diehard romantic, it possesses its own brand of intrigue, excitement, and curiosity, an affair of sorts with science, and the discovery and solution of perplexing problems. This book is a candid history of our acquisition of planetary ring information, told by an individual who was instrumental in making the discoveries (Elliot) and another who wrote about them (Kerr).

On the negative side, Elliot and Kerr occasionally present such a wealth of new and sometimes conflicting information that this reader was not completely able to synthesize it. Their meticulous account of the unfolding events as Voyager passed Saturn is one example, as well as their ten full pages of real-time dialogue which they felt was necessary to convey the discovery of Uranus' rings.

There is no doubt that the authors are passionate about their work, but they also express the fear that rivalry and the "knowledge explosion" is leading to what they call "instant science." Cutthroat competition leads to hasty results and poorer science. There is not enough time for serious reflection as everyone scrambles for the next research grant. Perhaps this is why the book details the debate without clearly focusing the reader's attention upon any one particular solution.

On the positive side, the authors left me with a distinct impression of the process by which science advances and of the joys and frustrations which accompany that quest. Many times, new discoveries are serendipitous and show extreme resourcefulness on the part of the researcher.

Another interesting thread, which adds color to the text, is science's ability to ignore observations which could have led to earlier ring discoveries. ALPO's John Westfall is credited with having provided some tantalizing information about Saturn's ring structure, being the only person to observe a predicted stellar occultation by the Ring System in April, 1957. [A very striking example of this failure to discover what should have been evident is the late discovery of Ring C of Saturn, which was finaly recognized about 1850. Yet the Crape Band had been easily visible for decades, or even centuries before then. It was probably assumed to be a ring shadow or a belt on the Globe, even when its aspect contradicted the geometry of such an interretation. Ed.] Likewise, evidence from the two Pioneer spacecraft hinted at a ring surrounding Jupiter. Even Galileo appears to have missed his chance at discovering the true nature of Saturn's Rings. Elliot and Kerr realize that hindsight is always 20/20, but their proposals are nonetheless intriguing.

Rings offers a personal, insider's look at astronomical discoveries which have revolutionized our concepts of the Solar System. Despite the lack of synthesis in some of its chapters, James Elliot and Richard Kerr manage to capture the excitement of the chase in the fast lane of modern astronomical conquests.

Physics of Planetary Interiors. By G.H.A. Cole. Adam Hilger, Ltd., P.O. Box 230, Accord, MA 02018, 1984. 208 pages. Price $ 39.00 cloth, $ 16.00 paper.

Reviewed by Alain Porter

The argument whether the recently-discovered companion of the star van Biesbroeck 8 should be called a planet begs the question of how "planet" is defined. Physics of Planetary Interiors is a graduate or advanced undergraduate text based on the concept that a planet is a body whose overall equilibrium is not affected by its thermal energy in that temperature does not appear in the material's equation of state.

The first chapter presents some observational data on our Solar System's planetary bodies. Chapters 2 through 6 discuss the physics of such bodies in a very basic and intuitive way, using back-of-the-envelope type mathematics to milk as much information as possible from the simplest ideas. Three more chapters cover planets of large mass, terrestrial planets, and icy planets. Included at the end of each chapter is a reference and discussion section, written to lead the student to more detailed treatments of the subject (often original papers) and to elaborate on relevant points of physics.

The philosophy and structure of this book would make it an excellent introduction to the subject were its execution not seriously flawed. The most annoying problem is that the text is riddled with misprints. I read the first five chapters carefully, and found dozens of such errors, mostly in the equations. Characters are omitted or substituted, exponents are wrong, and signs are reversed and, though the errors usually disappear by the next step in the argument, sometimes they do not. (Curiously, I found only two misspelled words.) Worse, there are a few errors in the physics. In Chapter 2, screening forces are inconsistently omitted from arguments which consider the attraction between the electrons in an atom and its nucleus. An example of the result is that the binding energy of an atom is found to be proportional to the atomic number, Z, whereas the true dependence is even stronger than Z^3. In Chapter 5, the two radiation constants σ and a are confused. The flux of heat from a black body of absolute temperature T, $q = \sigma T^4$, is stated to be $q = aT^4$. In fact, aT^4 is the energy density, not the flux. This is the sort of error that can easily fail a student taking an exam, and should not be propagated in a textbook. Sections 4.4 and 4.5, dealing with the equilibrium figure of a rotating planet and the acceleration of gravity at its surface, contain many algebraic errors, some of which remain in the final equations.

In a way, I regret being unable to recommend this book, because it taught me what it was meant to, but by forcing me to question every step that it took. However, this is not what those who buy a text for a course expect, and it cannot be trusted as a reference. I think that Physics of Planetary Interiors is worth saving for its conceptual approach and referencing sysem, but a thorough revision is absolutely necessary. Don't buy it yet. [Note: The reviewer has given the Editor a lengthy list of specific errors, available on request.]

Starwatch. By Ben Mayer. Perigee Books, The Putnam Publishing Group, New York, NY, 1984. 11X8.5 in., 144 pages. Price $ 15.95 cloth (ISBN 0-399-51008-7), $ 7.95 paper (ISBN 0-399-51009-5).

Reviewed by Richard G. Hodgson

The approach of Halley's Comet may serve to kindle a new, or an increased, interest in observing the night sky for many people. To help newcomers, and to enrich the understanding of present stargazers, Ben Mayer, the well-known California amateur astronomer and astrophotographer, has produced Starwatch, which is an excellent guide to the brighter constellations of the night sky.

Starwatch contains excellent star charts, some historical, that show the constellation figures of yesteryear's mythology, along with many photographic charts. However, coverage is limited to the brighter and better-known constellations of the northern and equatorial sky. Clearly, the author has observers in the mid-northern latitudes in mind. Some of the major deep-sky objects found in these constellations are described, particularly if they are visible in binoculars or small telescopes. Ben Mayer provides graphic instructions to help the beginning observer to find these objects.

A major strength of this book which will appeal to astrophotographers is Mayer's description of his "Problicom" (T.M.), a type of blink comparator which involves using two slide projectors mounted vertically to project slides of the same star field taken at somewhat different times. By projecting the two images alternately, planets or comets which have moved between exposures are readily detected. The author has done much to pioneer this dual-projector approach. He also presents many helpful suggestions for simple astrophotography.

The one criticism the reviewer has of this book is its omission of many fine constellations, particularly in the southern sky, including Carina, Centaurus, and Crux. One also misses some of the beautiful, easily-recognized, smaller northern constellations such as Delphinus and Corona Borealis, which have long been favorites of mine. Even some larger northern constellations like Draco and Boötes are missing, probably because they are somewhat harder for the beginner to find.

My suggestion to Ben Mayer would be to include more constellations in any second edition of Starwatch, perhaps in an added section for more advanced observers. The present edition is excellent, especially for the beginner; but many buyers may wish for more extensive coverage of constellations. An expanded second edition would doubtless cost more, but it would be worth the extra price.

Starwatch contains much useful information for both the beginning, and the more advanced, amateur astronomer. The price is very reasonable. Its purchase deserves consideration by all who love the starry skies.

NEW BOOKS RECEIVED

Notes by J. Russell Smith

A Comet Called Halley. By Ian Ridpath and Terence Murtagh. Cambridge University Press, 32 East 57th Street, New York, NY 10022, 1985. 48 pages, illustrated. Price $ 4.95 paper.

This is a handy booklet to have, and contains the following topics: "The Comet Arrives," "Counting Comets," "Collisions With Comets," "Did a Comet Kill the Dinosaurs?," "Comet Lore," "Understanding Comets," "Edmund Halley," "Halley and His Comet," "The Comet Returns," "The History of Comet Halley," "The Comet Cloud," "Comet Tails," "Cometary Fireworks," "Do Comets Carry Diseases?," "Great Comets," "Comet Hunters," "The Return of 1910," "Awaiting the Comet," "Through the Comet's Tail," "Space Probes to Comet Halley," "Looking for Halley's Comet," "Where to See Halley's Comet," "How to Observe Halley's Comet," and "How to Photograph Halley's Comet." I recommend this book to all interested in Halley's Comet.

Mankind's Comet. By Guy Ottewell and Fred Schaaf. Astronomical Workshop, Furman University, Greenville, SC 29613, 1985. 15X11 in., spiral-bound, 193 pages. Price $ 22.00 including ordinary postage.

This is an outstanding publication. It tells about Halley's Comet in the past, the present, and the future . The sections consist of: "The Unfolding," "Strobe-light," "1910," "A Topology of the Halley Visits," "A Grammar of Comets," "The Character of This Comet," "Re-entry on the Stage," "Spacecraft to the Comet," "Dark Skies for Comet Halley," "A Narrative Calendar for the 1985-1986 Visit," "The Future," and "Appendices," the last including an Atlas of the 48 visits from 1404 B.C. to A.D. 2061. This book should be passed on to your children and grandchildren, and on down through the generations.

Astronomical Calendar 1986. By Guy Ottewell. Astronomical Workshop, Furman University, Greenville, SC 29613, 1986. 15X11-in., 65 pages, paper. Price $ 10.00 postpaid.

Somewhat delayed this year because of the author's previous publication, this is an annual publication consisting of sky maps and notes for each month. There are also sections including "Moon," "Eclipses," each principal planet, "Meteors," "Jupiter's Satellites," "Asteroids," "Comets," "Halley's Comet," and a "Glossary." This book is well worth the price and I feel certain you will agree when you see it.

The Geology of the Terrestrial Planets. By Robert H. Carr, R. Stephen Saunders, Robert G. Strom, and Don Wilhelms. NASA, Washington, DC 20546, 1984. 9-1/4X11-5/8 in., 317 pages, illustrations. Price $ 16.00 cloth (overseas $ 20.00). Available from Superintendent of Documents, Government Printing Office, Washington, DC, 20402.

After an "Introduction," the authors cover their subject in the following chapters: "Asteroids," "Comets and Planet Formation," "Mercury," "Venus," "Earth," "Moon," and "Mars." These are followed by a "Summary" and an "Appendix" with several maps of the terrestial planets and the Moon, references, and an "Index." This is an outstanding volume, and if you are interested in the planets you will want this book.

ANNOUNCEMENTS

Erratum. Mr. Pablo Daumas Ladouce has asked us to publish the following notice regarding his article, "A Lunar Nomogram," which was incorrectly edited by the present Editor:

> "A LUNAR NOMOGRAM giving the PHASE, AGE, and LOCAL MERIDIAN CROSSING TIME of the MEAN MOON for every day of the Christian Era."
>
> The (reduced) reproduction of this work apeared in the ALPO JOURNAL (Vol. 30, No. 7-8, April 1984, page 164). - Due to a regrettable misunderstanding, Tables A and B, as well as figures of paragraph "Col. 6" page 165, were presented in the review with the values corresponding to real or apparent moons of certain periods instead of those of mean moon.- The true values of these tables and complementary details corresponding to mean moon for tracing the correct Nomogram, as well as a large copy of it, will be gladly furnished on demand by the author, Pablo Daumas Ladouce, P.O. Box 1410, Asuncion, Paraguay (South America).-

The Editor apologizes for his misunderstanding that caused the errors which are referred to above. Readers who wish to employ the very useful lunar nomogram are urged to take advantage of Mr. Daumas Ladouce's generous offer to supply a correct version.

Update on 1986 Annual Convention. As announced in Vol. 31, Nos. 3-4, on page 87, the A.L.P.O. accepted the invitation of the Astronomical League to meet with them at ALCON'86. We now have further information on that meeting, including the change of its name to ASTROCON 86 . The convention will be held August 4-10, 1986, on the campus of the College of Notre Dame of Maryland in Baltimore, and the participants will be the Astronomical League, with the A.L.P.O., I.O.T.A., I.A.P.P.P., Planetary Society, L-5 Society, and the Space Studies Institute.

Registration will be held on Monday afternoon and Tuesday (August 4-5), with field trips on Tuesday (to Goddard Space Flight Center and to the United States Naval Observatory) and Wednesday (August 6; to the Smithsonian Air and Space Museum). After an evening welcome reception at Notre Dame College on Wednesday, paper sessions will occupy Thursday, Friday, and Saturday (August 7-9). The Annual Banquet will be held Saturday evening, including the presentation of the Walter H. Haas Award for 1986. Other activities will include Business Meetings, exhibits, and "Astromart 86."

A.L.P.O. members can participate in several ways. We naturally urge them to come to our Business Meeting. Members may also wish to contribute displays. If so, they should write Julius L. Benton, Jr. (address on inside back cover), who has kindly offered to coordinate A.L.P.O. exhibits. Those who wish to present papers should indicate so upon their registration form. They will then receive a paper admission form. NOTE THAT THE PAPER SUBMISSION FORM IS DUE BACK ON OR BEFORE JUNE 1, 1986. Also, if you wish your paper delivered in the A.L.P.O. session, please send John E. Westfall (address on inside back cover) a copy of this form by June 1st, followed by a copy of the actual paper before August 1st.

To obtain a registration packet-form, write to ASTROCON 86, 642 Kingston Road, Baltimore, MD 21220. The form provides for convention registration and for field trips and on-campus dormitories and meals. You should register early because rates go up June 1st; also, field trips and dorm rooms are limited.

Eighth Annual Texas Star Party. --This Southwestern observing conference will be held on May 5-10 at Prude Ranch, near Fort Davis, Texas, and will include the national conventions of the International Occultation Timing Association (IOTA) and the National Deep Sky Observers Society (NDSOS). Bunkhouses, cabins, and campsites will be available. This meeting's emphasis is on deep-sky observing, aided by the excellent skies of the Davis Mountains and a New Moon. A.L.P.O. members will note that Venus, Saturn, and Halley's Comet will be well-placed in the evening sky, with Mars and Jupiter visible before dawn. There will also be paper sessions, including presentations by Bradford Smith and Stephen O'Meara, along with recreational opportunities. For registration information, write: T.S.P. Registrar, 128 N. Commerce, Burleson, TX 76028.

Address Changes for Jupiter Recorders. Effective immediately, Jupiter Recorder Phillip W. Budine's new address is P.O. Box 126, Plymouth, NY 13832; and the Assistant Jupiter Recorder, Photography, Jean Dragesco, has moved to B.P. 117, Butare, Rwanda.

Mars Section Publications. The standard ALPO Mars Observing Kit now contains information useful for the perihelic apparitions of 1986 and 1988. It includes reprints about global dust storms, a new Standard Observing Report Form that can be copied if more copies are needed, a 1986 Mars Physical Observation amd Geocentric Coordinates Ephemeris, a Central Meridian Calculator, a Mars Albedo/Topography Map in color with nomenclature of surface features by V. W. Capen, articles on color filter techniques and using Barlow Lenses, an introduction to Martian disk features, seasonal phenomena and graphs, surface feature names with a location list, "Planetary Photography" by Don Parker, and several references and Mars plotting charts. The entire kit is available at cost for $ 6.00 postpaid (foreign cost $US 9.00) from: A.L.P.O. Mars Recorder, Solis Lacus Observatory, Rt. 2, Box 262E, Cuba, MO 65453.

Active Mars observers should also subscribe to The Martian Chronicle '86 , which can be obtained by sending 6 to 8 self-addressed US postage-stamped long envelopes to the A.L.P.O. Mars Recorder at the above address. Please report any unusual Martian phenomena observed to him; he may be telephoned in the evening at 314-885- 3294.

Jupiter Observing Forms. Forms for recording and submitting drawings and central meridian transit timings for Jupiter have been prepared by Recorder Jose Olivarez and may be ordered from him in lots of 20 at a cost of $2.50 per lot, postpaid, at his address given on the inside back cover.

The A.L.P.O.-N.A.P.O. Connection. Our Journal is now exchanged with the publication of the National Association of Planetary Observer's journal, Iris . Established in 1983, the Australia-based N.A.P.O. has acted as a "clearing house" for amateur observations of planetary and related phenomena. Iris is the first national journal for Australian amateur planetary observers, and publishes all collected "raw" and reduced data from Australian observers, along with instructions for new and experienced observers, notes from foreign groups working in similar fields, reviews of activities of Australian societies, and practical predictions of planetary phenomena. These predictions are published annually in the NAPO Yearbook (Number 6 of each volume), which is delivered in December of the preceding year. Contributions and letters are welcome, and it should be noted that the N.A.P.O. and the A.L.P.O. have collaborated for several years in their Jovian Satellite Timing Programs. The subscription rate, in Australian funds only, is $A 20 for one year or $A 35 for two years for foreign suscribers (via air mail), made out to "National Associaion of Planetary Observers," and sent to N.A.P.O., P.O. Box 504, Sutherland, N.S.W. 2232, Australia.

Astronomy Day, 1986. The A.L.P.O. is a participant in Astronomy Day, which falls on April 19, 1986. Our members can promote both astronomy and the A.L.P.O. by participating with their local astronomy club or even on their own, permitting public viewing with their telescopes, preparing exhibits, and showing drawings or photographs, or by contacting the media. Public viewing sessions have a choice of several Solar System objects on the evening of April 19th: the Moon will be 11 days old, Venus will be visible in the west in the early evening, Saturn will rise in the east in the late evening, while Comet Halley will be up all evening, at maximum altitude in the south about 10:30 PM local standard time.

This year's Astronomy Day will be truly international, exposing thousands of laypersons to astronomy, often for the first time. For further information, contact: Gary Tomlinson, Astronomy Day Coordinator, Astronomical League, Chaffee Planetarium, 54 Jefferson S.E., Grand Rapids, MI 49503 (telephone 616-456-3985).

Riverside Telescope Makers Conference-W.A.A.-I.A.P.P.P. Meeting. This major Western United States event will be held at Camp Oakes, a YMCA camp at 7300 feet above sea level, about 50 miles northeast of Riverside, in southern California. Besides the annual telescope display and star party, there will be guest speakers and award presentations, including the G. Bruce Blair and E.E. Barnard Awards by the Western Amateur Astronomers. The meeting days will be May 23-26, 1986 (Friday-Monday, over Memorial Day weekend). On Monday, the I.A.P.P.P. (International Amateur-Professional Photoelectric Photometry) will conduct a symposium, including a session on "Comet Photometry." The observing conditions at this dark-sky site are usually excellent. With a Full Moon on May 23rd, Solar System objects may be popular this year. Venus, Saturn, and Comet Halley will be visible in the evening, while pre-dawn viewers can observe Mars and Jupiter. For further information, and a registration form, write: Riverside Telescope Makers Conference, P.O Box 4026, Riverside, CA 92514.

Next Year's Comets. The publication, Comet Predictions for 1987, is available for those who believe in "life after Halley." This unbound 58-page handbook by Charles Townsend, John Rogers, and Scott Hanssen can be had from Charles Townsend, 3521 San Juan Avenue, Oxnard, CA 93033 at a postpaid cost of $ 6.00 for the United States and $ 8.00 abroad; the supply is limited. The bulk of this publication consists of orbital parameters and ephemerides for 24 periodic comets, with 1950.0 coordinates, Comet-Sun and Comet-Earth distances, elongations from the Sun, and visual magntudes, at 2- to 30-day intervals.

Free Publication for Educators. If you teach a course in Astronomy, Sky Publishing can supply the 1986 Guide to The Heavens free to students. This 8-page publication includes a beautiful graphic almanac, a detailed map of the Moon, and a summary of planetary events for 1986. For more information, please write, under your school's letterhead, to: William Lawrence, Sky Publishing Corporation, 49 Bay State Road, Cambridge, MA 02238. Be sure to include a description of the astronomy course(s) that you teach and the number of students in each class.

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* FOR SALE: Optical Craftsman 8-in.f/9 reflector. Excellent performance on the Moon and planets. 1.5-in. secondary, massive mount, newly-coated mirrors and in perfect condition. $ 775.00, will consider trade. Roger A. DeKing, 5 Edgewood Ct., Baldwinsville, NY 13027. (315) 638-8846. *
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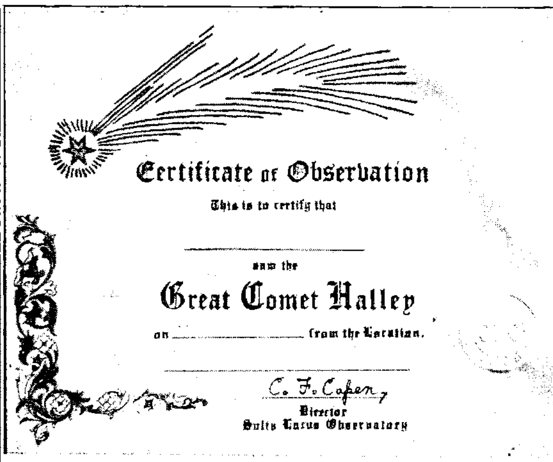

A Certificate of Observation has been produced on antiqued parchment to officially record your personal sighting of Comet P/Halley. The Time and Place of your Observation as documented by you is certified with a hand stamped archival seal by an astronomer who has been studying comets for four decades. This unique lifetime document can be mounted in a standard display frame or this valuable heirloom may be given to your descendants who will view Halley's Comet in the summer of 2061. Special ALPO pre-perihelion prices:

$ 2.25 ea. plus $ 0.50 postage and flat packaging.
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