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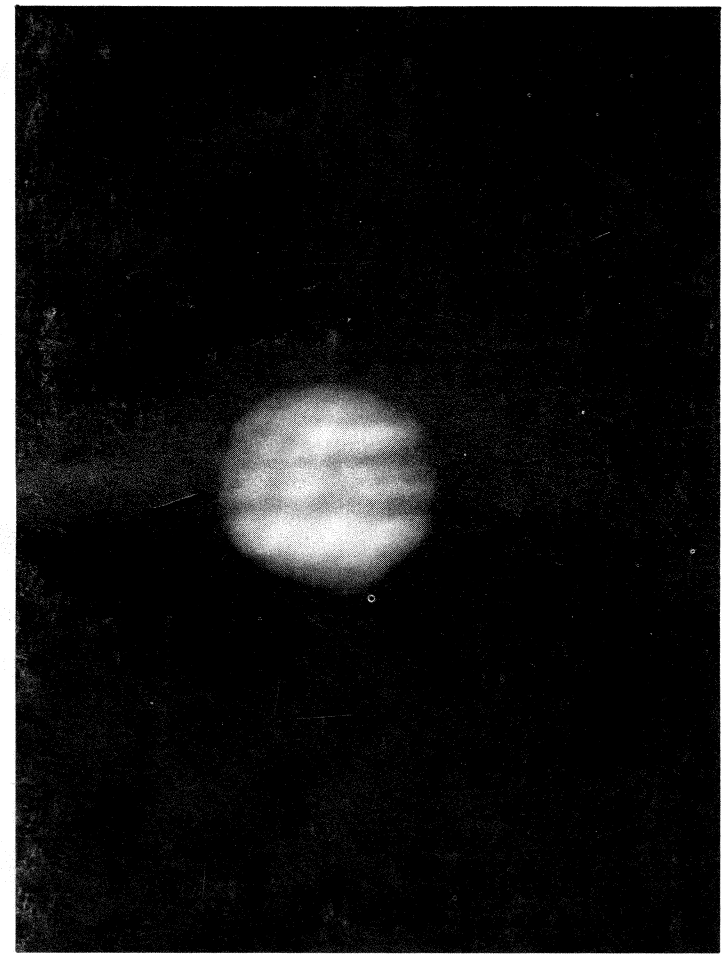

Photograph of Jupiter by John Sanford at Orange, Calif. on March 5, 1979, during the Voyager 1 flyby. 30-cm. f/10 Cassegrain plus 3 x telex. Exposure 1 second. Developer SO-115/Microphen. Seeing 6 on a scale of 0 to 10 with 10 best. Simply inverted view with south at the top. The Red Spot is the dusky oval in the upper left part of the disc. Readers may enjoy comparing this Earth-based view to the maze of fine details on concurrent Voyager 1 photographs.

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A MEETING OF GIANTS: MILAN, 1893*

By: John Lankford, Professor of Social History, University of Missouri, Columbia

In the summer of 1893 Edward Emerson Barnard (1857-1923) took a leave of absence from his post as astronomer at the Lick Observatory and sailed for Europe. By that time he was well known in international astronomical circles for his phenomenal record as a comet finder and, more importantly, as the discoverer of Jupiter V for which the French Academy of Sciences awarded him the Lalande medal. From his earliest days as an amateur in Nashville, Barnard had also been active as a planetary observer. Indeed, although little in the heavens escaped his attention, the bibliography included in the National Academy of Sciences biographical Memoir, published after Barnard's death, lists more publications on the planets than on any other topic.

It is not surprising, therefore, that after visiting his wife's relatives in England and the Royal Astronomical Society at Burlington House, Barnard crossed over to the continent and was soon knocking on the door of the Brera Observatory in Milan. Since 1862 the director of the Brera Observatory had been Giovanni Virginio Schiaparelli (1835-1910), one of the great planetary observers of the nineteenth century.

The meeting between these two giants of observational astronomy did not receive public notice at the time. It came to light only when George Van Biesbroeck (1880-1974), an astronomer at the Yerkes Observatory, published a transciption of the discussion between the two. Miss Rhoda Calvert, Barnard's niece and assistant at Yerkes, found the document in the Observatory files and called it to Dr. Van Biesbroeck's attention. He, in turn, published it in Popular Astronomy.[1]

But how can we account for the curious circumstances which left a detailed historical record of the meeting? Let Van Biesbroeck tell the story: "Neither one [Barnard or Schiaparelli] was conversationally versed in the other's language, but both were determined to discuss matters of common interest and they, therefore, conversed in writing." Members of the Association of Lunar and Planetary Observers might be interested in that historic meeting, especially the portions dealing with planetary observations.

Most readers are acquainted with the life of E. E. Barnard, the Tennessee amateur who rose Horatio Alger-like from a photographer's assistant to become one of the most respected and versatile astronomers of his day. Indeed, the author of the Barnard entry in the Dictionary of Scientific Biography argues that he should be classed with the elder Herschel as a master of observational astronomy. But Schiaparelli's life is less well known. Some biographical details are in order.

Twenty years Barnard's senior, Schiaparelli took a degree in Civil Engineering at the University of Turin (1854) and stayed on to teach. Three years later he was sent by the government to study astronomy at the great observatories of Berlin and Pulkovo. He returned in 1860 and took up a post a Brera. Two years later he succeeded to the directorship. Schiaparelli, like Barnard, was the recipient of many national and international honors, including the unprecedented award of two Lalande prizes from the French Academy.

Schiaparelli's career can conveniently be divided into three parts. During the early years at Brera instrumentation was primitive, and he concentrated on theoretical problems and the computation of orbits. It was during these years that he explored the relationship between meteor showers and comets. In 1877 a Merz refractor (8-inch object glass) was installed, and he turned to planetology. In addition to his well-known mapping of the surface features of Mars, he devoted a great deal of effort to establishing the rotation periods of the inferior planets. The Italian also observed double stars with the 8-inch, and after 1886 with an 18-inch refractor. In the 1890's, his eyesight failing, Schiaparelli turned to the history of astronomy. A thorough command of classical languages allowed him to become a respected authority on astronomy in the ancient world.

It was Schiaparelli who opened the conversation by carefully penning in English: "We can speak by writing." Then the two astronomers exchanged formalities. Barnard brought with him glass copies of his wide-angle Milky Way and comet photographs taken

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*This research was funded by grants from the Research Council of the Graduate School, University of Missouri, Columbia

at Lick. These they inspected together. In turn, Barnard was shown drawings of the planets, and they looked over the Italian master's observing books. Reading the full transcript, one gets the impression that there was considerable movement from room to room examining various materials, looking at telescopes, and the like.

But the shop talk was earnest. "Is the atmosphere steady here in the day time?" Barnard asked. "It is always unsteady in the day at Mt. Hamilton. We cannot, therefore, observe either Venus or Mercury when at any altitude above the horizon." Schiaparelli, who pioneered daylight observations of the inferior planets, answered that "Such observations are possible here in winter, autumn and spring."

For his part, Schiaparelli expressed envy at the high magnification Americans could employ with their large refractors. He said that a power of about 1050 was the maximum he could work with. Barnard quickly responded by stressing how rare it was for either himself or his colleague, S. W. Burnham the double star observer, to use high magnification. Barnard and his friend Burnham preferred "the more moderate powers."

Conditions which promoted good seeing entered the conversation. Both observers agreed that wind was a problem, but Schiaparelli felt that "The best conditions are here with the East wind, with moderate velocity." He sadly remarked that "Our position in the middle of a great town is a great drawback." Barnard wondered if the observatory might move to a better location, but Schiaparelli answered that the time for that "is not near."

Barnard was especially interested in Schiaparelli's observations of Mercury and Venus and his determination of their periods of rotation. He queried the older scientist closely. "You are absolutely certain that Venus and Mercury revolve once on their axes while revolving once around the sun?" Schiaparelli answered, "For Mercury I have not the slightest doubt: for Venus the observations are too scarce and somewhat doubtful: the rotation I regard as probable but not as definitely settled."

Mars, of course, came in for a good deal of attention. Barnard wondered if "the surface of Mars is in a stable condition? Is it not changing very much in the lesser details?" Schiaparelli responded: "The great configurations are stable in outline, but not in colour: there are moreover very considerable changes in the lesser details." They apparently examined the Italian's drawings of Dawes' forked bay and discussed Lacus Solis. Barnard asked "Has the Lacus Solis ever been seen so large as it was at the last opposition? Schiaparelli agreed and recalled that "In 1877 this spot was perfectly round--in other years somewhat elliptical." The Italian planetologist complained that the weather in 1892 did not permit him much chance to work on Mars.

Records of Schiaparelli's observations of Venus were given to Barnard to look over. They discussed the use of dark glass to cut down the glare when observing the inferior planets. Barnard had not found this technique to be very helpful.

Barnard's curiosity then turned the talk toward the color correction of the Brera telescopes. "Do you think the correction of your objective gives you an advantage in observing a red or reddish object? Is it corrected for the red more than other objectives?" Slowly, Schiaparelli wrote out his reply. "Our 8-inch is very favorably corrected for red objects: the 18-inch also, but in a less degree. In both telescopes blue objects are badly seen." On the whole, the Italian observer seemed to prefer the 8-inch. He felt that he was able to use proportionally higher powers on it than on the 18-inch. Again, Barnard spoke of the relatively low powers he used on both the 12-inch and the great 36-inch Clark on Mt. Hamilton.

As shop talk will often do, the course of the discussion changed abruptly. Again the subject was Mars. "In respect to the clouds on Mars; have you often seen evidence of them?" Barnard asked. "Are they dark or white? I saw in August last a white spot 2" diameter which was very distinct a little N. of the equator; the next day it had wholly disappeared." Schiaparelli answered, "Such white spots are not infrequent, but I am not sure they are clouds. They may be transient condensations. However, one of these spots has been visible on three consecutive oppositions; it is not probable that clouds may last so long."

Barnard then asked about the canals. "In your published drawings of Mars the canals are shown very strongly marked. The drawings in your notebook do not show these lines so heavy. Is it an accident of the reproduction that they are so heavy and dark in the engraving?" Schiaparelli agreed. "The canals can have a different aspect in different times. They may disappear wholly, or be nebulous or indistinct, or be so strongly marked as a pen line. The reproductions of my drawings unfortunately can mislead the reader. I cannot find artists who reproduce them well."

Then, with old world politeness and Southern courtesy, the two astronomers took leave of one another. Promises were made to exchange photographic likenesses and pictures of their telescopes. It was agreed that they should also send one another off-prints. Barnard invited the Milan astronomer to visit him on Mt. Hamilton and assured Schiaparelli of the esteem in which American astronomers held the Italian master.

The interview ended on a touching note. It is worth quoting in full:

B. I shall keep these notes to refresh my memory as I shall want to keep a diary of my journey to Europe.

S. It was my desire to keep them, but I will let you have your way. Adieu, and my best thanks for your visit.

So it was that Edward Emerson Barnard packed the record of his discussion with the great Italian astronomer away in his traveling bag and in due time brought it back to America. Today, the original document is to be found among the Barnard papers at Vanderbilt University.

Reference

[1] G. Van Biesbroeck, ed., "E. E. Barnard's Visit to G. Schiaparelli," Popular Astronomy, Vol. 42, No. 10 (December 1934), pp. 553-558. I have not changed the punctuation to conform with modern standards. Nor have I attempted any other editorial emendations. The text is clear, and I did not want to alter the flavor of the encounter.

THE ASSOCIATION OF LUNAR AND PLANETARY OBSERVERS AT "ASTRONOMY WEST 78".

By: John E. Westfall, A.L.P.O. Associate Director

On July 27-30, 1978, Thursday through Sunday, about 250 amateur and professional astronomers came together on the campus of California Polytechnic State University, San Luis Obispo, California, for "Astronomy West 78." This conclave was exceptional because it was sponsored by four groups--the Western Amateur Astronomers, the Astronomical Society of the Pacific, the Astronomical Association of Northern California, and our Association of Lunar and Planetary Observers.

The 3½-day program was a varied one, including about two dozen amateur papers. It was clear (to coin a phrase) that the coming February, 1979, total solar eclipse cast its shadow over this meeting, resulting in presentations dealing with the results from the October, 1977, eclipse cruises as well as with plans for the forthcoming event. Other popular topics were telescope making and astrophotography; but reports of amateur computer applications were also noteworthy, and James McMahon's and Don Kusterer's papers about the recent discovery of a satellite of asteroid 532 Herculina stirred a great deal of interest. Besides Ashley McDermott's luncheon talk on scientific skepticism, a contributed paper by Thomas Cragg proposed a supernova search program for amateur astrophotographers; and Andrew Fraknoi and Dr. Bart Bok gave evening talks on pseudoscience and the southern skies, respectively.

Naturally, events were not confined to papers. A slide show and several excellent films were shown, most of the group took a half-day tour of nearby Vandenburg Air Force Base (the site of the LANDSAT satellite launchings, and of the future polar orbit Space Shuttle launches), and an exhibit consisting largely of amateur astrophotographs was very popular. The traditional star party was held on Friday evening at the campus airfield; and given the proximity of the city of San Luis Obispo, a surprising number of Messier objects were viewed until fog closed in.

Thursday afternoon, seven A.L.P.O. papers were delivered to a sizeable audience (five of these papers are available in the convention Proceedings). A.L.P.O. Director Walter Haas spoke on "A Computer Program to Calculate Meteor Radiants and Orbital

"The Association of Lunar and Planetary Observers at 'Astronomy West 78'."

Figure 1. The meeting place of "Astronomy West 78," the campus theater of California Polytechnic State University, San Luis Obispo, in south central California. Note amateur telescopes on display near entrance. Figures 1-3 are photographs taken and contributed by John E. Westfall.

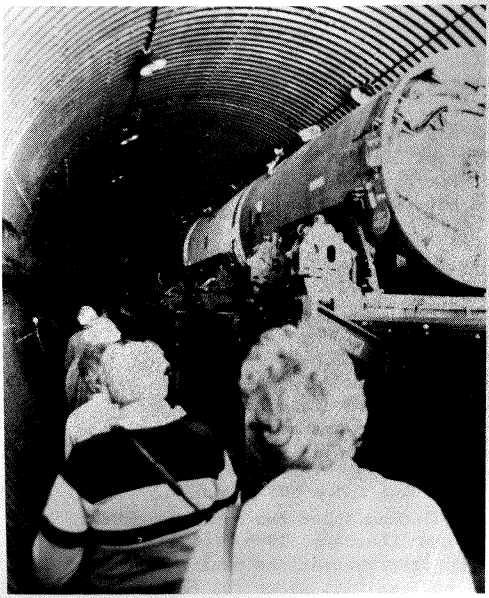

Figure 2. A high point of Astronomy West 78's Vandenburg Air Force Base field trip was the opportunity to inspect a Minuteman missile.

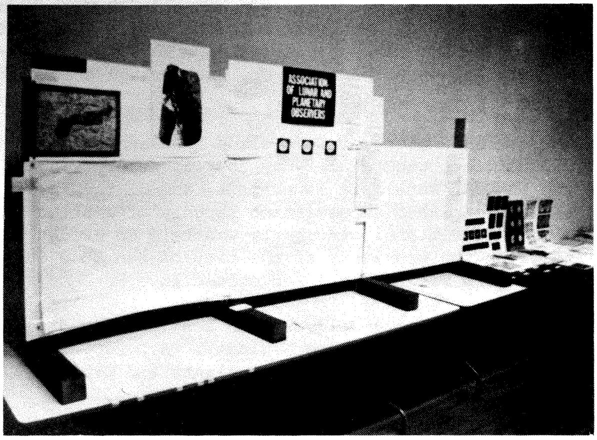

Figure 3. The A.L.P.O. Exhibit at the San Luis Obispo meeting. From left to right, the display shows work from the Lunar Section's "Luna Incognita" project, the Jupiter Section, and the Mars Section.

Elements"; and Harold Provenmire discussed "The Upsilon Pegasid Meteor Shower Pre-History," including useful tips on meteor photography. The two Jupiter papers were Ron Doel's "Color Investigations in Jupiter's Atmosphere: A Justification for Continued Amateur Observation" and John H. Rogers' "Patterns of Activity in Jupiter's North Equatorial Belt," which utilized historical B.A.A. observations. Mars Recorder Charles Capen spoke on Mars and on the "Colorimetry of Bright Comets," while Lunar Recorder John Westfall gave a "Luna Incognita Progress Report."

The Association of Lunar and Planetary Observers was also represented by an exhibit, which included extensive materials from the Jupiter and Mars Sections and from the Lunar Section's "Luna Incognita" project.

An A.L.P.O. business meeting was held Friday afternoon and is outlined in the next article by A.L.P.O. Secretary J. Russell Smith.

In summary, those A.L.P.O. members attending at San Luis Obispo enjoyed, and contributed to, the experience; and we hope that Portland this year will prove at least as, if not even more, popular.

MINUTES OF THE A.L.P.O. BUSINESS MEETING AT SAN LUIS OBISPO, JULY 28, 1978

By: J. Russell Smith, A.L.P.O. Secretary

The A.L.P.O. met in a business session on July 28, 1978, at San Luis Obispo, California. Those present were as follows: Director Walter H. Haas, Associate Director John E. Westfall, Secretary J. Russell Smith, Tim Robertson, John Rogers, Mark F. Mahon, Charles Anderson, Jackson Carle, Darryl J. Davis, and Charles F. Capen.

Director Haas reported that the membership in the A.L.P.O. had dropped in the last year from 810 to 750. [In March, 1979, membership stood at 740.] He explained the probable causes as follows: Young people have other interests and subscription prices are higher.

The Journal now costs about $1030 per issue--envelopes $30.00, postage $300.00, publisher $550.00, and wages (typist) $150.00. This is $6,180.00 per volume of 6 issues. There was some discussion about mailing on a non-profit basis or getting a permit for controlled circulation, sorted mail--labels sorted by zip code, possible book rate, and possible magazine rate.

An advertisement in Sky and Telescope was suggested as a possible way of increasing membership, and the Astronomical League Chairman might be asked to help advertise the Journal.

Guidelines for papers, such as clean typed manuscripts and camera-ready illustrations, were suggested by Dr. John Westfall.

A circular letter to the astronomical societies of the U.S. was also suggested. The letter would invite members interested in the A.L.P.O. to share in lunar and planetary work. Jackson Carle will prepare an outline for Director Haas to use in a campaign for this purpose.

Chas. F. Capen mentioned that the professional planetary patrol programs are at an end. This leaves systematic work on Mars and Jupiter more up to the amateur. It was suggested that a letter requesting observations of the planets, such as Mars and Jupiter, might be sent to the numerous astronomical societies.

Dr. John Westfall proposed an attractive brochure on the A.L.P.O. It could be mailed to various individuals and societies. Jackson Carle moved that Dr. Westfall prepare the brochure. The motion received a second by Charles F. Capen. Motion carried.

The question as to what is going to happen to our telescopes after our deaths arose, and Director Haas stated that he might be able to undertake a lending library of optics and telescopes similar to one maintained by the B.A.A.

The A.L.P.O. received an invitation to meet with the Astronomical League National Convention in Portland, Oregon, on August 15-19, 1979. There was a motion by J. Russell Smith that the A.L.P.O. accept the invitation. There was a second by Dr.

John Westfall. The motion carried.

There was no other business. Director Haas thanked Cal Poly for an excellent convention, and there was a motion by J. Russell Smith that the meeting adjourn. There was a second by Charles Capen. Motion carried. Meeting adjourned.

ITALIAN OBSERVATIONS OF SATURN DURING 1975/78

By: Emilio and Paolo Sassone-Corsi, Saturn Section of Unione Astrofili Italiani

The Saturn Section of the U.A.I. (Italian Astro-amateurs Union) has gathered for the 1975-76, 1976-77, and 1977-78 apparitions of Saturn 291 visual observations from approximately 40 Italian observers. Also, we have received observations from French, Swiss, Spanish, and English amateurs. We have gathered together 3506 intensity estimates, 1897 color estimates, and 945 latitude measures.

During the three apparitions taken into consideration, the Saturnicentric tilt value (B = -22° to -12°) has allowed the observation of some part of the northern hemisphere. The observed area was the North Polar Region (NPR) and the North Temperate Zone (NTZ), which did not show any important detail.

1. Rings and globe aspects

SPR (South Polar Region)--larger than previous years, with brown greenish reflections; the adjacent South Polar Band was often seen.

SSTB (South South Temperate Belt)--light in intensity, with smaller average latitude than in previous years.

STZ (South Temperate Zone)--color white ivory with pink reflections, the northern edge with the SEB_s not being well marked.

STB (South Temperate Belt)--narrow, noted closer to SEB_s with smaller average latitude compared to previous years.

SEB (South Equatorial Belt)--seen divided into SEB_s and SEB_n; the northern edge of the SEB_n often showed indentations and plumes; sometimes it was reddish in color.

EZ (Equatorial Zone)--sometimes pink in color, noted sometimes temporary bright hollows (see Figure 4 and J.A.L.P.O., Vol. 27, Nos. 5-6, pp. 124-126).

EB (Equatorial Band)--narrow and not well marked.

Ring A--greenish, often divided into outer and inner parts. Encke's line has been seen at the 3.0 ± 0.4 position (10 observations), assuming as 0 (zero) the external edge of Cassini's Division and as 10 the Ring A external border.

Cassini's Division--seen less well as the rings slowly close. The B value has probably caused a lowering in intensity valuations (diffusion phenomena from nearby rings, Table 1).

Ring B--clearly divided into inner and outer parts; we have not noted divisions within the ring, or between Ring B and Ring C (Lyot Division, B0).

Ring C--visible and violet in color.

The axial tilt B has been such that it has been difficult to observe the shadow of the rings on the globe during the three apparitions considered.

Table 1 shows the estimated numerical intensities of features on the globe of Saturn or in its rings as determined by Unione Astrofili Italiani observers. The values in parentheses are the number of observed intensities available to determine that tabulated value.

Table 2 gives observed Saturnicentric latitudes, where the numbers in parentheses are again the number of observations made. The latitudes were computed according to the Crommelin formulae with these values of the tilt: $B = -21^\circ.3$ for the 1975-76 apparition, $B = -16^\circ.7$ for the 1976-77 apparition, and $B = -12^\circ.0$ for the 1977-78

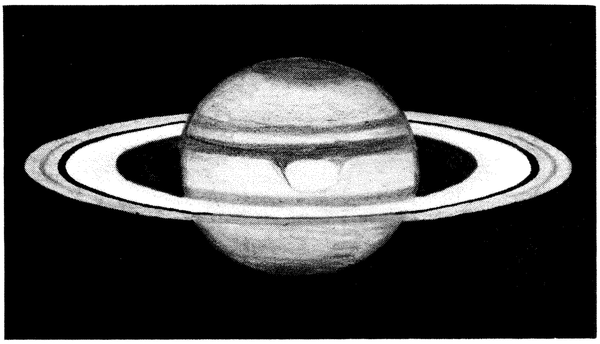

Figure 4. Drawing of Saturn by Emilio and Paolo Sassone-Corsi at Naples on March 5, 1978 with a Celestron 8-inch reflector at 220X and excellent seeing. Simply inverted image with south at the top. Note the large white oval in the south part of the Equatorial Zone (see also Journal A.L.P.O., Vol. 27, Nos. 5-6, pp. 124-126, July, 1978).

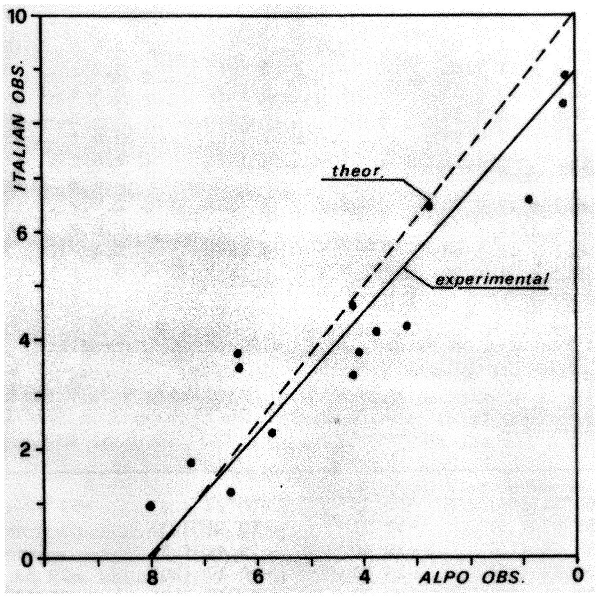

Figure 5. Diagram to show theoretical and empirical straight lines for the relation between intensity scales used on Saturnian features by European and American observers. Each point is a planetary feature observed by both A.L.P.O. observers and Italian observers and is the average of intensity estimates in 1972-76. See also text.

apparition. [Note by Editor: It would appear to be preferable to reduce each set of observed latitudes with the value of B at that time; but this refinement may not have much effect on the final results, especially if most of the observations are made close to opposition.]

The photographs on hand cover the 1975-76 apparition and come from the Pic-du-Midi Observatory (107-cm. telescope, France), where Prof. J. Dragesco took pictures from 22nd to 24th December, 1975 on Pan F Ilford at an equivalent f.l. of about 90 meters. We further received some interesting material from Mr. Viscardy from St.-Martin-de-Peille Observatory (52-cm. telescope, France), he used Tri-X-Pan Kodak Film at an equivalent focal length of 70 meters.

On the best 30 frames we carried out photodensitometric analysis using a Joyce-Loebl Microdensitometer; the rectangular slit employed for scanning along the major and minor axes was 31 x 70 microns. Photometric traces along the minor axis permit determining the latitude of globe features, and those along the major axis allow calculation of the ring width.

2. Conversion Between American and European Standards for Intensity Values

For estimating the intensity of planetary features various methods and scales are used. The two chief scales are as follows:

Table 1. Observed Intensities of Features on Saturn, 1975-1978, Unione Astrofili Italiani

Feature	75/76	76/77	77/78
Ring A outer	4.1 ± .1 (116)	3.2 ± .3 (59)	2.8 ± .1 (93)
Encke's Division	6.2 ± .3 (9)	5.0 ±1.0 (3)	5.8 ± .4 (6)
Ring A inner	3.9 ± .1 (112)	2.9 ± .2 (59)	2.7 ± .1 (93)
Cassini's Division	8.6 ± .1 (112)	8.1 ± .2 (59)	7.8 ± .2 (83)
Ring B outer	0.8 ± .1 (113)	0.9 ± .1 (59)	1.1 ± .1 (95)
Ring B inner	1.2 ± .1 (103)	1.2 ± .1 (59)	2.1 ± .1 (93)
Ring C	6.7 ± .2 (72)	6.2 ± .3 (32)	7.0 ± .1 (78)
SPR	4.2 ± .1 (116)	4.2 ± .2 (57)	4.2 ± .1 (95)
SSTB	4.2 ± .2 (15)	3.0 (1)	----
STZ	----	3.3 ± .3 (3)	2.0 ± .1 (9)
STB	3.1 ± .1 (12)	4.8 ± .1 (3)	----
STrZ (S. Trop. Zone)	2.9 ± .1 (97)	2.6 ± .1 (54)	2.6 ± .1 (86)
SEB$_s$	4.4 ± .1 (102)	4.7 ± .2 (56)	3.7 ± .1 (92)
IZ (or SEB$_Z$)	2.0 ± .2 (15)	4.0 ±1.0 (2)	2.4 ± .2 (10)
SEB$_n$	4.6 ± .1 (98)	5.0 ± .2 (57)	4.2 ± .1 (94)
EZ	1.3 ± .1 (99)	0.7 ± .1 (58)	0.6 ± .1 (94)
EB	----	3.0 (1)	2.6 ± .1 (17)
NTZ	----	----	2.5 ± .1 (78)
NPR	4.7 ± .3 (28)	2.8 ± .2 (50)	2.7 ± .2 (37)
Ring C across globe	5.9 ± .2 (60)	6.1 ± .3 (35)	6.0 ± .2 (64)
Shadow rings on globe	8.2 ± .2 (44)	7.9 ± .3 (34)	8.4 ± .1 (77)
Shadow globe on rings	9.3 ± .1 (88)	9.3 ± .1 (43)	9.8 ± .1 (91)

Table 2. Observed Latitudes*of Features on Saturn, 1975-1978, Unione Astrofili Italiani

Feature	75/76	75/76 photographs	76/77	77/78
SPR, north edge	-60°54'(66)	-58°55'	-50°24'(26)	-59°52'(67)
SSTB	-55 57 (9)	-52 31	-50 25 (01)	----
STB	-39 48 (10)	-39 40	-29 41 (3)	----
SEB$_s$, south edge	-26 27 (59)	-25 33	-26 17 (28)	-29 53 (80)
SEB$_s$, north edge	-23 41 (36)	-20 37	-23 46 (17)	-22 33 (49)
SEB$_n$, south edge	-18 18 (45)	-17 26	-17 36 (28)	-18 41 (55)
SEB$_n$, north edge	- 8 20 (54)	-12 34	-13 11 (39)	-13 47 (84)
Ring C across globe	+10 30 (42)	+ 4 33	+ 9 59 (22)	+ 3 48 (74)

*The latitudes in Table 2 are Saturnicentric.

(a) 0 = brightest area of planet;
10 = dark sky near planet.
This scale is very popular in Europe and has been adopted by astronomical associations in France, U.K., Switzerland, Spain, and Italy.

(b) 8 = outer edge Ring B;
0 = dark sky near planet.
Adopted by A.L.P.O.

To allow comparing estimated intensities of Saturnian features in the two ways, we used an empirical conversion relation utilizing 1972/76 observations made by A.L.P.O. and U.A.I. Saturn Section observers. We computed the average value for every Saturnian feature observed according to both systems (a) and (b). We thus obtained 15 intensity couples, which have been diagrammed (Figure 5); and we then computed a Least Squares Line, which better interpolates values. This line has the following equation:

$$x = 8.05 - 0.901\ y,$$

where 'y' is the intensity value referred to the European System and 'x' is in the

American System. For example, an STZ valuation = 2.5 made by method (a) has as its equivalent in the (b) system: $y = (-2.5 + 8.05)/0.901 = 6.2$.

This conversion can also be made graphically by using Figure 5. The graph also shows the theoretical straight line which links the extreme values, ($x = 0$, $y = 10$) and ($x = 8$, $y = 0$). It is comforting to note that the theoretical and empirical straight lines are only slightly different, and it is also good that the dispersion of the points for the Least Squares Line is readily acceptable.

We propose to use this empirical ratio in future work for comparing visual observations of planetary intensities.

We wish to thank Doctor L. Luzzatto, IIGB Director, for allowing the use of the Joyce-Loebl Microdensitometer.

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THE TOTAL LUNAR ECLIPSE OF SEPTEMBER 6, 1979

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

On September 6, 1979, the Moon will undergo the first total eclipse visible from the United States since 1975, with eclipse magnitude 1.099 (magnitudes of 1.0 or greater indicate total). The Universal and Local Daylight Savings Times of the eclipse events are given below; the Local Times are all A.M.

	Time (September 6, 1979)				
	U.T.	E.D.T.	C.D.T.	M.D.T	P.D.T.
Moon enters penumbra	(08:20.2)	04:20.2	03:20.2	02:20.2	01:20.2
Moon enters umbra	(09:17.9)	05:17.9*	04:17.9	03:17.9	02:17.9
Total eclipse begins	(10:31.3)	(06:31.3)	05:31.3*	04:31.3	03:31.3
Middle of eclipse	(10:54.2)	(06:54.2)	05:54.2*	04:54.2	03:54.2
Total eclipse ends	(11:17.1)	(07:17.1)	06:17.1*	05:17.1*	04:17.1
Moon leaves umbra	(12:30.5)	(08:30.5)	(07:30.5)	(06:30.5)	05:30.5*
Moon leaves penumbra	(13:28.3)	(09:28.3)	(08:28.3)	(07:28.3)	(06:28.3)

In the above table, asterisked times indicate that astronomical twilight will have begun, and times in parentheses mean that the Moon will have set, within that time zone. For the entire United States, the eclipse will occur on the morning of September 6th; and observers in the mountain and western States will have the best view.

Figure 6 shows the Moon's movement during the eclipse, in relation to the Earth's umbral and penumbral shadows. The first umbral contact (at about 09:18 U.T.) will be 48° east of celestial north on the Moon's limb, while the last umbral contact (about 12:30 U.T.) will be 82° west of north.

Because this eclipse is total, observers fortunately located will have the opportunity to make a number of possible types of observations. Observers unfamiliar with lunar eclipse observing techniques may wish to obtain the A.L.P.O. Lunar Eclipse Handbook, which is available from this writer (address on inside back cover) for one dollar, and will also receive an "A.L.P.O. Lunar Eclipse Observation Form." The form may also be obtained separately by sending a stamped, self-addressed envelope.

In summary, observers with equipment ranging from the simple to the complex can make the following types of studies:

General Observations of the appearance of the penumbra and the umbra, and of the luminosity of the Moon during totality.

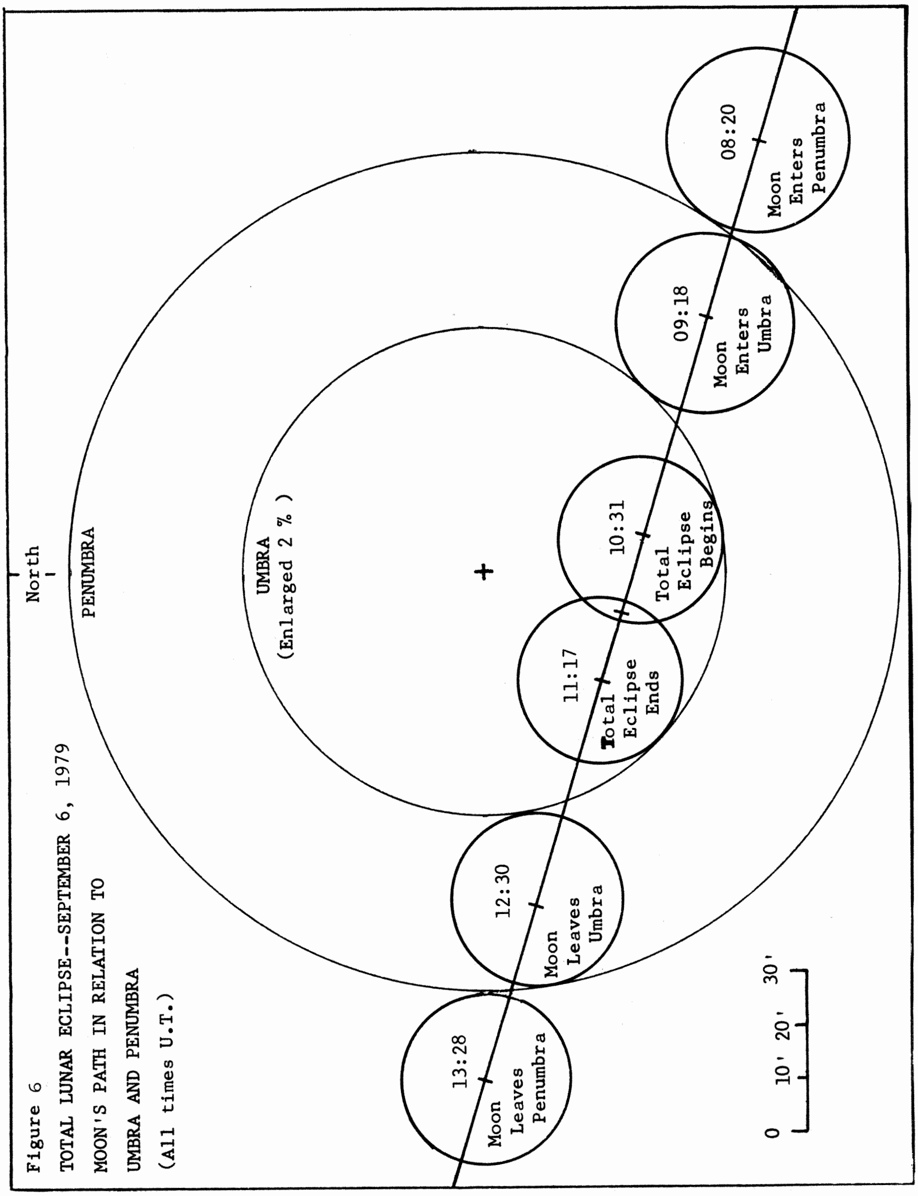

Figure 6

TOTAL LUNAR ECLIPSE--SEPTEMBER 6, 1979

MOON'S PATH IN RELATION TO

UMBRA AND PENUMBRA

(All times U.T.)

Photometry of the apparent visual magnitude of the Moon throughout the eclipse, but particularly during totality. Such estimates are most often made by comparing the Moon with stars or planets. Figure 7 shows the stars in the vicinity of the eclipsed Moon, with their apparent visual magnitudes (expressed to 0.01 magnitude with decimal point omitted). Class M stars, roughly comparable in color to the totally-eclipsed Moon, are shown with their magnitudes underlined. Magnitudes marked "v" represent variable stars, which should not be used. Outside the chart boundaries are other possible comparison objects, such as Vega (Mag. +0.04), Capella (+0.05), Procyon (+0.37), Sirius (-1.47), and Jupiter (-1.5).

Limb and Crater Umbral Contact Timings are always welcome, as they permit us to calculate the size and ellipticity of the umbra. The 15 "standard" craters and their approximate (± 5 min.) Universal Times of umbral immersion and emersion given in parentheses are:

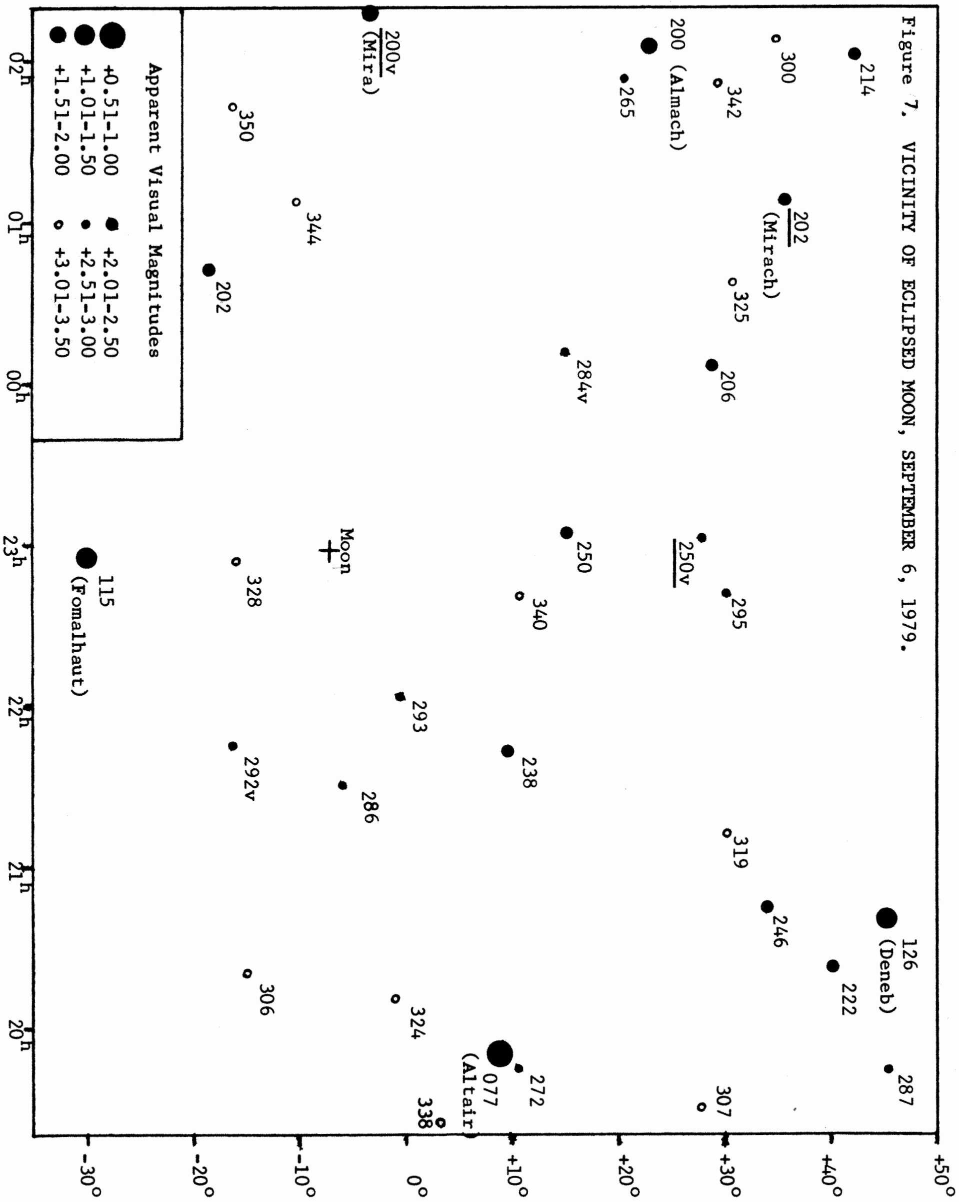

Figure 7. VICINITY OF ECLIPSED MOON, SEPTEMBER 6, 1979.

Grimaldi (09:20, 11:35)
Aristarchus (09:25, 11:45)
Kepler (09:30, 11:40)
Copernicus (09:35, 11:50)
Pytheas (09:35, 11:55)
Timocharis (09:40, 12:00)
Tycho (10:00, 11:30)
Plato (09:40, 12:10)
Aristoteles (09:45, 12:10)
Eudoxus (09:50, 12:10)
Manilius (09:50, 12:05)
Menelaus (09:55, 12:05)
Plinius (10:00, 12:10)
Taruntius (10:05, 12:20)
Proclus (10:10, 12:20)

Lunar Changes of a temporary nature (such as "Lunar Transient Phenomena") may be looked for with medium-sized or large instruments. In this context, it may be significant that mid-eclipse occurs only six hours after lunar perigee.

Finally, Photography may be done with a wide variety of films and equipment.

As a final note of encouragement, there will not be another total lunar eclipse visible from the United States until July 6, 1982! We hope that A.L.P.O. observers will take advantage of this currently-rare opportunity.

RESULTS FROM THE LTP OBSERVING PROGRAM FOR THE ASSOCIATION OF LUNAR AND PLANETARY OBSERVERS (A.L.P.O.)

(concluded from preceding issue)

By: Winifred Sawtell Cameron, A.L.P.O. Lunar Recorder, National Space Science Data Center, Goddard Space Flight Center, Greenbelt, Maryland

[Foreword by Editor. The present installment is a continuation of Mrs. Cameron's paper from Journal A.L.P.O., Vol. 27, Nos. 9-10, pp. 195-207. We regret the need to publish her paper in two parts but felt obliged to do so because of its length. Readers may find it helpful to refer back to the first part of the paper in studying the discussion in this second part. There are, unfortunately, some references in the second part of the paper to figures and tables in the first part. When these occur, they are followed by the letter P (e.g., Figure 14P or Table IIIP).

All photographs in this paper have been kindly provided by the National Space Science Data Center (NSSDC).]

East Mare Crisium (67°E, 15°N) - Bruce Frank, Fairport, N.Y. 6-in. reflector.

Figure 8 shows the last feature to be discussed--Mare Crisium. The area monitored is at the left edge of the photo. This area was originally assigned as a seismic zone. Since that time, the seismic zone epicenter has been shifted so that now this area is considered as a comparison area, although it may be in the region of LTP recorded in Mare Crisium. The latter have been reported from many areas in it, some of which were in the eastern sector of the mare (see Fig. 8). That it is not a variable region is indicated by the albedo chart (Table V). There were 26 nights with 152 separate measurements. No LTP were reported; and only two possible, unreported anomalies appear. Percentages on frequencies of such anomalies for this region are 2/26 = 8% of nights and 2/152 = 1% of individual measures. Behavior of individual points (see Tables V and VII and Fig. 14P) are: A is steady; B is steady, perhaps dropping slightly at local noon but not at Full Moon; C also is steady. This region has little variability. In general the southern area behaves oppositely to the floor area in the first half of the lunation, then behaves similarly in the last half (see Fig. 14P). Table VI shows comparable data for Dawes, which will not be discussed again. See Cameron, 1974. Table VII summarizes the albedo average behavior for each feature and its points, from which Fig. 14P was derived.

Table VIII summarizes the data on the objects discussed above. The columns for Table VIII are respectively: (1) Feature, (2) Selenographic Coördinates, (3) Observer, (4) Location of observer and size (in inches) and kind (R = refractor, L = reflector) of telescope, (5) Total number of nights of observation, (6) Number of individual measures, (7) For LTP the upper row gives the number of observations (N) and frequency for nights in parentheses, and the lower figures are the same for individual measures, (8) Same categories as in column 7 but for suspected anomalies, (9) Combined LTP and anomalies frequency of occurrence with respect to nights (N) and individual measures (M), and (10-16) Albedo and summary of behavior of the wall, floor, central peak, and nearby plain points, where SS = sunset.

Tidal Effects

Various tides affect the Moon (Burley and Middlehurst 1966, Chapman 1967). These result primarily from the influence of the Earth and the Sun. The tidal effects from the Earth are the strongest and vary in a period called the anomalistic period, measured from perigee to perigee. The Sun's tide is superimposed on this effect and has a 14-month period which affects the amplitudes (therefore the eccentricity of the orbit) of the anomalistic period curve. It is reflected in local tides which are based on librations. The Sun's tidal effects will be ignored in this discussion. For the first time we can now consider the data according to frequency of occurrence, i.e., normalize the data, since all observations have been reported. In Figure 9 the data are plotted for the phase of the anomalistic period (ϕ) in intervals of 1/10 of a period for the five features for nights of observation under discussion (B) and for age of the Moon in days (A). Figure 9 includes anomalies (reported ones and unreported possible ones), normal (negative) aspects, and those two combined, designated All. The numbers in parentheses are the total number of observations (right side is for anomalistic phase, and those on the left side are for age of the Moon). The solid curve is all observations, the dashed curve is the anomalies, and the dotted curve is

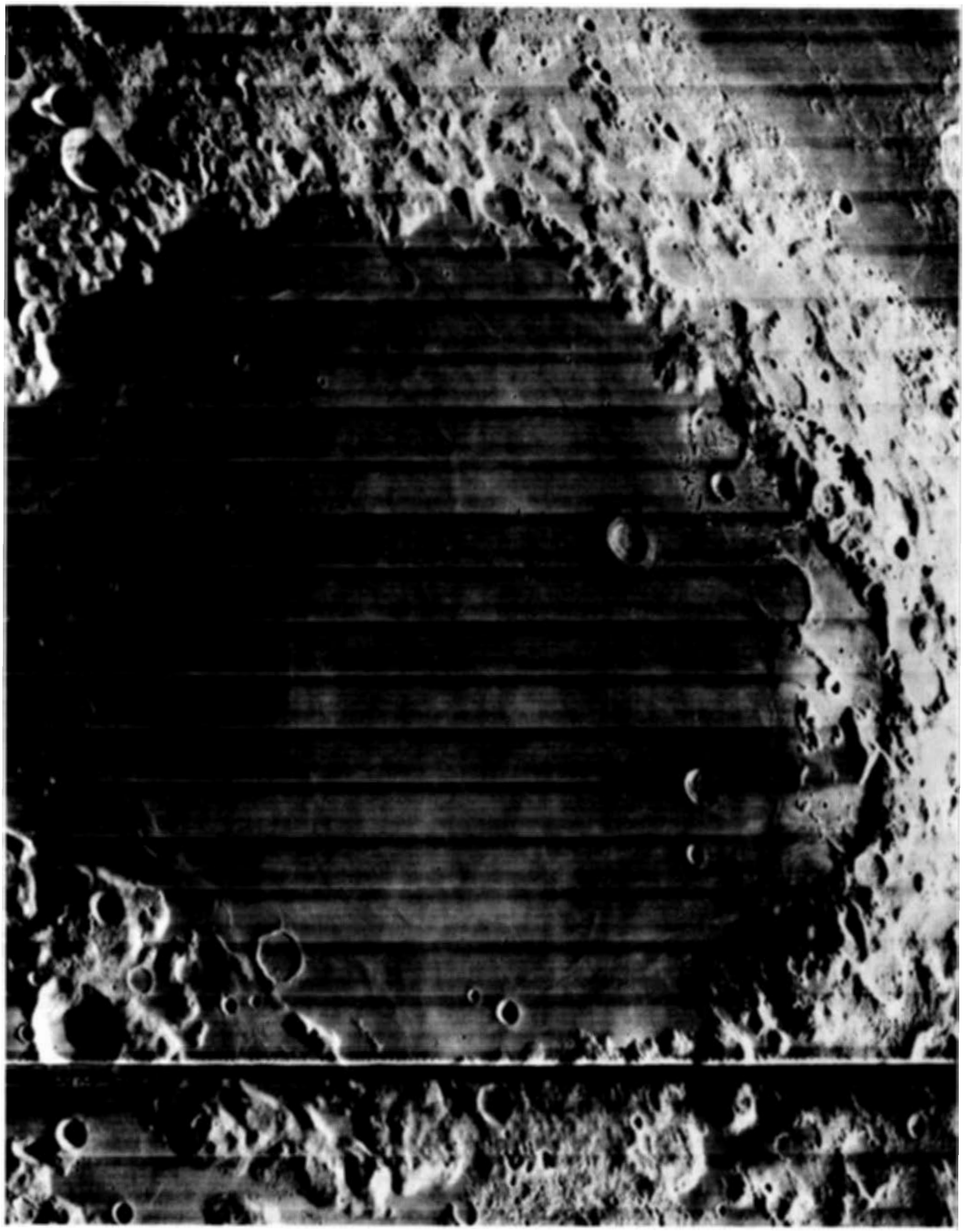

Figure 8. Lunar Orbiter IV frame $192H_3$, photograph of Mare Crisium. The area of observations is at the extreme left edge (East) at the middle of the picture. The two prominent craters on the western part of the mare are Picard (upper) and Peirce, with Peirce A just below it. Lunar south at top, lunar west (hemisphere of Oceanus Procellarum) at right.

the normal. If tides were the only cause of LTP, we would expect (for anomalies) strong peaks at perigee and apogee, ϕ = 0.0 and 0.5 respectively (emphasized by vertical lines) and minima at 0.25 and 0.75; and further, the anomalies and normal aspects would exhibit mirror (opposite) behavior.

B. Frank
Fairport, NY
6L

Index of Points
A S ↑
Ⓓ × C
B

SEISMIC ZONE, E. MARE CRISIUM (67°E, 15°N)

ALBEDO CHART

Sunrise Colongitude = 293° = 3^d age
Sunset Colongitude = 113° = 18^d age
Local Noon Colongitude = 23° = 9^d age

AGE	Point A (S. [illegible])	Av.	Point B (N. Wall)	Av.	Point C (Nearby Plain)	Av.	Point D (Floor)	Av.
$0^d.0$–$0^d.9$ . . 2.0–2.9			DARKSIDE SUNRISE					
3.0–3.9	3.5, 4; 3.5, 4; 4.5, 4.5;	3.8	(3.5, 4); 5.5, 6; 6.5, 7;	5.4	4.5, 4.5; 5, 5; 5.5, 5.5;	5.0	- -; - -; 4.5, 4.5;	4.5
4.0–4.9	3.5, 3.5; 4, 4;	3.8	5, 5; 7, 7.5;	6.1	5, 5; 6.5, 6;	5.6		
5.0–5.9								
6.0–6.9	4.5, 4.5; 4.5, 4.5; 4.5; 4, 3.5; 4, 4.5;	4.3	6, 6; 5.5, 6.5; 7; 7.5, 7.5; 7, 6.5;	6.6	5.5, 6; 5, 5.5; 6.5; 6, 6; 6.5, 6.5;	5.9		
7.0–7.9	3.5, 4;	3.8	6, 6;	6.0	5.5, 5.5;	5.5	3.5, 4;	3.8
8.0–8.9	3.5, 3.5; 4.5, 4.5;	4.0	6.5, 6.5; 6.5, 6;	6.4	6, 6; 5.5, 5;	5.6	- -; 4, 4;	4.0
9.0–9.9	3.5, 3.5;	3.5	7, 7;	7.0	6, 6;	6.0		
10.0–10.9	3.5; 5, 5;	4.5	5.5; 5.5, 6;	5.7	6; 5.5, 5.5;	5.7	-; 5, 5;	5.0
11.0–11.9	4, 3.5;	3.8	5, 5.5;	5.2	5.5, 5.5;	5.5		
12.0–12.9								
13.0–13.9	4, 4; 3.5, 3; 4.5;	3.8	5.5, 5.5; 6.5, 6.5; 6;	6.0	4, 4; (6.5, 6.5); 6;	5.4		
14.0–14.9								
15.0–15.9	3.5, 4;	3.8	6.5, 7;	6.8	5.5, 5.5;	5.5		
16.0–16.9	5, 5; 4, 4;	4.5	6, 6.5; 6, 6.5;	6.2	5.5, 5.5; 6, 6;	5.8		
17.0–17.9	4, 4; 3, 3;	3.5	5.5, 5.5; 7, 7;	6.2	5.5, 5.5; 6, 6;	5.8		
18.0–18.9 . . 29.0–29.5	0;		0;	SUNSET DARKSIDE	0;			
Lunation Average		3.9		6.1		5.6		4.4

( ) = Unreported, Possible Anomalies

Whole Crater Albedo Average = 4.7
Nearby Plain Albedo Average = 5.6

26 Nights of Observation
152 Individual Measures
2 Unreported Possible Anomalies

Table V. Summary of observations of east part of Mare Crisium. See also text on page 228.

Examining the histograms for these relationships we find:

Aristarchus (lowest graph in Figure 9B). Anomalies include the recent albedo reports and the probable events found in Cameron's 1972 results (Cameron 1972). One, strong peak occurs at 0.75 for anomalies and 0.7 for normal. This does not correlate with the hypotheses of tidal effects on LTP. For anomalies there are three peaks descending in importance at $\phi = 0.75$, 1.0, and 0.4 respectively. For normal there are two peaks, the major one at $\phi = 0.65$ and the minor one at 1.0. Thus phenomena and normal behave similarly instead of oppositely as would be expected if only tides caused LTP. Note that Aristarchus and Proclus, which are hemispherically opposite in location,

Table VI Chart of Albedo vs. Moon's Age
A. Porter
Narragansett, R. I. 6L, 100X, 193X

DAWES(26°E, 17°N)

Sunrise colongitude 334° ≅ 5^d age
Sunset colongitude 154° ≅ 20^d age

Index of points

Age	Point A(S. wall)	Av.	Point B(W. wall)	Av.	Point C(N. wall)	Av.	Point D(E. wall)	Av.	Point E(nearby plain)	Av.
0.0-4.9					DARKSIDE Sunrise					
5.0-5.9	5,4.5;5.5,5.5(2,2,2;5;6,6,6;	4.5	6.5,6;5,5;6.5,6.5,6.5;6.5; 7,7,7;	6.3	3.4,4;7,7(2.5,2.5,2.5)5.5; 6.5,6.5,6.5;	4.9	4.5,4.5;5.5,5.5;5.5,5.5,5.5; 5;6,6,6;	5.5	2.5,2.5;3.5,3.5;2.5,2.5,2.5; 3;2.5,3,3;	2.8
6.0-6.9	2.5,2;5,4,4;35,3,3;4,4;3,3,3	3.4	4.5,5;5.5,6,5.5;6,6,6;6,6; 6.5,6.5,6.5;	5.8	5,4.5;6,5,5;4,3,3.5;4,4;3,3,3;	[illegible]	2.5,3;4.5,4.5,4;5,4,4;4.5,4.5; 3.5,3.5,3.5;	3.9	2.5,2.5;3,3.5,3.5;3,2.5,2.5; 4.5,4.5;2.5,2.5,2.5;	3.0
7.0-7.9	4,3,3.5;4,5;4.5,4;4,4,4;5,5; 5,5,5.5;6,6,6;4.5,4.5;	4.6	6,5.5,5.5;6,6.5;5.5,6.5;6,6,5; 6,6;5.5,5.5,6;6.5,6.5,6.5;5,5;	5.9	6,5,6;5,5.5;4,4;5,5,5;5,5; 5,5,5.5;6,6,6;4.5,4.5;	5.2	3.5,3,3.5;4.5,4;4.5,4;4.5,4.5; 4.5;5.5,5.5;5,5,5;5,5,5,5;4,4;	4.5	2,2.5,2.5;3.5,3.5;3,3.5;3,3, 3;4,4;4,4,3;4,3.5,3.5;3,3;	3.3
8.0-8.9	4,4,4;4.5,4.5,4.5;5,5;	4.4	5.5,6,6;6.5,6.5,6.5;5.5,5.5;	6.0	4,4,4;4.5,4.5,4.5;5,5;	4.4	3.5,3.5,3.5;5,5,5;5,5;	4.4	3,3,3;2.5,2.5,2.5;4,4;	3.1
9.0-9.9	4,6,6,6,5.5;*6,6;5,5;5.5,5.5 5.5;4.5,4.5;5,5,5;5,5;5.5,5.5;	5.3	6.5,6.5,6.5,6.5,6.5;*6.5,6.5; 6,6;6,6,6;5.5,5.5;5.5,5.5,5.5; 6,6;6,6;	6.0	4,6.5,6.5,5,6;*6,6;5,5;5.5, 5.5,5.5;4.5,4.5;5,5,5;5,5;6,;	5.4	4,6,5.5,6,6;*4.5,4.5;5,5;5, 5,5;5,5;4,4,4;5,5;5.5,5.5;	5.0	3,3.5,3.5,3,3;*3,3;4,4;2,2, 2;4,4;2.5,2.5,2.5;4,4;4,4;	3.2
10.0-10.9	6,6;5,5,5;5.5,5.5,5.5;6,6; 6,6,6;6,6;	5.7	6.5,6.5;6.5,6.5,6.5;6,6,6; 6,6;6,6,6;6.5,6.5;	6.2	6,6;6,6,6;5.5,5.5,5.5;6,6; 6,6,6;6,6;	5.9	5.5,5.5;4,4,4;6,6,6;6,6; 5.5,5.5,5.5;6,6;	5.4	3.5,3.5;3,3,3;2,2,2;2,2; 4,4,4;3,3;	2.9
11.0-11.9	5.5,6.5;7.5,7.5;6,6;6,6.5, 6.5;6,6;6,6;6.5,6.5,6.5;5,5;	6.2	5,5.5(8,8)6.5,6.5;6,6.5,6.5; 6,6;6,6;6,6,6;5.5,5.5;	6.2	5.5,6;7.5,7.5;6,6;6,6.5,6.5; 6,6;6,6;6,6,6;5,5;	6.1	(4.5),5.5(8,8)6,6;6.5,7,7;6,6; 6,6;6.5,6.5,6.5(3,3;)	6.0	2,2;2.5,2.5;2.5,2.5;3,3,3; 3.5,3.5;3,3.5;2.5,2.5,2.5;	2.8
12.0-12.9	5.5,5;6.5,6.5;7,7;6.5;6.5,6.5; 6.5,6.5,6.5;5.5,5.5,5.5;	6.2	5,5.5;6,6;7,7,7;6,6;6,6,6; 5.5,5.5,5.5;	6.0	6,6;6.5,6.5;7,7,7;6,6;6.5, 6.5,6.5;5.5,5.5,5.5;	6.3	6,6;6.5,6.5;7,7,7;6,6;7,7,7; 6,6,6;	6.5	3,3;3,3;3,3,3;3.5,3.5;2.5, 2.5,2.5;2.5,2.5,2.5;	2.9
13.0-13.9	5.5,5.5;6,6;6.5,6.5;6,6;6,6; 6,6,6,6;	6.0	6,6;6,6;6,6;6,6;6,6;6.5,6.5, 6.5,6.5;	6.1	6,6;6,6;6.5,6.5;6,6;6,6; 6.5,6.5,6.5,6.5;	6.2	7,7;6.5,6.5;7,7;6.5,6.5;7,7; 6.5,6.5,6.5,6.5;	6.7	2.5,2.5;3,3;2.5,2.5;2.5,2.5 3,3;3,3,3,3;	2.8
14.0-14.9	6,5.5;6,6;6.5,6.5,6.5;6,6,6; 6,6;	6.1	5.5,5.5;5.5,5.5;6,6,6;6,6,6; 6,6;	5.8	6,6;6,6;6.5,6.5,6.5;6,6,6; 6,6;	6.1	7,7;6.5,6.5;7.5,7.5,7.5; 7,7,7;6.5,6.5;	7.0	2.5,2.5;2.5,2.5;3,3,3;2,2, 2;3,3;	2.6
15.0-15.9	(8,8,8,8 8;)6,5.5;5.5,5.5,5.5; 6,6,6;	6.6 (5.8)	3,4,4,4,4.5;5.5,5.5;4.5,4.5, 4.5;6,6,6;	4.8	(3,3,3,3,3;)6,6;5.5,5.5,5.5; 6,6,6;	4.7 (5.8)	(4,4,4,4.5,4.5)7.5,7.5;7,7,7; 7.5,7.5,7.5;	6.1	3,3,4,2.5,3;2.5,2;3,3,3.5; 3.5,3.5,3.5;	3.1
16.0-16.9	6,5;5.5,5,6;6,6;	5.6	4:,5.5;4,5,5;5.5,5.5;	4.9	(3.5;)5.5;5,5.5,5.5;6,6;	5.3	8.5,8.5;7,7,7;7,7;	7.4	2.5,2.5;3,3,3;2,2;	2.6
17.0-17.9	(3.5,3.5;)	3.5	4,4.5;	4.2	4,4;	4.0	8,8.5;	8.2	3,3;	3.0
18.0-18.9	6,6;6,6,6;4.5,4.5;	5.6	5,5;5,5,5;4,4;	4.7	5.5,5.5;4.5,4.5,4.5;4.5,4.5;	4.8	8,8;7,7,7;6.5,6.5;	7.1	2.5,2.5;3.5,3.5,3.5;3.5,3.5;	3.2
19.0-19.9	6.5;5.5,5.5,5.5;5.5;	5.7	6;5,5,5;5;	5.2	6.5;5.5,5.5,5.5;5.5;	5.7	8.5;8,8,8;6.5;	7.8	2.5;2,2,2;3.5;	2.4
20.0-29.5					Sunset					
Lunation average		4.6		5.6	DARKSIDE	5.3		6.1		2.9

· uncertain
* LTP reported
, separates observations within a night
; separates nights of observations
( ) average excluding anomaly

Table VI. Summary of observations of Dawes in LTP Program of A.L.P.O.

also behave oppositely under tidal effects as might be expected if local tides (Sun's effects) were taken into account.

Proclus (next to lowest graph). There is a strong peak at $\phi = 0.0$ (perigee) and a lesser one at 0.7 for anomalies, while the strong peak for normal is at 0.1. The perigee peak suggests that a tidal effect occurs at Proclus at times of perigee, but not at apogee, but also is somewhat effective at 0.7 where a minimum would be expected. The positive and negative observations behave similarly but are offset by 1/10 period.

Godin (middle graph in Figure 9B). Anomalies have little correlation, showing several peaks (strongest ones at 0.8 and 0.0, and lesser ones at 0.2 and 0.5). The normal aspects have two major peaks at 0.4 and 0.6. The anomalies and normal aspects do behave oppositely.

E. Mare Crisium (next to top graph in Figure 9B). This is really an area rather than a feature (See Fig. 8). It is not far removed from Proclus, at least as compared with the other sites; and one hence might expect its behavior to be similar to that of Proclus. This is not particularly true of the anomalies, although there are too few for Mare Crisium for reliable statistics. For all observations there is general similarity, with some offset near perigee. Anomalies and normal behavior are somewhat similar except at perigee, where anomalies have their highest peak while normal aspects drop off. This result would be expected under the tidal hypotheses.

Calippus (top graph in Figure 9B). Calippus and Godin are at the same longitude but are separated by 36° in latitude, though both are in the northern hemisphere. We might expect them to behave somewhat similarly. We find that the anomalies do, but the normal are opposite. The major peak for Calippus is at 0.95 with lesser ones at 0.35 and 0.75 (where we would expect minima for tidal effects). The anomalies and normal aspects do behave oppositely.

We thus get conflicting and ambiguous results concerning the tidal hypothesis. The overall, general behavior for anomalies shows a buildup of tidal effect (stress) reaching a climax at 0.7 for Aristarchus, perigee for Proclus, 0.9 for Godin, 0.8 for East Mare Crisium, and 0.95 for Calippus. For normal aspects the corresponding maxima are: 0.65 for Aristarchus, 0.1 for Proclus, 0.4 for Godin, perigee (0.0) for E. Mare Crisium, and 0.1 for Calippus. Anomalies and normal points behave similarly for Aristarchus, Proclus, and E. Mare Crisium, while Godin and Calippus have mirror behavior. It should be kept in mind that the numbers of observations are few for E. Mare Crisium and Calippus.

ALBEDO AVERAGES

	ARISTARCHUS (47°W, 23°N)							PROCLUS (46°E, 16°N)						GODIN (10°E, 2°N)						CALIPPUS (10°E, 33°N)				E.M.CRISIUM (67°E,15°N)			
Age d	South Wall	West Wall	North Wall	East Wall	S. Flr.	N Flr.	Centr. Peak	South Wall	West Wall	North Wall	East Wall	Floor	Centr. Peak	South Wall	West Wall	North Wall	East Wall	Nearby Plain	Floor	South Wall	North Wall	Nearby Plain	Floor	South Point	North Point	Middle	Nearby Plain
0.0-0.9																											
1.0-1.9									D A R K S I D E															D A R K S I D E			
2.0-2.9									S U N R I S E						D A R K S I D E					D A R K S I D E				S U N R I S E			
3.0-3.9										6		3	6											3.8	5.4	4.5	5
4.0-4.9									5.9	6		3.4	4											3.8	6.1		5.6
5.0-5.9		D A R K S I D E										3.3	4.6		S U N R I S E						S U N R I S E						
6.0-6.9								4	4.5	7.5	5	3.5	4.6	4.9	7.4	7	4.8	5		6	7		4.2	4.3	6.6		5.9
7.0-7.9								4	4	4	4	2.9	4.7	5.8	7.6	6.5	5.2	4.7		6	6.5	6.2	5	3.8	6	3.8	5.5
8.0-8.9								4	4		4	2.7	4.6	6.2	7.4	6.6	5.5	5.2	5.9	2.5	7.5		6	4	6.4	4	5.6
9.0-9.9												2.3	4.9	6.1	7.2	6.4	5.5	5.3	6.5	7.2	7		5.8	3.5	7		6
10.0-10.9		S U N R I S E										1.8	4.4	6.9	7.1	6.5	5.9	5.6	6.7	5.2	5.5	5	4.9	4.5	5.7	5	5.1
11.0-11.9		8			8	8						1.6	4.3	7.4	7.9	7.2	7.3	5.7	6.8	4.2	4.2		4.8	3.8	5.2		5.5
12.0-12.9	8											1.8	4.1	7.5	7.9	7.2	6.8	5.6	7.1								
13.0-13.9	9											1.4	4.9	7.6	8.1	7.3	7	5.8	7.6	4.7	6.2		5.8	3.8	6		5.4
14.0-14.9	9											1.8	3.8	7.6	8	7.9	7.9	6.1	7.2								
15.0-15.9	8	8	8		8	8	10	8	8	10	9	2.0	4.8	8	7.8	8	8	6		6.2	7.5		5.8	3.8	6.8		5.5
16.0-16.9	7.5	8	8	8	6	8	8				8.5	3.1	4.2	7.6	6.8	7.6	8	5.6		5.4	7.5		6	4.5	6.2		5.8
17.0-17.9	9	8	8	8	5.7	8	10	7.2	7.3	6.8	7	4.0	4.9	7	6	7.5	8	5		4.9	6.5		5.8	3.5	6.2		5.8
18.0-18.9	8	8	8	8	6	8		9			8.3	0	4	6	4.9	6.7	7.2	5	6.5	7.2	4.5		4.8	S U N S E T			
19.0-19.9	8.5	8	8	8	6.3	8			S U N S E T					6.5	5.6	6.5	8.1	5.1	6.5	8	3.8		4.5				
20.0-20.9	8.5	8	8	8	6	8								6	5.5	5.5	8	4	6.0	0	0		8				
21.0-21.9	8.3	8	8	8	5.5	8								5	5.3	5.2	8.2	5									
22.0-22.9	7.7	6	7	8	5.8	7									S U N S E T						S U N S E T						
23.0-23.9				7.7					D A R K S I D E																		
24.0-24.9		5			4.5	4.5	10																	D A R K S I D E			
25.0-25.9				7.3											D A R K S I D E					D A R K S I D E							
26.0-26.9				7.5																							
27.0-27.9		S U N S E T																									
28.0-28.9		D A R K S I D E																									
29.0-29.5																											

Table VII. Summary of observed average albedoes of features studied in LTP Program of A.L.P.O.

Low-Angle Illumination Effects

Three effects may be operating here, all having a correlation with sunrise and one also with sunset. If gases have escaped during the lunar night, then they might be rendered visible (if dense enough) with highly oblique light paths through them (Greenacre 1964). This would occur very near sunrise and sunset, and UV light may excite the gases to luminescence. This effect would occur mainly at sunrise and may be augmented by the oblique light path. Thermoluminescence may take place (near sunrise) as the radiation and heat trapped in the interstices of the rocks and soil are

Feature	Coordinates λ°, β°	Observer	Location, Telescope	Nites No.	Indiv. Meas. No.	Reported LTP Nites Measures N	(Freq) %	Unreported Anomalies Nites, Measures N	(Freq) %	Combined LTP Frequency N %	M %	S. Wall	W. Wall	N. Wall	E. Wall	Floor	Central Peak	Nearby Plain
Aristarchus	47W, 23N	Bartlett	Baltimore,Md 3R-5L	37	131	11 19	(30) (14)	7 7	(22) (7)	49	20	8.3 steady	7.6 steady, decr. nr. SS	7.9 steady	7.9 steady	6.3S, 7.6N decr.; steady	9.5 steady	--
Proclus	46E, 16N	Bartlett	Baltimore,Md 3R-5L	252	556	28 28	(11) (5)	8 8	(3) (1)	14	6	6.0 dull, incr.	5.6 dull, incr.	6.7 steady	6.5 dull, incr.	2.6 bright, decr., bright	4.6 steady	--
Godin	10E, 2N	Porter	Narragansett, RI, 6L	65	878	1 5	(1.5) (0.5)	9 21	(14) (2)	15	3	6.3 incr., decr.	6.9 bright, decr.	6.8 incr., decr.	6.9 dull, incr.	6.7 incr., decr.	--	5.3 incr., decr.
Calippus	10E, 38N	Frank	Fairport,*NY 6L	22	127	2 12	(9) (9)	6 14	(27) (11)	36	20	5.6 (6.5) decr., incr.	--	6.1 steady	--	5.6 ?	--	5.5 incr., decr.
E. Mare Crisium	67E, 15N	Frank	Fairport,* NY 6L	26	152	0 0	(0) (0)	1 1	(4) (1)	4	1	3.9 steady	--	6.1 steady	--	4.4 steady	--	5.6 incr., decr.? incr.
Dawes	26E, 17N	Porter	Narragansett, RI, 6L	74	920	1 25	(1) (3)	8 33	(11) (4)	12	6	4.6 incr., decr.	5.6 decr.	5.3 incr., slight decr.	6.1 incr.	--	--	2.9 steady
									Average frequency	21	8							

*Latest address formerly Hopkins, Minn.

Table VIII. Summary of data on six features observed in LTP Program of A.L.P.O. See also Lunar Recorder Cameron's text on page 228.

liberated upon heating after sunrise (Sidran 1967, Blizard 1967). All three mechanisms could be effective.

These effects may be assessed from Table IX and Fig. 9A. Sunrise and sunset are indicated on the histograms (Fig. 9A):

Aristarchus (bottom graph in Fig. 9A). Anomalies have a slight rise near sunrise and sunset, but their major peaks are near Full Moon. The normal aspects peak (strongest) near sunrise and after Full Moon and have a slight rise near sunset. Normal aspect and anomalies have opposite behavior as would be expected if an effect were operating; however, it is the normal aspects which peak at sunrise rather than the anomalies. Therefore, there appears to be no low-angle illumination effect for Aristarchus. The difference between these results and those of Cameron (1972) is probably due here to elimination of most bluish phenomena from the anomalies, but they are included under normal.

Proclus (next to lowest graph in Fig. 9A). Anomalies continue to increase after sunrise with the strongest peak coming at age 9 days, which is at local noon, and with another peak near Full Moon. Normal observations decline after sunrise, then peak at local noon till Full Moon. Normal and anomalies behave oppositely. There appears to be a low-angle illumination effect on anomalies at Proclus.

Godin (middle graph in Fig. 9A). Anomalies have their highest peak near sunrise, then rise again near local noon and at sunset. Normal aspects peak at about age 10 days but have sharp rises and peaks at both sunrise and sunset. Normal and anomalies behave somewhat similarly. There may be a low-angle illumination effect on anomalies at Godin.

East Mare Crisium. There are only two anomalies, one of which occurred near sunrise. Normal aspects also rose at sunrise but the strongest peak was at 1st Quarter (7 days). The curve also rises near sunset. Normal and anomalies perhaps behave similarly.

Calippus. Anomalies had their strongest peaks near sunrise and local noon, but also showed a lesser peak at sunset. Normal aspects peaked strongly at sunrise and at age 17 days but dropped off near sunset. Anomalies and normal perhaps behave oppositely except at sunrise.

We would expect that normal aspects and anomalies would show opposite behavior if a real external influence was affecting LTP. This was the case with Aristarchus and Proclus; but East Mare Crisium showed the same behavior, and Calippus and Godin showed mixed behavior. Generally, there is a peaking of LTP near sunrise and sunset. Most of them had stronger peaks at other times, many of them at times which have no significance in the hypotheses considered.

Magnetic Tail Effects

There are two possible effects from the Earth's magnetic tail. Both involve acceleration of solar flare particles (or plasma). The neutral sheet in particular and the magnetopause region in general, which contain magnetic lines of force, may accelerate charged particles (which increases their energies) in them and focus them at small, local areas on the Moon (as they do on the Earth when the particles flow in the opposite direction, Speiser 1965, 1967). These particles cause magnetic storms and aurorae on Earth. They may stimulate luminescence on the Moon. The bow-shock front of the magnetic tail may have turbulence inside its boundaries; and this may also accelerate solar particles, which in turn may excite lunar gases or surface materials to luminance (A. Cameron 1964). The Moon crosses the bow-shock front at about 4.5 days before and after Full Moon, and crosses into and out of the magnetopause at about 2 days before and after Full Moon, respectively. We would expect correlations, then, between ± 4.5 days of Full Moon, particularly ± 2 days of Full Moon.

Looking at Fig. 9A again, these boundaries are indicated with vertical lines. The heaviest line indicates approximate Full Moon (usually at about 15 days age), the narrower solid lines are the approximate magnetopause (MP) boundaries, and the dashed lines are the approximate bow-shock front (BSF) boundaries.

Aristarchus. The major peak for anomalies is in the magnetopause and has dips at the BSF boundaries. The normal aspect has its major peak at age 13 days, which has no hypothetical cause, and also has a rise in the MP but not at the BSF. Generally the normals and anomalies behave oppositely.

Proclus. Anomalies have a peak in the MP, but the strongest peak is at the BSF entry. Sunset on Proclus occurs before the Moon exits the BSF. Normal aspects have their strongest peak at the BSF entry but remain high into the MP. Behavior of normals and anomalies is generally mirror-like.

Godin. The anomalies begin to rise at the BSF entry and have a peak at the exit too, but decline in the MP. Normals also have peaks at those two times, but further show a rise in the MP. Anomalies and Normals behave similarly at the BSF boundaries but oppositely in the MP.

E. Mare Crisium. Of the two anomalies, one is in the MP. One of the several peaks in the Normals is in the MP and at the BSF entry. Normal and anomalies behave similarly.

Calippus. Anomalies have a peak at the BSF entry and in the MP, but not at the BSF exit. The Normals have one in the MP. The Normals and anomalies have a mixed behavior, both having peaks in the MP but differing at the BSF.

Thus again we have ambiguities. All anomalies but Godin's have peaks in the MP. All have peaks at the BSF entry, but only Godin has one at the BSF exit. Aristarchus and Proclus have opposite behavior between their respective normal aspects and the anomalies. E. Mare Crisium has them behaving similarly, while Godin and Calippus have mixed behavior. Aristarchus and Proclus behave somewhat similarly to each other while Godin and Calippus are mirror-like, and so are E. Mare Crisium and Proclus. One would expect the latter two respective pairs to behave oppositely from what they do (i.e., similarly to each other) if there were real magnetic tail effects. These comparisons differ from the tidal effects behaviors. Aristarchus and E. Mare Crisium behave differently (oppositely) to what we would expect for all hypotheses if these effects existed. Proclus only matches expected behavior with magnetic tail effects. Godin and Calippus match expected behavior only under tidal effects. Aristarchus vs.

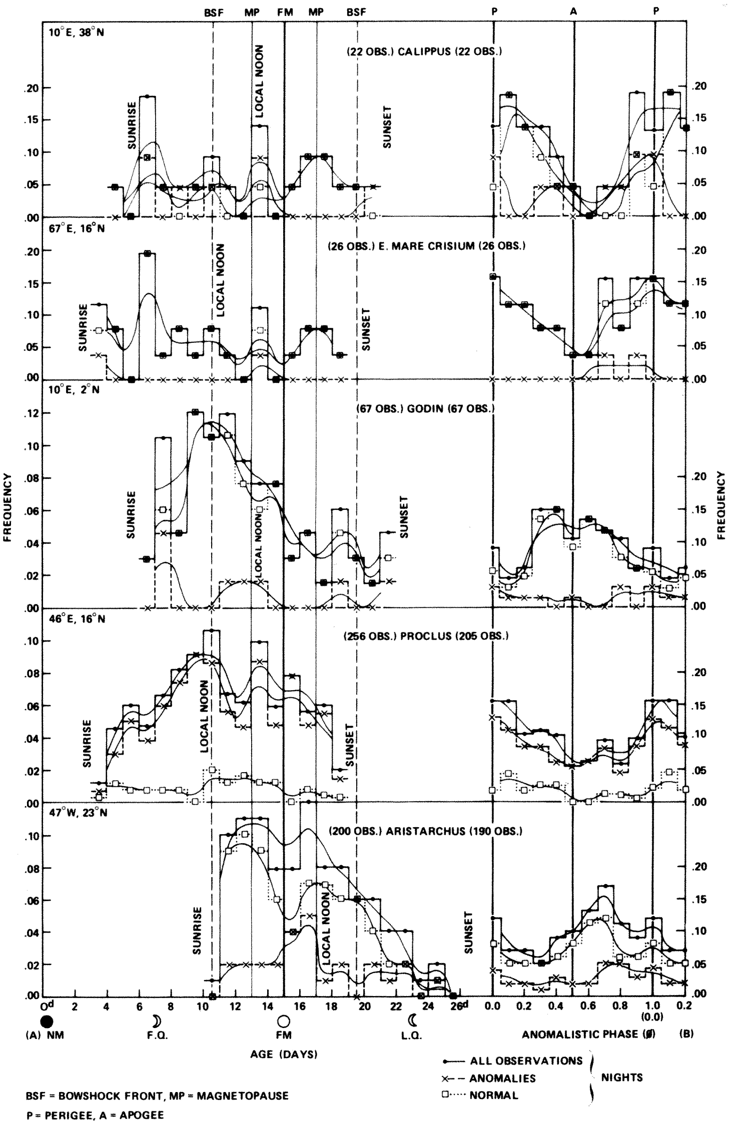

Figure 9. (A) Plots of frequency of observation vs. age of the Moon for the three categories: Anomalies, Normal Observations, and All Observations. Vertical lines have the same meaning as in Fig. 14P. The selenographic coördinates of each feature are given in the upper left corner, and the total number of observations is given in the parentheses at the left of the name. (B) Plots of the frequency of observations vs. the phase of the anomalistic period (ϕ), which produces the tidal effects, for the same categories and features as in (A). The number of observations involved is given in the parentheses to the right of the name. These frequencies are with respect to the number of nights of observation, rather than to the individual measures of points. Vertical lines indicate times of perigee (P), and apogee (A). The first three points are repeated at the right edge better to show the relationship to perigee. See also discussion in text of Mrs. Cameron's report.

Proclus behave as expected in the tidal and low-angle illumination effects. Proclus and E. Mare Crisium behave as expected (similarly) under tidal and magnetic tail effects but differ under low-angle illumination effects. Godin and Calippus behave oppositely to expectation except for anomalies in the low-angle illumination effects.

Observed Versus Expected Percentages

In order to assess the correlations with the various hypotheses, we must have some idea of the percentage of observations which would fall within the assumed boundary conditions assuming that observations were evenly distributed throughout the period under consideration. For example, if 1/10 of a period in the anomalistic phase (perigee to perigee) were taken as a unit, then we can take the boundary condition of ≤ ± 0.1 of perigee. A peak in this region would constitute a correlation. If observations were distributed evenly throughout the anomalistic period, then it would be expected that 20% of all observations would fall within ± 0.1 period (10% on either side of perigee). Similarly, for sunrise conditions--under the boundary condition of ≤ + 1 day of sunrise, 1 out of 15 observations (lighted half of a lunation) = 7%, so 7% of all observations could be expected by chance to fall within one day after sunrise if all observations were distributed evenly throughout the lighted half of the lunation (for that feature). Table IX is constructed to show the observed and expected percentages of observations under various boundary conditions for each hypothesis and feature. The ratio of observed to expected gives a measure of the correlation, where observed equal to expected would give a ratio of unity (1.0). The expected percents for each boundary condition are given at the right edge. Under each feature there are four large columns. Each large column has data for phenomena (reported plus unreported, possible anomalies), Normal Aspects (negative), and All Data (phenomena and normal combined); and the last column (frequency) gives the frequency of occurrence out of the total number of nights of observations for phenomena (P), Normal Aspects (N), and All (A) respectively. The respective small columns under each of the other three headings (large columns 1, 2, and 3) are (1) the number of nights of observations (No.) for that category which were observed within the boundary conditions given at the left edge (first column, Effects), (2) the number (in column 1) given as a percent (%) out of the total number of nights of observation (given at the bottom, in the row Total No.), and (3) O/E, the ratio of column (2) to the percent given in the colum marked expected percent (Exp.) found in the last column of the table (extreme right), where a ratio of 1.0 means that the percent actually observed was the percent expected to be observed if observations were distributed evenly throughout the period under consideration, 27.6 days for anomalistic period (tidal) and about 15 days for the other hypotheses.

In this table, the highest ratio O/E for each column of phenomena is circled. This gives a measure of the correlation. For each phenomena column, the highest percentage in any boundary condition is boxed. For example, under Aristarchus, the largest effect was for solar effect, where the maximum O/E = 4.0, which indicates that four times as many events were observed as would be expected under those boundary conditions (magnetic storm and anomaly observed on same date and the Moon was in the magnetic tail) if observations were distributed uniformly throughout the lighted half of the lunation (15 days). On the other hand, 70% of all observations of phenomena occurred when the Moon was within the limits of the Earth's magnetic tail; i.e. within ± 4.5 days of Full Moon (60% would be expected).

The results from this table are surprising since they differ from the results obtained when the whole body of LTP (∿ 1400 observations) are analyzed in the same manner (Cameron, 1977). In the latter, the vast majority of O/E ratios were highest for the boundary condition of ≤ + 1 day of sunrise under low-angle illumination. In this present table only Godin shows that result. Another unusual result is that for Proclus, not only is the highest ratio of O/E (13.0) found under solar effects (as has been found previously); but the highest percent (37%) of observations for phenomena were also under solar flare effects.

Only East Mare Crisium showed the highest ratio (ten times expected) and the highest percentage (100%) under the tidal effects. All phenomena (two) observed in Eastern Mare Crisium occurred within 0.1 period of perigee. These figures are not significant because of the very small number of anomalies (two). Three of the five features showed highest correlation (O/E) with solar flare effects, one with sunrise, and one with tidal (the least reliable statistics). Three showed the highest percentage of phenomena in the magnetic tail, though one of those (Godin) tied with low-angle illumination and one (Calippus) tied with solar and low-angle illumination. One feature had the highest percentage of phenomena under solar flare effects, and the remaining one under tidal.

The most frequently cited correlation in the literature for lunar transient phenomena (LTP) is tidal effects, where it is stated (without foundation) that LTP (most, or all implied) correlate with perigee and apogee. This idea has been refuted several times (Cameron 1967, 1972, 1974, 1975, and 1976); but the statements persist, usually made by others who have not worked with the data, but who cite early papers, Burley and Middlehurst, 1966, and Green, 1965, which did show such a correlation but which also did not investigate other hypotheses in detail. Let us examine the data in the present paper for tidal correlations in Table IX. For Aristarchus 50% more observed than expected phenomena were found within ± 1.4 days of perigee (.05P), but 20% less than expected at apogee. At wider boundary conditions, 40% more were observed than would be expected (O/E = 1.4) within ± 2.8 days (0.1P), while observed were equal tc expected within ± 2.8 days of apogee. When combining the widest limits for perigee and apogee (≤ ± 0.1P and A), 40% would be expected to fall there under a uniform distribution; and 47% were observed, or we get a ratio of O/E = 1.2, which is 20% more than expectation. This is hardly having all or even most LTP occurring at perigee and apogee. Proclus had 50% more than expected close to perigee, but 100% fewer at apogee. Combining the widest limits for perigee and apogee, 20% fewer were observed at Proclus than would be expected. Godin showed a high correlation within the narrow-limits of perigee and slightly above (20%) expectation for apogee; but when the widest limits of each are combined, 10% fewer were observed at Godin than would be expected by chance. Calippus behaved similarly to Godin (both near the center of the Moon in longitude), though Calippus shows a wider deficiency at apogee; thus 40% fewer observed than expected lie within 2.8 days of perigee and apogee. As discussed before, E. Mare Crisium's two observed phenomena happened to be within 2.8 days (0.1 period) of perigee. Thus it is inaccurate to say that most LTP occur near perigee (or even perigee and apogee). In none of the above features were there more than half of the anomalies that did (except for the two phenomena in M. Crisium).

Observed versus Expected Percentages for Various Hypotheses

EFFECTS	ARISTARCHUS (47W, 23N)												PROCLUS (46°E, 16°N)											
	Phenomena			Normal			All			Frequency			Phenomena			Normal			All			Frequency		
Tidal	No.	%	$\frac{O}{E}$	No.	%	$\frac{O}{E}$	No.	%	$\frac{O}{E}$	P	N	A	No.	%	$\frac{O}{E}$	No.	%	$\frac{O}{E}$	No.	%	$\frac{O}{E}$	P	N	A
$\leq \pm .05$P	8	15	1.5	19	14	1.4	27	14	1.4	.04	.10	.14	5	15	1.5	26	15	1.5	31	15	1.5	.02	.13	.15
$\leq \pm .05$A	4	8	0.8	16	12	1.2	20	11	1.0	.02	.08	.11	0	0	0.0	14	8	0.8	14	7	0.7	.00	.07	.07
$\leq \pm .1$P	15	28	1.4	30	22	1.1	45	24	1.2	.08	.16	.24	8	24	1.2	52	30	1.5	60	29	1.4	.04	.25	.29
$\leq \pm .1$A	10	19	1.0	29	21	1.0	39	21	1.0	.05	.15	.21	3	9	0.4	25	14	0.7	28	14	0.7	.01	.12	.14
$\leq \pm .05$P+A	12	23	1.2	35	26	1.3	47	25	1.2	.06	.18	.25	5	15	0.8	40	23	1.2	45	22	1.1	.02	.20	.22
$\leq \pm .1$P+A	25	47	1.2	59	43	1.1	84	44	1.1	.13	.31	.44	11	32	0.8	77	45	1.1	88	43	1.1	.05	.38	.43
Total No.	53			137			190			190			34			171			205			205		
Low-angle Illumination																								
$\leq +1^d$ SR	6	11	1.6	25	47	6.7	31	16	2.3	.03	.12	.16	3	9	1.3	6	3	0.4	9	4	0.6	.01	.02	.04
$\leq -1^d$ SS	1	2	0.3	0	0	0.0	1	0	0.0	.00	.00	.00	6	18	2.6	9	4	0.6	15	6	0.9	.02	.04	.06
$\leq +2^d$ SR	7	13	1.0	41	77	5.9	48	24	1.8	.04	.20	.24	1	3	0.3	19	9	0.7	20	8	0.6	.00	.07	.08
$\leq -2^d$ SS	2	4	0.3	2	4	0.3	4	2	0.2	.01	.01	.02	3	9	0.7	26	12	0.9	29	11	0.8	.01	.10	.11
$\leq \pm 1^d$ SR&SS	7	13	1.0	25	47	3.6	32	16	1.2	.04	.12	.16	4	12	1.0	20	9	0.7	24	9	0.7	.02	.08	.09
$\leq \pm 2^d$ SR&SS	9	17	0.6	43	81	3.0	52	26	1.0	.04	.22	.26	9	26	1.0	40	18	0.7	49	19	0.7	.04	.16	.19
Total No.	53			147			200			200			34			222			256			256		
Magnetic Tail																								
$\leq \pm 2^d$ FM	24	45	1.7	51	35	1.3	75	38	1.4	.12	.26	.38	9	26	1.0	65	38	1.4	74	29	1.1	.04	.25	.29
$\leq \pm 4.5^d$ FM	37	70	1.2	125	85	1.4	162	81	1.4	.18	.62	.81	21	62	1.0	123	72	1.2	144	56	0.9	.08	.48	.56
$\leq \pm 3.5^d$ 4.5^d FM	4	8	0.6	18	12	0.9	22	11	0.8	.02	.09	.11	3	9	0.7	21	12	0.9	24	9	0.7	.01	.08	.09
Total No.	53			147			200			200			34			222			256			256		
Solar																								
ms day	6	11	1.0	22	16	1.6	28	15	1.5	.03	.12	.15	8	27	2.7	35	24	2.4	43	25	2.5	.05	.20	.25
$\leq \pm 1^d$ ms	6	11	0.4	34	25	0.8	40	21	0.7	.03	.18	.21	11	37	1.2	57	39	1.3	68	39	1.3	.06	.33	.39
$\geq K_{p\,max}$ 6	4	8	2.0	13	10	3.3	17	9	3.0	.02	.07	.09	2	7	2.3	27	18	6.0	29	17	5.7	.01	.16	.17
ms in MP	2	4	4.0	8	6	6.0	10	5	5.0	.01	.04	.05	4	13	13.0	2	1	1.0	6	3	3.0	.02	.01	.03
ms in MT	4	8	4.0	22	16	8.0	26	14	7.0	.02	.12	.14	5	17	8.5	10	7	3.5	15	10	4.5	.03	.06	.10
ms in BSF	1	2	4.0	1	1	2.0	2	1	2.0	.01	.01	.01	1	3	6.0	5	3	6.0	6	3	6.0	.01	.03	.03
Total No.	53			134			187			187			30			146			174			174		

EFFECTS	GODIN (10°E, 2°N)												CALIPPUS (10°E, 38°N)											
	Phenomena			Normal			All			Frequency			Phenomena			Normal			All			Frequency		
Tidal	No.	%	$\frac{O}{E}$	No.	%	$\frac{O}{E}$	No.	%	$\frac{O}{E}$	P	N	A	No.	%	$\frac{O}{E}$	No.	%	$\frac{O}{E}$	No.	%	$\frac{O}{E}$	P	N	A
$\leq \pm .05$P	2	25	2.5	4	7	0.7	6	9	0.9	.03	.06	.09	1	25	2.5	2	11	1.1	3	14	1.4	.05	.09	.14
$\leq \pm .05$A	1	12	1.2	6	10	1.0	7	10	1.0	.01	.09	.10	0	0	0.0	1	6	0.6	1	5	0.5	.00	.05	.05
$\leq \pm .1$P	2	25	1.2	5	8	0.4	7	10	1.0	.03	.07	.10	1	25	1.2	6	33	1.6	7	32	1.6	.05	.27	.32
$\leq \pm .1$A	1	12	0.6	11	19	1.0	12	18	0.9	.01	.16	.18	0	0	0.0	1	6	0.3	1	5	0.2	.00	.05	.05
$\leq \pm .05$P+A	3	38	1.9	10	17	0.8	13	19	1.0	.04	.15	.19	1	25	1.2	3	17	0.8	4	18	0.9	.05	.14	.18
$\leq \pm .1$P+A	3	38	0.9	16	27	0.6	19	28	0.7	.04	.24	.28	1	25	0.6	7	39	1.0	8	36	0.9	.05	.32	.36
Total No.	8			59			67			67			4			18			22			22		
Low-angle Illumination																								
$\leq +1^d$ SR	2	25	3.6	4	7	1.0	6	9	1.3	.03	.06	.09	0	0	0.0	5	28	4.0	5	23	3.3	.00	.23	.23
$\leq -1^d$ SS	1	12	1.7	3	5	0.7	4	6	0.9	.01	.04	.06	1	25	3.6	0	0	0.0	1	5	0.7	.05	.00	.05
$\leq +2^d$ SR	3	38	2.9	10	17	1.3	13	19	1.5	.04	.15	.19	1	25	1.9	5	28	2.2	6	27	2.1	.05	.23	.27
$\leq -2^d$ SS	1	12	0.9	3	5	0.4	4	6	0.5	.01	.04	.06	1	25	1.9	1	6	0.5	2	9	0.7	.05	.05	.09
$\leq \pm 1^d$ SR&SS	3	38	2.9	7	12	0.9	10	15	1.2	.04	.10	.15	1	25	1.9	5	28	2.2	6	27	2.1	.05	.23	.27
$\leq \pm 2^d$ SR&SS	4	50	1.9	13	22	0.8	17	25	0.9	.06	.19	.25	2	50	1.9	6	33	1.2	8	36	1.3	.09	.27	.36
Total No.	8			59			67			67			4			18			22			22		
Magnetic Tail																								
$\leq \pm 2^d$ FM	1	12	0.4	15	25	0.9	16	24	0.9	.01	.22	.24	1	25	0.9	5	28	1.0	6	27	1.0	.05	.23	.27
$\leq \pm 4.5^d$ FM	4	50	0.8	38	64	1.1	42	63	1.0	.06	.57	.63	2	50	0.8	10	56	0.9	12	55	0.9	.09	.45	.55
$\leq \pm 3.5^d$ 4.5^d FM	0	0	0.0	11	19	1.5	11	16	1.2	.00	.16	.16	0	0	0.0	2	11	0.8	2	9	0.7	.00	.09	.09
Total No.	8			59			67			67			4			18			22			22		
Solar																								
ms day	0	0	0.0	8	14	1.4	8	12	1.2	.00	.12	.12	2	50	5.0	1	6	0.6	3	14	1.4	.09	.05	.14
$\leq \pm 1^d$ ms	0	0	0.0	14	24	0.8	14	21	0.7	.00	.21	.21	2	50	1.7	2	11	0.4	4	18	0.6	.09	.09	.18
$\geq K_{p\,max}$ 6	0	0	0.0	3	5	1.7	3	4	1.3	.00	.04	.04	1	25	8.3	1	6	2.0	2	9	3.0	.05	.05	.09
ms in MP	0	0	0.0	2	3	3.0	2	3	3.0	.00	.03	.03	1	25	25.0	1	6	6.0	2	9	9.0	.05	.05	.09
ms in MT	0	0	0.0	6	10	5.0	6	9	4.5	.00	.09	.09	1	25	12.5	1	6	3.0	2	9	4.5	.05	.05	.09
ms in BSF	0	0	0.0	2	3	6.0	2	3	6.0	.00	.03	.03	0	0	0.0	0	0	0.0	0	0	0.0	.00	.00	.00
Total No.	8			59			67			67			4			18			22			22		

EFFECTS	EAST MARE CRISIUM (67°E, 16°N)												
	Phenomena			Normal			All			Frequency			Exp.
Tidal	No.	%	$\frac{O}{E}$	No.	%	$\frac{O}{E}$	No.	%	$\frac{O}{E}$	P	N	A	%
$\leq \pm .05$P	1	50	5.0	3	12	1.2	4	15	1.5	.04	.12	.15	10
$\leq \pm .05$A	0	0	0.0	1	4	0.4	1	4	0.4	.00	.04	.04	10
$\leq \pm .1$P	2	100	[illegible]	5	21	1.0	7	27	1.4	.08	.19	.27	20
$\leq \pm .1$A	0	0	0.0	1	4	0.2	1	4	0.2	.00	.04	.04	20
$\leq \pm .05$P+A	1	50	2.5	4	17	0.8	5	19	1.0	.04	.15	.19	20
$\leq \pm .1$P+A	2	100	2.5	6	25	0.6	8	31	0.8	.08	.23	.31	40
Total No.	2			24			26			26			
Low-angle Illumination													
$\leq +1^d$ SR	0	0	0.0	0	0	0.0	0	0	0.0	.00	.00	.00	7
$\leq -1^d$ SS	0	0	0.0	3	12	1.7	3	12	1.7	.00	.12	.12	7
$\leq +2^d$ SR	1	50	3.8	2	8	0.6	3	12	0.9	.04	.08	.12	13
$\leq -2^d$ SS	0	0	0.0	5	21	1.6	5	19	1.5	.00	.19	.19	13
$\leq \pm 1^d$ SR&SS	0	0	0.0	3	12	0.9	3	12	0.9	.00	.12	.12	13
$\leq \pm 2^d$ SR&SS	1	50	1.9	7	29	1.1	8	31	1.1	.04	.27	.31	27
Total No.	2			24			26			26			
Magnetic Tail													
$\leq \pm 2^d$ FM	1	50	1.9	5	21	0.8	6	23	0.9	.04	.19	.23	27
$\leq \pm 4.5^d$ FM	1	50	0.8	11	46	0.8	12	46	0.8	.04	.42	.46	60
$\leq \pm 3.5^d$ 4.5^d FM	0	0	0.0	2	8	0.6	2	8	0.6	.00	.08	.08	13
Total No.	2			24			26			26			
Solar													
ms day	0	0	0.0	4	17	1.7	4	15	1.5	.00	.15	.15	10
$\leq \pm 1^d$ ms	1	50	1.7	6	25	0.8	7	27	0.9	.04	.23	.27	30
$\geq K_{p\,max}$ 6	0	0	0.0	3	12	4.0	3	12	4.0	.00	.12	.12	3
ms in MP	0	0	0.0	2	8	8.0	2	8	8.0	.00	.08	.08	1
ms in MT	0	0	0.0	2	8	4.0	2	8	4.0	.00	.08	.08	2
ms in BSF	0	0	0.0	0	0	0.0	0	0	0.0	.00	.00	.00	0.5
Total No.	2			24			26			26			

Table IX. Summary of observed frequency of certain events in five lunar regions studied vs. their expected random frequency under several different hypotheses. This table can be carefully examined in connection with Winifred Cameron's textual discussion on page 236 <u>et seq</u>.

So far we have just looked at the phenomena. Next we examine the normal aspects (negative) behavior under tidal effects. About as high a percentage (and ratio) of normal aspects occurred within 1.4 days of perigee as did phenomena, and also close to apogee. We would expect, if only tidal effects operated, that there would be very few or none (or O/E = 1.0 if evenly distributed) at these times. Similarly with Proclus and E. Mare Crisium. Only Godin shows results nearer expectation for a tidal effect. Calippus shows that observed numbers are near expected close to perigee, but as deficient near apogee even for normal aspects. In other words, most features (except Godin) behave with respect to tidal effects nearly as would be expected if observations were uniformly distributed. Therefore, I would conclude that there is little or no cause by tidal stress for lunar transient anomalies.

All features but M. Crisium showed high correlations with low-angle illumination effects, mostly within 1 day of sunrise (1 day of sunset for Calippus and Proclus). The effects dropped to near unity with the wider boundaries and with a combination of sunrise and sunset. Only Aristarchus and M. Crisium showed much correlation with the magnetic tail (magnetopause); the others were near unity (60% below expectation for Godin).

The amount of correlation with solar effects is surprising. The row MS day includes lunar events which happened on the same day as a terrestrial magnetic storm (MS), which means solar flare particles were in the Earth-Moon vicinity, bombarding their surfaces. The row ≤ ± 1 day of MS means lunar events occurred within one day before or after a terrestrial magnetic storm. The row Kp max ≥ 6- means that the magnetic energy index Kp, which ranges from 0-9 was rated 6- or higher at some time of the day when a lunar event was observed. Magnetic storms usually occur when the Kp index is 6- or higher, though not always; and often they occur at lower index ratings. The row MS in MP means that a lunar event occurred on the day a magnetic storm occurred on Earth, and the Moon was within the Earth's magnetopause of the magnetic tail (near Full Moon). The next row indicates that a lunar event occurred on the same day as a magnetic storm, and the Moon was within the magnetic tail (including the BSF) which is within ± 4.5 days of Full Moon. The final row means that the lunar event occurred on the day of a magnetic storm, and the Moon was in the turbulence of the bow-shock front of the tail (within 3.5-4.5 days of Full Moon).

Events in Aristarchus were observed about as expected during high magnetic activity (high energy particles), and 60% more than expected for normal observations. Proclus had almost 3 times as many events as expected during terrestrial magnetic storms, but more than twice as many normal ones then too. Godin had no events during solar flare activity and a few more than expected for normal. Calippus shows a real solar flare effect since five times more than expected lunar events were observed while substantially fewer normal aspects were observed than expected then. Mare Crisium shows no solar effects, except within 1 day of a magnetic storm. This boundary condition is really too broad, except when a magnetic storm or activity persists into the next day. A more accurate comparison should be made considering times of lunar events and magnetic storms.

In most cases here we are dealing with small numbers, and we can have little confidence in the statistics.

In summary, we find that examination of the albedo charts reveals several instances of anomalous behavior in the features which were not noticed at the time by the observer (circled on charts presented). There are good reasons why the observer did not notice them. In some cases they were the first measures made, and the normal aspect was not known. Usually no change took place during the observing time, and hence attention was not drawn to the anomalies. There were apparently no fluctuations during observations. Even in the cases where there were many previous measures, the observer did not remember (nor should he) what the albedo was before for that age and that point. It is now recommended that the observer consult his albedo chart after his observations. If he finds a discrepancy of two or more full albedo steps from the average of previous measures he should go back and observe that site more to determine whether he sees any changes or other phenomena. He should not consult his chart before observing. Each observer will be furnished with albedo charts I have compiled. From these he can see where observations are lacking and can check on anomalies.

The graphs of the albedos show the behavior of the points throughout a lunation. I would expect the north and south walls to behave similarly to each other, and to be steady throughout a lunation, and the east and west walls to behave oppositely to each other. The west wall would be expected to be bright at sunrise, and diminish toward sunset, while the east wall would be dim near sunrise and be bright near sunset. All points might be expected to be bright at local noon and at Full Moon. Dark areas (nearby plains and dark floors) might brighten near local noon and Full Moon, or may darken, e.g., as reported about Plato. In four cases, Aristarchus, Proclus, Godin, and Calippus, the floors and nearby plains brighten at these times. Only East Mare Crisium darkens. Only for Godin are the east and west walls plotted, and they show opposite behavior as expected. For Proclus the central peak and floor behave oppositely. The histograms of the observations versus age and versus phase in the anomalistic period reveal different behavior for each feature. In the anomalistic period data it might be expected from terrestrial tidal effects alone that all features would behave similarly with respect to perigee and apogee; but if local tides (including the solar contribution to tidal effects) were superimposed, then features in opposite hemispheres would respond oppositely and close neighbors similarly. We find that each feature behaves differently but that Proclus and Aristarchus are opposite, while Proclus and East Mare Crisium are similar, though Godin and Calippus are opposite. The latter two are at the same longitude but are separated widely in latitude, perhaps enough that local tides (influenced by north-south librations) would impose different responses. Proclus and Calippus phenomena have correlations with perigee but not with apogee while the others have little correlation with either. It would be expected that events and normal aspects would behave oppositely. Only Calippus and Godin do. Aristarchus and Proclus behave oppositely to each other while Godin and Calippus behave similarly, and so do E. Mare Crisium and Proclus. In the age histogram, all have peaks (not the strongest) in the magnetopause of the Earth's magnetic tail and near sunrise and sunset. All except Godin have a peak near local noon, with Proclus having its major peak there. All but Aristarchus have their major peak near sunrise, while Aristarchus' is in the magnetopause (near Full Moon). In this diagram Aristarchus and Proclus behave somewhat oppositely (but should not), but so do Godin and Calippus which would be expected to be similar. Proclus and M. Crisium are not too similar either, though they are fairly close neighbors. All should behave similarly to each other for the hypotheses considered under age vs. frequency (low-angle illumination, magnetic tail effects).

It is concluded that correlations of phenomena can be found for some features with each hypothesis but that normal aspects often behave in the same way when one would expect them not to. I don't think a strong case can be made for any hypothetical influence. In most cases we are dealing with small numbers, and hence less confidence can be put in the results. The one result that is impressive is that unnoticed brightness changes do occur. Their frequency is about 10% of the nights of observation, or about 5% for individual measures. This frequency has been established for the first time because negative as well as positive observations are reported. The proportion of reported LTP is not more than 1% of the time. It is hoped that these results will spur the participants in the program to resume their observing and to fill in their albedo charts.

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PERIODICITY IN THE ACTIVITY OF JUPITER'S ATMOSPHERE

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Abstract

Analysis of features lying between the South Temperate Belt and the North Temperate Belt shows that the atmospheric activity of Jupiter is higher near and past the perihelion of its orbit than at the aphelion. The sinusoidal component of the velocity of the STB ovals, namely FA, BC, and DE, and of an equatorial plume[1] is here interpreted in terms of solar heating, which depends mainly on the eccentricity of the orbit.[2]

Introduction

Several papers concerning the cyclic behavior of some Jovian features (with respect to their velocities or dates of occurrence) have been published in recent years. Some of them are reported in Table I, which shows that different modulating parameters have been suggested to account for various phenomena whose periodicity is frequently the same, namely about 12 years. As an example, Reese and Beebe recently pointed out a possible correlation between the harmonic component of the velocity of one north equatorial plume and the planetocentric declination of the Sun, claiming thus the discovery of a true seasonal effect.[1]

As a contribution to the study of the periodicity concerning the overall activity of Jupiter's atmosphere, we shall discuss here some results established during a century of systematic visual observations of the planet. We have obtained a 100-yr. span of Jupiter observations, combining the work of Peek,[3] the subsequent reports of the Jupiter Section of the British Astronomical Association, and our own systematic observations carried out between 1969 and 1977.

Because of the fact that near the poles the atmospheric circulation is influenced mainly by the heat coming from the planet's interior,[4] we have taken into account only features lying not far from the equator. Moreover, we considered only "bona fide" long-lived features or phenomena with a recurrent nature. Two sets of elements fulfilling these requirements were selected, the first related to velocity variations and the second relevant to the dates of occurrence of activity outbreaks.

Experiment I: Velocity Variations

The behavior of the mean velocity of the white ovals FA, BC, and DE belonging to the South Temperate Current (zenographical latitude about -33°) was studied between 1940 and 1977. Velocities have been computed as differences of opposition longitudes ($\Delta\lambda/\Delta$ time), and a mean value was obtained. This figure was assigned to times corresponding to the midpoint of each time interval. The results are shown in Figure 10.*

We did not take into account the motion of other features (e.g., the Red Spot) because of the complication introduced in their behavior by interaction with other

*Similar data have been published in part by Reese[5] and Jetzer.[6]

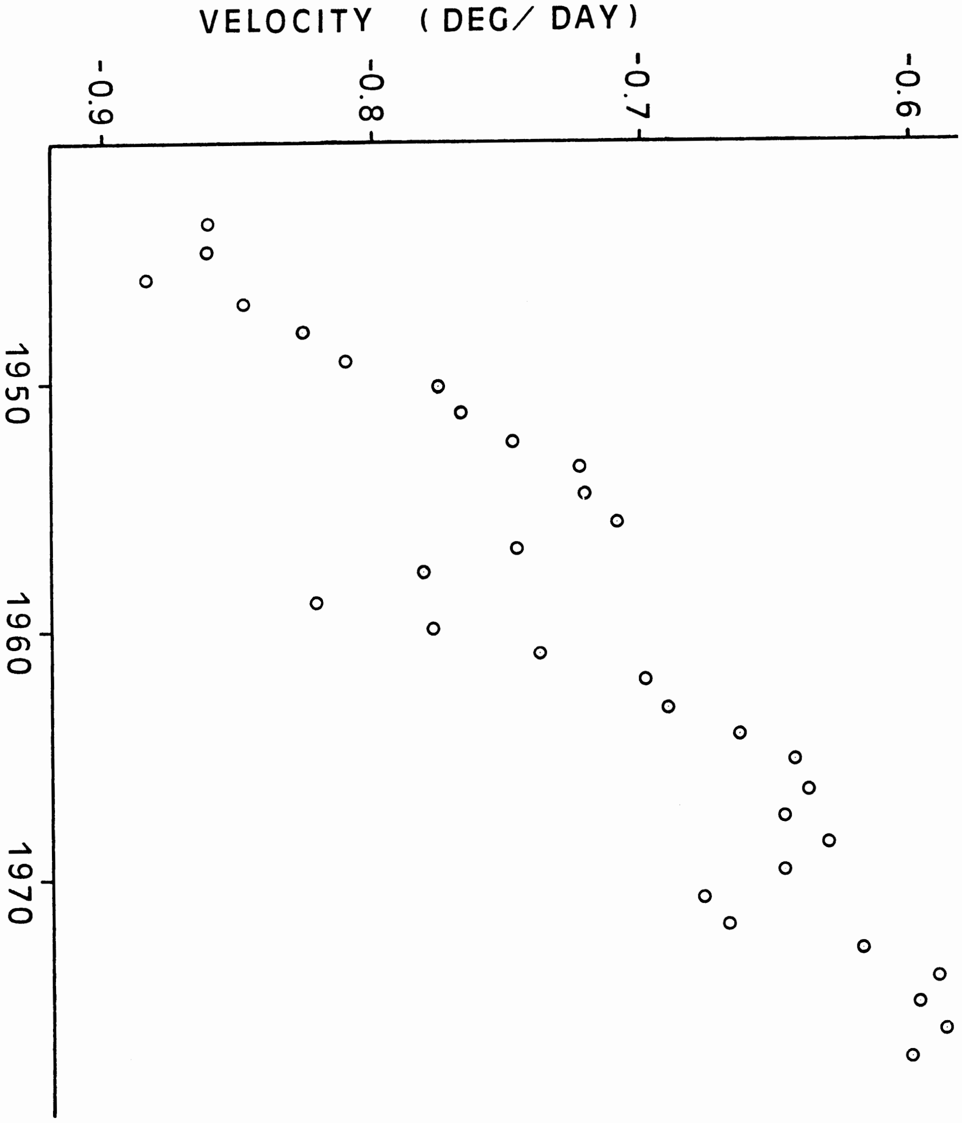

Figure 10. Mean velocity of the white oval spots FA, BC, and DE between 1941 and 1977. The spots lie on the southern edge of the STB at an average latitude of -33°. See also text.

features (e.g., the South Tropical Disturbances and the Revivals of the SEB).

Inspection of Figure 10 clearly reveals that the observed behavior is the result of a constant deceleration term and an oscillatory component. Neither of these components is related to interaction between the ovals and the Red Spot which, by contrast, does accelerate the ovals.[5] A least-squares analysis of the data plotted in Figure 10 shows that a sine curve having a period of about 4400 days would fit the oscillatory component remarkably well. This period is strikingly close to the period of the sinusoidal component of the velocity of the equatorial plume studied by Reese and Beebe[1] as well as to Jupiter's period of revolution. Moreover, comparison of our Figure 10 with Figure 2 in the referred work of Reese and Beebe[1] reveals a perfect synchronism and parallelism in the motion of the southern and northern features under discussion. This phenomenon is unexplainable in terms of the classic seasonal effect proposed to account for the motion of the northern plume[1] and strongly suggests a

Table I. Periodicity in the behavior of some Jovian features and proposed modulating parameters.

Feature	Periodicity	Modulating Parameter	Author(s)
FA, BC, and DE mean velocity	12 yrs.	-	F. Jetzer[6]
Red Spot velocity	50 yrs.	Latitudinal fluctuations	A. P. Lenham[13]
Red Spot velocity	90 days	-	H. G. Solberg[14]
Equatorial plume velocity	11.86 yrs.	Jovicentric declination of the Sun	E. J. Reese[1] R. Beebe
Current's mean rotational period	11 yrs.	Sunspot number	L. Krivsky[15] Z. Pokorny
Jupiter's decametric rotation period	11.86 yrs	Jovicentric declination of the Earth	M. L. Kaiser[16] J. K. Alexander
Red Spot intensity	11 yrs.	Sunspot number	C. J. Banos[17]
Outbreaks of NTC "C"[3]	12 yrs.	-	E. J. Reese[9] B. A. Smith
SEB Revivals	1085 days	-	C. R. Chapman[18] E. J. Reese
Planet's reduced magnitude	11.86 yrs.	-	D. L. Harris[19]

modulating parameter which must be common for the two hemispheres. Starting from the observation that the lower limits of the velocity range are reached near the epochs of the perihelion passages, we suspect that the parameter which modulates the wind velocities in the atmosphere of Jupiter can be related to the variable position of the planet in its orbit. If this is true, even the general atmospheric activity should be modulated with the same synchronism. This point of view has been tested against the second set of periodic elements taken into account.

Experiment II: Recurrent Activity Outbreaks

Among the most interesting events which have occurred periodically in Jupiter's atmosphere during the last century are the revivals of the South Equatorial Belt. Several papers on the subject have been published following the fundamental work of Peek,[3] and finally Reese proposed for these revivals a "Uniformly Rotating Three-Source Hypothesis."[7] This hypothesis has been positively tested during the three-center revival which occurred in 1975,[8] supporting the choice of these events as recurrent activity outbreaks.

The production of rapidly moving spots near the south component of the North Temperate Belt, belonging to the well-known North Temperate Current "C",[3] which has the shortest rotation period ever recorded on Jupiter, is another event for which a twelve-year periodicity has been proposed[9] and also confirmed during the 1975 apparition.[8] Moreover, we propose here a correlation between these outbreaks and the nearly contemporaneous appearance of little red spots in the North Tropical Zone, as for example those recorded by Pioneer 10 in 1973,[10] following the 1971 NTC "C" revival.[5]

Following Rogers,[11] we considered the periodic shading of the Equatorial Zone as a further element of a recurrent nature.

A collection of dates of starting occurrences of (a) SEB Revivals (latitude from -20° to -10°), (b) EZ shadings (from -7° to +7°), (c) Little Red Spots in the NTrZ (about +20°), and (d) NTC "C" outbreaks (about +24°) is given in Table II. On the basis of this table the histogram of Figure 11 has been obtained, where each event is plotted versus the time before or after the nearest Jovian perihelion transit. From the histogram it is apparent that the atmospheric activity is substantially higher near and past the perihelion than at the aphelion of the orbit. It is worth noting that the negative skew of the distribution shown in Figure 11 is a real effect. It would have been even greater if not just the starting dates of the events had been plotted, but instead the interval of time occupied by the outbreaks of activity.

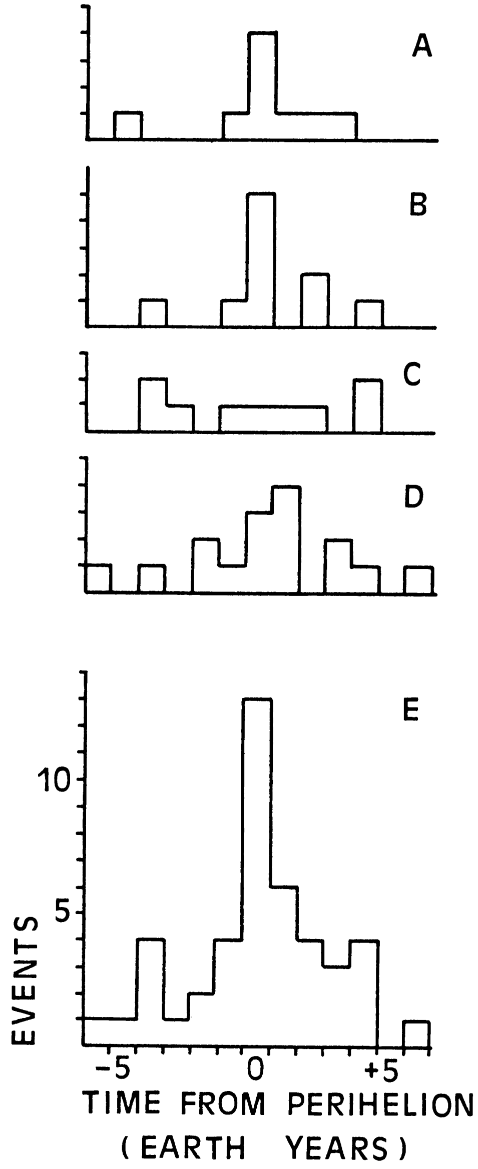

Figure 11. Distribution of certain events selected to define atmospheric activity over the Jovian year as a function of the distance from perihelion measured in terrestrial years. A: NTC "C" outbreaks; B: Little Red Spots in the North Tropical Zone; C: Equatorial Zone shadings; D: SEB Revivals; E: A + B + C + D.

Discussion

The analysis of the activity of Jupiter's atmosphere based on systematic visual observations carried out in the last hundred years has clearly revealed the marked tendency for recurrent events to occur with higher frequency (probability) around the perihelion of the orbit. Even the velocity of southern and northern long-lived currents has shown a definite dependency on the position of the planet along its orbit, the minimum occurring near perihelion.

Recent calculations of the distribution of incident solar radiation and its variability with latitude and season during a Jovian year have pointed out an equatorial maximum of solar heating near the perihelion.[2] Moreover, this heating is nearly symmetric with respect to the equator because of the small obliquity (inclination of equator to orbit) of the planet. Using the equations given in another paper,[2] we have calculated the amount of solar radiation incident at the top of the atmosphere at the latitudes of +7° (equatorial plume) and of -33° (STB ovals) as a function of the distance of the planet from its perihelion. Comparison of these values (Figure 12) with the harmonic component of the velocity of the plume and the ovals shows a similar behavior with a definite shift in the time coördinate. This time delay between the maximum energy input and the minimum velocity of the currents is of the same order of magnitude as the skew observed in the distribution of the atmospheric activity over the Jovian year (Figure 11). It can reflect an induction time necessary for the impinging energy to be transformed into mechanical energy and finally to manifest itself in the form of rising gases. This last phenomenon can in fact account for the deceleration of the currents (increase in radius of rotation) and the eruptions of dark material inside the zones (revivals, disturbances, shadings, etc.).

A detailed interpretation of the various aspects of the Jovian meteorology is beyond the scope of this work, but it appears reasonable to assume that during the periods of higher atmospheric activity an increase in dark material at the top of the clouds (zones) can synergetically increase the solar heat absorption. This mechanism can lead to substantial variation of energy absorbed along the orbit despite the small eccentricity (0.048). A delicate equilibrium between the heat coming from the planet's interior and the variation of solar radiation absorption due to latitude, season, and cloud reflectivity is probably the key to the Jovian meteorology, at least between the STB and the NTB.

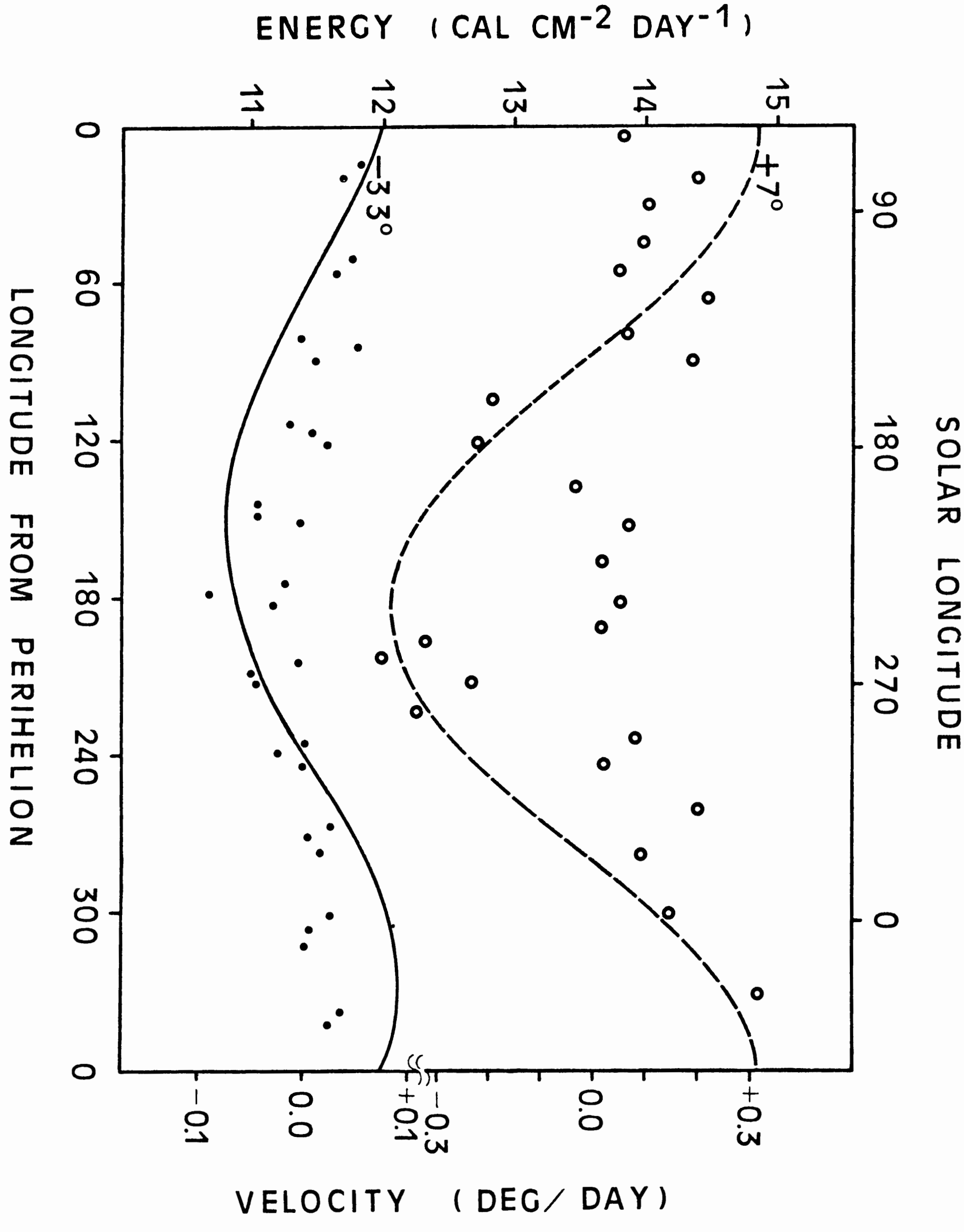

Figure 12. Velocity of the north equatorial plume (open circles) and of the South Temperate Zone ovals FA, BC, and DE (dark spots) with respect to the relevant reference System (either I or II) <u>versus</u> the longitude of the planet from the perihelion of its orbit. Also reported are the solar energy values reaching the top of Jupiter's atmosphere at latitudes of +7° (---) (plume) and of -33° (——) (ovals) during the Jovian year. A solar longitude of 0° corresponds to the beginning of the northern hemisphere spring. It is apparent that the modulation in the solar energy is mainly due to the eccentricity of the planet's orbit.

It is pertinent to note here that secular changes in the Earth's climate respond to periodic variations in the Earth's tilt and in eccentricity and precession of the orbit. Milankovitch[12] assumed in fact that glaciations correspond to periods during which the relevant latitude receives a minimum of summertime solar radiation. On the

Table II. Dates of occurrence (to the nearest year) of selected activity outbreaks.

SEB Revivals	EZ Shadings	Little Red Spots	NTC "C"	Perihelion
1882	1881	1881	1881	1881
1892	-	1892	1892	1892
1904	-	1904	-	1904
1920	1920	1920	-	1916
1929	1927	1930	1927 1930	1928
1938 1943	1936 1942	1940	1940 1943	1940
1950 1953 1955	1953	1951	-	1952
1958 1963 1965	1961 1968	1966	1965	1964
1972 1976	1972	1972 1976	1971 1976	1976

Earth the tilt of the axis and its variation have an effect on climate which compares well with the variation of orbital eccentricity. On Jupiter the tilt is of minor importance, and changes in climate probably are subject to orbital parameters only.

Acknowledgments

We thank Prof. G. Colombo and Prof. L. Rosino for their encouragement and stimulating discussions.

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AN A.L.P.O. REJOINER TO THE B.A.A.: WAS THERE A NTrZ DISTURBANCE IN 1975?

By: Paul K. Mackal, A.L.P.O. Jupiter Recorder

John Rogers, Esq., of the British Astronomical Association, suggests in a recent note about the 1975 apparition of Jupiter that there was no NTrZ (North Tropical

Zone) Disturbance in that year.[1] Activity in the region, just south of the NTB$_s$, is considered by him to be due entirely to shearing forces (J.A.L.P.O., 27, 178). The eight spots recorded by A.L.P.O. observers from October 4 through October 23, 1975, moved with an average rotation-period of $9^h52^m49^s$, according to Co-Recorder Budine[2] (J.A.L.P.O., 26, 230). Though the facts surrounding these spots are clear enough to all, interpretation may be open to discussion. In 1969, and subsequently before 1975, a NTrZ band (or belt) formed to the extreme north of the NEB$_n$. In the case of the 1975 outbreak, a set of circumstances did occur which simply can't be adequately explained by any notion of residual activity over a full 82° of longitude in System II at the outset, contracting to 62° II near the end. The circumstances were these: festoons crossed the entire zone from the NTB$_s$ to the NEB$_n$; i.e., features were not limited to the extreme southern edge of the NTB$_s$.

Indeed, it may appear hazardous to call the NTrZ outbreak a classical disturbance in the same sense in which the 1919 SEB Z event has come to be identified. Such NTrZ events as were recorded in 1975 probably took place prior to 1919, just as NEB events are now known to have done. There is a closer morphological similarity between events in the NEB and the NTrZ outbreak. It is in that sense only that the event can be legitimately denied.

To deny the existence of an event which fails to fall into an arbitrary (or a limited) classification scheme, is to fail to make distinctions between what can happen and what does (or may yet) happen. Often, what does occur is far more unpredictable than what we expect to take place. And indeed, what may yet occur is not always going to conform to what has already taken place. Finally, there is no reason why a pre-classical disturbance can not occur in the NTrZ. And this is reason enough to be confident that a disturbance did occur in 1975. In meteorology it is not uncommon to regard a hurricane or a batch of tornadoes as a disturbance. Notwithstanding the sizable difference between the scale of such events, ordinary usage dictates as much. No set of causes should so limit our concept of a disturbance in this part of Jupiter, by comparison to the southern hemisphere. If in fact shear was partly (or wholly) responsible, the A.L.P.O. should still regard the outbreak of 1975 as genuine: being active; agitated; or even, disturbed!

By comparison, the B.A.A. Jupiter observers recorded seven spots from January 8 through April 8 of 1932 in the same latitude, confined to the extreme southern edge of the NTB$_s$, with a mean rotation period of $9^h52^m46^s.1$, according to Director Phillips.[3] (B.A.A. Mems., 34, 23.) It should be noted that no NTrZ Disturbance took place in 1932, even though spots moved at similar speeds! And the B.A.A. rightfully did not report a thing.

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THE 1977-1978 APPARITION OF SATURN

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

Abstract

Visual and photographic observations of the planet Saturn and its satellites were executed in 1977-78 by twelve individuals using instruments ranging in aperture from 3" (7.6 cm.) to 14" (35.6 cm.). A total of 96 observations was compiled during the apparition, from which it is determined that atmospheric activity on Saturn remained about the same in 1977-78 as it was in 1976-77. Studies of the ring system revealed similar information with respect to morphology and activity. The brighter satellites of Saturn are discussed in conjunction with the passage of Iapetus (S VIII) through the shadow of the ring system of the planet. Tables and illustrations accompany the report to enhance the importance of the text and to clarify descriptive notes about Saturnian phenomena.

Introduction

The analytical report which follows pertains to visual and photographic observations of the planet Saturn and its satellites from 1977, October 16 through 1978, June 21. Southern regions of the planet's globe and ring system were chiefly visible, but the northern hemisphere was becoming more and more open to investigation during the apparition. The numerical value of B, which is the planetocentric latitude of the Earth referred to the ring plane, fluctuated within a range of -8°.4 to -13°.9 Opposition took place on 1978, February 16^{d}04^{h};*and the apparent visual magnitude of Saturn on that date was +0.3. The major axis of the ring system at opposition was 45".57, and the minor axis was then 9".16. Also, on 1978, February 16, the equatorial diameter of Saturn was 20".23, while the polar diameter was 18".11. The numerical value of B at the opposition date was -11°.6. [1,2]

The following twelve individuals undertook observing programs in coöperation with the A.L.P.O. Saturn Section throughout 1977-78:

Observer	Location	No. of Observations	Instrumentation
Benton, Julius L.	Clinton, SC	14	4" (10.2 cm.) RR 4.2" (10.7 cm.) RR 3" (7.6 cm.) RR 6" (15.2 cm.) RR
Fliss, David M.	Buffalo, NY	24	8" (20.3 cm.) S-C
Gombos, Gabor	Pecs, Hungary	11	5" (12.7 cm.) NEW
Haas, Walter H.	Las Cruces, NM	2	12.5" (31.8 cm.) NEW
Heath, Alan W.	Nottingham, England	10	12.0" (30.5 cm.) NEW
Iskum, Jozsef	Budapest, Hungary	1	4" (10.2 cm.) CAT
Parker, Donald C.	Coral Gables, FL	11	12.5" (31.8 cm.) NEW
Sabia, John D.	Scranton, PA	9	6" (15.2 cm.) NEW 9" (22.9 cm.) RR
Soder, James	Sidney, OH	4	10" (25.4 cm.) NEW
Szabo, Elemer	Tata, Hungary	8	3.1" (7.9 cm.) RR
Szoke, Balazs	Pecs, Hungary	1	5" (12.7 cm.) NEW
Westfall, John E.	San Francisco, CA	1	14" (35.6 cm.) S-C

Total Number of Observers: 12 } . . . 1977-78 Apparition
Total Number of Observations: 96 }

NEW: Newtonian Reflector, CAT: Catadioptric, S-C: Schmidt-Cassegrain, RR: Refractor

As shown above, there were 96 observations submitted by a group of 12 individuals during the 1977-78 apparition of Saturn, and the overall distribution of observations by month is presented in the form of an accompanying histogram in Figure 13.

Study of the histogram reveals that the greatest number of observations came in during the months of 1978, February through 1978, May (69.8% of the total received for the apparition). There was a sharp decline in the number of submitted observations before and after this period. Looking at the periods before and after opposition specifically, it is noticed that 31.25% of the data were received prior to 1978, February 16; and 68.75% came following that date. In comparison to the immediately preceding apparition, a similar set of percentages emerged before and after the time of opposition; observers are characteristically slower getting started during any given period, one might assume.[3] Also, Saturn is a morning object during the early months of an apparition, a situation not particularly conducive to useful work for those who must work at something else as a profession and enjoy astronomy when convenience permits. The 1977-78 apparition came to a close as the planet Saturn entered conjunction with the Sun on 1978, August 27^{d}15^{h}.

Rather good response to programs of the Saturn Section continued during the 1977-78 apparition, and tremendous gratitude is in order for those in this country and abroad who participated in the observational effort. Potential observers are encouraged to join with us in our efforts in the coming years, including those persons who

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*All dates and times in this Saturn Report are by Universal Time.

have been inactive for one reason or another. An important observing period is approaching when Saturn's rings will be edgewise to our line of sight, and a devoted team of observers is needed to carry out the numerous programs of the Saturn Section.[4]

The globe of Saturn

The discussion which follows is based upon numerous descriptive notes derived from observational reports and data submitted to the A.L.P.O. Saturn Section throughout the 1977-78 apparition. Observers' names have been largely omitted from the summary; but where the identity of an individual is meaningful to the text, such has been included. Specific information regarding background data for the 1977-78 report is available from the author upon request. Tables, graphs, and related illustrative material accompany the discussion in the pages to follow, and it is suggested that reference be made to these for added clarity and understanding. The drawing on the front cover of Vol. 27, Nos. 9-10 should also be mentioned as a reference item here.

Southern Portion of the Globe. Visible atmospheric phenomena on Saturn remained at about the same level throughout 1977-78 as was the case during the immediately preceding apparition, although some subtle changes were recorded by observers in various belts and zones throughout the southern hemisphere of the planet. Rather inconspicuous brightenings, faint mottlings, and festoons were noted periodically in the more conspicuous zones on the planet, while dark spots and related disturbances were occasionally suspected or confirmed with only moderate confidence in the belts. A summary discussion of the various zones and belts in the southern hemisphere of Saturn will follow in the next few paragraphs, with detailed considerations given under specific headings later in the present report.

Even though instrumentation varied in aperture from 3" (7.6 cm.) to 14" (35.6 cm.), and despite obvious differences of expertise and practical experience among individuals, contributors were in general agreement that the southern hemisphere of Saturn showed more detail and atmospheric activity during 1977-78 than in the observing season two years ago. It has already been iterated that the planet appeared much the same in 1977-78 as in 1976-77 in terms of overall atmospheric phenomena. The more subtle differences between 1976-77 and 1977-78 will emerge in the analysis below.

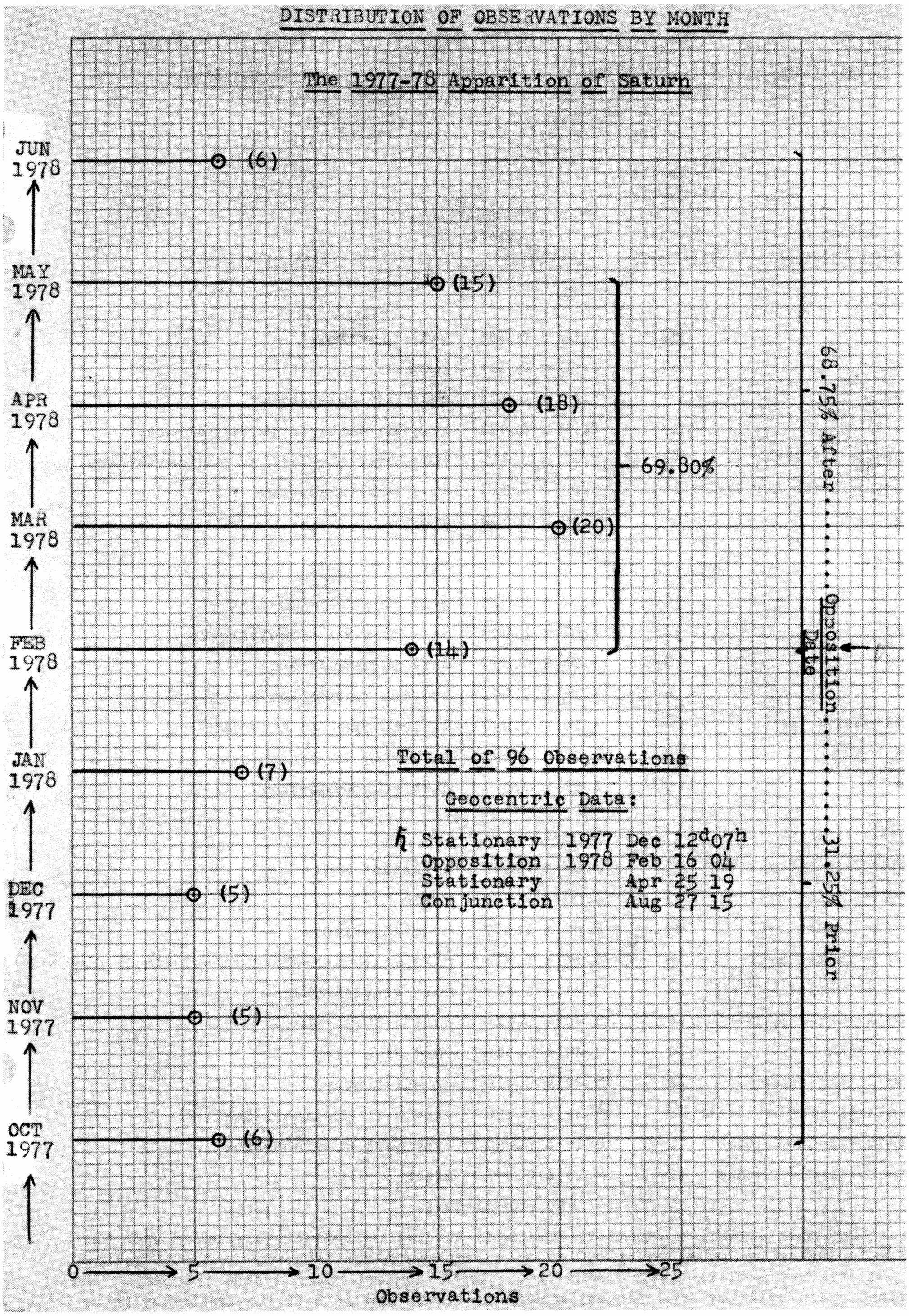
In a collective overview, the zones of Saturn's southern hemisphere were presumably brighter in 1977-78 than in 1976-77, with the exception of the South Temperate Zone (STeZ) (which remained unchanged) and the South Polar Region (SPR) (which was slightly darker). The mean increase in brightness amounted to about the same value for the Equatorial Zone (EZ), the South Tropical Zone (STrZ), and the South Equatorial Belt Zone (SEB Z); that is, a mean factor of 0.5 to 0.6 on the relative numerical intensity scale. The diminution in brightness of the South Polar Region (SPR) since 1976-77 amounted to a factor (mean value) of 0.4 units on the relative numerical intensity scale.

The southern hemisphere belts on Saturn showed differences of perhaps a little greater significance since 1976-77. The South Polar Cap (SPC), South Temperate Belt (STeB), and South Polar Belt (SPB) were all darker in 1977-78 than in 1976-77 by a mean value of 0.9 to 0.6 on the relative numerical intensity scale. Of the three just mentioned, the SPC showed the greatest diminution in brightness (0.9), while the STeB displayed the smallest (0.6). The Equatorial Belt (EB), South Equatorial Belt--Southern Component (SEB_s), and South Equatorial Belt--Northern Component (SEB_n) were all brighter in 1977-78 than in the immediately preceding apparition; the increase in brightness for the belts and belt components amounted to the same mean value of 0.7 units.

An extensive investigation of Saturnian belt and zone visual intensity data from 1966-67 through the end of the up-coming 1979-80 apparition will be presented in published form in this Journal at a later date. It is hoped than an obvious pattern to the apparent transient and long-term variations of zone and belt intensities can be deduced from the data aside from random and systematic errors. We need to evaluate the quality and quantity of the data in the course of such an analysis. Coöperation with our British Astronomical Association colleagues to establish correlations with a similar study in Great Britain is sought, and a comparative report should optimistically emerge in time.

The notes which have been outlined above are drawn from an in-depth comparative analysis of visual relative numerical intensity data for selected Saturnian global

(text continued on page 251)



Geocentric Data:

♄ Stationary	1977	Dec	12^d07^h
Opposition	1978	Feb	16 04
Stationary		Apr	25 19
Conjunction		Aug	27 15

Figure 13. Histogram to show time distribution of A.L.P.O. observations of Saturn during the 1977-78 apparition. Prepared by Saturn Recorder Julius Benton. See also text.

Table 1

Visual Numerical Relative Intensity Estimates of Major Global and Ring Features
For the Planet Saturn during the 1977-78 Apparition
With Accompanying Absolute Color Data
(see Figure 14 for nomenclature)

Global or Ring Feature	Relative Intensity: No. of Visual Estimates	Mean Intensity with Standard Deviation	Absolute Color
ZONES:			
EZ	51	7.63 ± 0.596	yellowish-white
STrZ	26	6.40 ± 0.751	brownish-grey
STeZ	7	5.83 ± 0.302	dull yellowish-grey
SEB Z	18	5.79 ± 0.403	greyish-white to yellowish-grey
Globe N. of rings	47	5.21 ± 0.353	dull greyish-white to yellowish-grey
Globe between SEB & SPR	22	5.03 ± 0.517	dull yellowish-grey
SPR	47	4.58 ± 0.798	grey
BELTS:			
EB	10	4.94 ± 0.529	grey to yellowish-grey
SEB_s	13	4.07 ± 1.208	dark grey to brownish-grey
STeB	5	3.96 ± 0.553	dark yellowish-grey
SPC	6	3.75 ± 0.901	greyish to greyish-brown
SEB (whole)	34	3.56 ± 0.313	diffuse grey to brownish-grey
SEB_n	18	3.42 ± 1.290	dark grey to bluish-grey
SPB	8	2.69 ± 0.827	dark yellowish-grey
RINGS:			
Terby White Spot (TWS)	2	9.00 ± 0.000	brilliant white
Ring B (outer 1/3)	51	8.00*± 0.000	white
Ring B (inner 2/3)	30	6.64 ± 1.470	greyish-white
Ring A (inner 1/2)	6	6.33 ± 0.236	pale yellowish-white to yellowish-grey
Ring A (whole)	24	5.93 ± 0.817	dull greyish-white
Ring A (outer 1/2)	6	5.80 ± 0.224	dull greyish-white
Crape Band	33	2.20 ± 0.526	very dark grey
Ring C (off globe)	29	1.70 ± 0.410	brownish-grey
Cassini's or B10(ansae)	27	0.52 ± 0.186	very dark greyish-black
Shadow Rings on Globe	2	0.45 ± 0.050	very dark greyish-black
Shadow Globe on Rings	49	0.10 ± 0.346	black

*By definition.

Visual numerical relative intensity estimates (visual photometry) are based upon the A.L.P.O. Intensity Scale, where 0.0 denotes complete black (shadows) and 10.0 refers to the greatest brilliant white condition (very brightest Solar System objects). The adopted scale utilizes (for Saturn) a reference standard of 8.00 for the outer third of Ring B, which appears to be fairly stable with time and most ring inclinations. Details on the method of attempting visual photometric work on Saturn can be studied in the Saturn Handbook, available at cost from the author.[4]

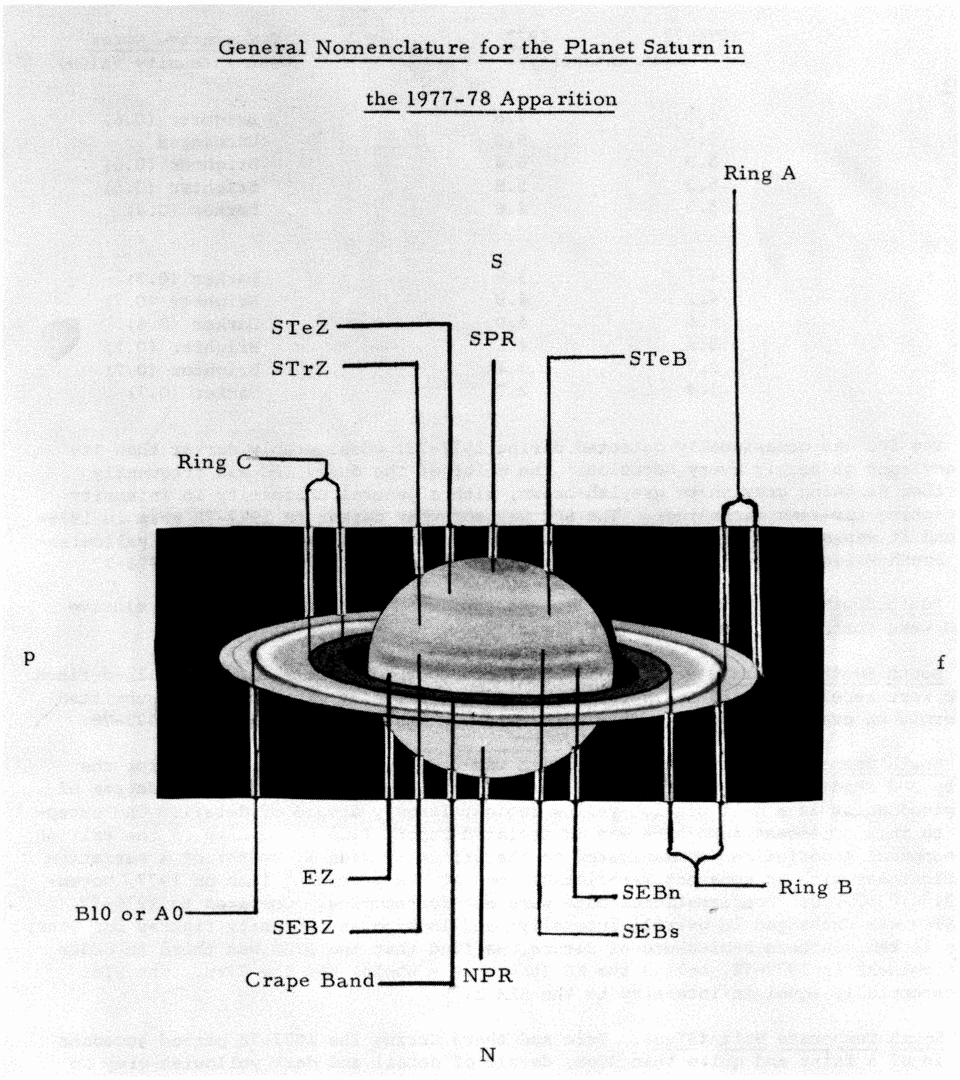


Figure 14. Diagram to show nomenclature used in accompanying Saturn Report by Julius Benton. Drawn by Dr. Benton for an axial tilt of -11°, the approximate average value during the 1977-78 apparition.

(text continued from page 248)

features; this treatment is extended in the following table to include 1977-78 data, a continuous comparative sequence which began in 1966-67 as noted earlier.[3,5]

A representative sketch of Saturn with its accompanying ring system for a numerical value of B equal to approximately -11° is included as Figure 14 with the apparition report and gives the proper representation of nomenclature. Reference to Figure 14 should provide a better understanding of the features discussed.

South Polar Region (SPR). The SPR showed a diminution in overall brightness during 1977-78, a shift toward a darker tone that was characteristic of the region in 1975-76. The SPR was described as a very dusky region, displaying a greyish coloration. There was a gradual but very definite gradation toward a darker intensity as one approached the south pole of Saturn, and a definite South Polar Cap (SPC) was apparent in the region near the south limb.

[*Note by Editor.* With the current apparition of Saturn in its final weeks when this issue reaches our readers, observers should report their 1977-78 work to Julius Benton at the address on the back inside cover. Our next issue will include an overall discussion of the important 1979-80 edgewise apparition of Saturn and predictions of some rare mutual phenomena of the satellites in the autumn of 1979.]

	1976-77	1977-78	Comparative Notes
	(mean intensity)		(mean intensity value)
Zones:			
EZ	7.0	7.6	Brighter (0.6)
STeZ	5.8	5.8	Unchanged
STrZ	5.9	6.4	Brighter (0.5)
SEB Z	5.3	5.8	Brighter (0.5)
SPR	5.0	4.6	Darker (0.4)
Belts:			
SPC	4.7	3.8	Darker (0.9)
EB	4.2	4.9	Brighter (0.7)
STeB	4.6	4.0	Darker (0.6)
SEB$_s$	3.4	4.1	Brighter (0.7)
SEB$_n$	2.7	3.4	Brighter (0.7)
SPB	3.4	2.7	Darker (0.7)

The SPC was occasionally detected during 1977-78, considerably darker than its SPR environs on nearly every occasion. The color of the dusky SPC was frequently described as being greyish to greyish-brown, with a general uniformity in intensity (correcting for limb darkening). The SPC was somewhat darker in 1977-78 than in 1976-77, and it was bounded occasionally to the north by a diffuse, linear, dark yellowish-grey South Polar Belt (SPB). The SPB was a bit darker in 1977-78 than in 1976-77.

South South Temperate Zone (SSTeZ). No confirmed reports of the often elusive SSTeZ were forthcoming in the 1977-78 apparition.

South South Temperate Belt (SSTeB). Scattered reports of a faint and ill-defined SSTeB were received during the apparition, but no intensity estimates were submitted to permit an evaluation of the overall relative prominence of the belt in 1977-78.

South Temperate Zone (STeZ). The STeZ was usually indistinguishable from the nearby SPR shading; but on a few occasions the zone emerged with a limited degree of conspicuousness as a dull greyish-yellow region, largely devoid of detail. One exception to this quiescent condition was an isolated report from David Gray of the British Astronomical Association (communicated to the writer by Alan W. Heath) of a variation in brightness with an apparent irradiating spot at the preceding limb on 1977, November $21^d07^h30^m.0$, UT; confirmational data were not forthcoming. Compared to 1976-77, the STeZ was unchanged in overall intensity; and looking at intensity figures for other zones in the southern hemisphere of Saturn, we find that the STeZ was third in order of brightness in 1977-78, behind the EZ (taken as a whole) and the STrZ. The STeZ was essentially equal in intensity to the SEB Z.

South Temperate Belt (STeB). Here and there during the 1977-78 period accounts came in of a faint and quite thin STeB, devoid of detail and dark yellowish-grey in color. Third in intensity behind the EB and SEB$_s$, the STeB was more uniform in intensity and darker in 1977-78 than in 1976-77.

South Tropical Zone (STrZ). Second only to the EZ (limiting ourselves here to southern global features), the STrZ was seen to advantage in the 1977-78 apparition in comparison to its apparent nature in 1976-77. The overall hue of the STrZ was brownish-yellow, and it appeared brighter in 1977-78 than in the immediately preceding apparition. Some observers recorded columns and diffuse dark patches in the STrZ intermittently in 1977-78, but most such features were of low contrast and uncertain. More often than not the STrZ was featureless, sometimes indistinguishable even from the SPR; but it was much more easily detected in 1977-78 than was the STeZ.

South Equatorial Belt (SEB). The SEB was usually diffuse, very wide in comparison to the other belts, and was most frequently undifferentiated into any components. Looking at the comparative intensity data for 1976-77 and 1977-78, the overall intensity of the SEB remained essentially unchanged (a difference in mean intensity of 0.1 on the relative numerical intensity scale is not considered significant). The color of the single SEB was described as being a diffuse grey to brownish-grey.

Observers reported that the SEB was intermittently dual in the 1977-78 period, subdivided into the SEB$_n$ and SEB$_s$ (and the SEB Z in between). As in 1976-77, the

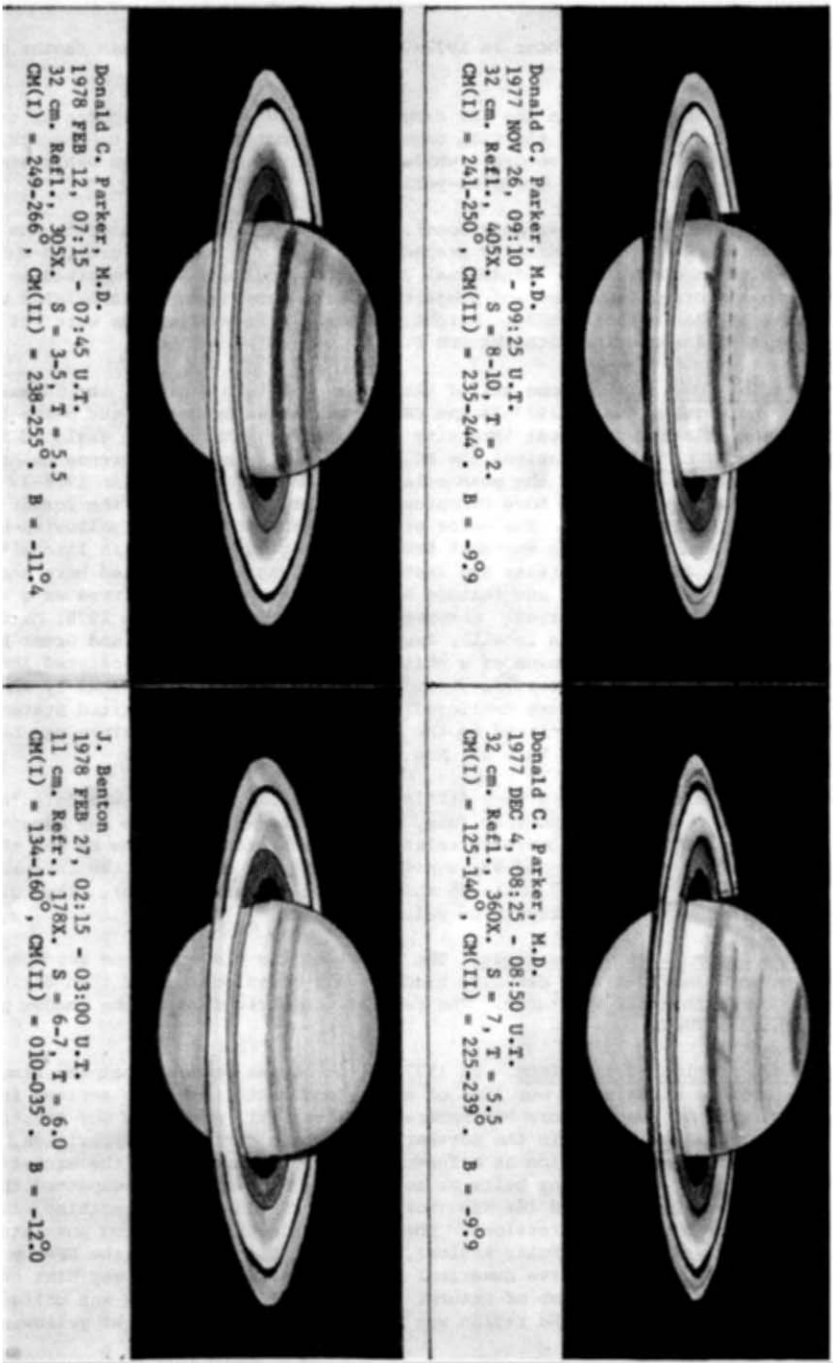


Figure 15. Representative drawings of Saturn during the 1977-78 apparition. Selected by Julius Benton and prepared for publication in the format above by John E. Westfall. The drawings are simply inverted views with south at the right. The seeing (S) is on a scale of 0 to 10, with 10 best; and the transparency (T) is the limiting naked-eye stellar magnitude. The values of CM(I) and CM(II) are according to Dr. Westfall's tables in this journal, Vol. 27, Nos. 1-2, pp. 22 and 23.

SEB_n was always darker than the SEB_s, in 1977-78 by a mean value of 0.7, a little more significant perhaps than was the case in the previous observing season. Both components were, however, brighter in 1977-78 than in 1976-77 by a mean factor of 0.7 units on the intensity scale.

With regard to activity in the SEB components, only scattered reports of transient dark spots or humps along the SEB_n came in. The color assigned to the SEB_s was usually dark greyish to brownish-grey, while the SEB_n was described as exhibiting a dark greyish to bluish-grey or brownish-yellow hue.

The SEB Z (South Equatorial Belt Zone), appearing a little brighter in the 1977-78 apparition than in the immediately preceding period, was commonly greyish-white to yellowish-white in coloration. Occasional dark, fuzzy columns were reported in the SEB Z; various short-lived humps and projections were more commonly associated with the SEB_n rather than with the SEB_s. Bright spots and related features were not reported in 1977-78 in association with the SEB Z.

Equatorial Zone (EZ). Among all of the zones on Saturn's globe, the EZ was clearly the brightest; and in 1977-78 the EZ was almost as bright as the outer third of Ring B, the relative numerical intensity standard for Saturn at an assigned value of 8.0. In fact, on a few occasions the EZ surpassed the latter reference point in overall brightness. Comparing the mean relative intensity of the EZ in 1976-77 to 1977-78, the zone was a little more conspicuous and brighter than in the former period (by a mean factor of 0.6). The color of the EZ was consistently yellowish-white in 1977-78, and the entire zone was most frequently regular, uniform in intensity, and featureless. Transient streaks and festoons were vaguely suspected here and there throughout the apparition, but one feature is all that could be confirmed as a long-lived phenomenon during the period. Observations were collected from 1978, March 5 through 19 (eleven observations in all), from Spain, Naples (Italy), and Great Britain by the Italian Astro-Amateur Union of a white spot in the EZ which persisted long enough to yield an estimated rotation period of $10^h18^m \pm 1^m\!\!.5$ (as determined by the Saturn Section of the Italian group just mentioned). Observations in the United States of a confirming nature were not submitted to the Saturn Section. This feature was briefly discussed in *Journal A.L.P.O.*, Vol. 27, Nos. 5-6, pp. 124-126, 1978.

On a few dates in 1977-78 a very difficult Equatorial Band (EB) was detected, interrupted along its length and very fuzzy at the edges when seen to any advantage. From the standpoint of conspicuousness relative to other features, the EB was the least dusky belt on the planet and was somewhat lighter in mean relative intensity in 1977-78 than in 1976-77 (by 0.7 units on the relative intensity scale). The color assigned to the EB was light greyish to yellowish-grey.

Shadow of the Globe on the Rings. The shadow of the planet on the accompanying ring system was usually a very definite black on all occasions, other than during poor seeing or with small apertures. The regular geometric form of the shadow persisted throughout 1977-78.

Northern Portion of the Globe. In 1977-78, it became obvious that the ring plane will soon be edgewise to our line of sight; and until that time arrives in 1979-80, more and more of the northern hemisphere of Saturn will emerge to our scrutiny. Not many observers saw detail in the northern hemisphere during the apparition, most individuals describing the region as a featureless environment (with the exception of the NPR) with only a hint of any belts or zones. One or two people suspected the NTeZ (North Temperate Zone) and the NEB (North Equatorial Belt), but nothing was submitted to confirm these impressions. The only region which appeared consistently observable was the NPR (North Polar Region), which was brighter than the SPR by a mean value of 0.6 on the relative numerical intensity scale, without any hint of a cap at the extreme northern limb of Saturn. The intensity of the NPR was uniform throughout, and the color of the region was dull greyish-white to light yellowish-grey.

Latitude Data. For the first time in several years, visual latitude estimates and latitudes determined by other techniques were virtually lacking in the observational data submitted to the Saturn Section. It is the fervent hope of this writer that this situation will improve in subsequent apparitions; such quantitative data are needed, and observers are encouraged to undertake latitude programs systematically.

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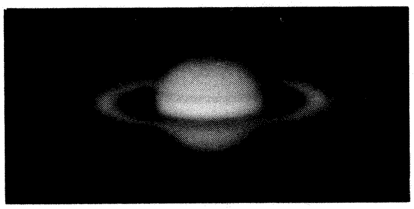

Figure 16. Photograph of Saturn by D.C. Parker, taken with a 32 cm. Newtonian at e.f/69 on April 8, 1978. 7 sec. exposure on SO-115 film. S = 7-10, T = 5.0. South at top.

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(to be concluded in next issue)

BOOK REVIEWS

God and the Astronomers, by Robert Jastrow. W. W. Norton and Company, Inc., 500 Fifth Avenue, New York, N.Y. 10036. 1978. 136 pages. Illustrated. Price $7.95.

Reviewed by Kenneth J. Delano

Robert Jastrow, an internationally known astronomer, who founded and directs NASA's Goddard Institute for Space Studies, states in the opening paragraph of God and the Astronomers that he is an agnostic in religious matters and is "fascinated by some strange developments going on in astronomy--partly because of their religious implications and partly because of the peculiar reactions of my colleagues." Jastrow presents a very clear and concise account of three lines of evidence (the recession of the galaxies, the laws of thermodynamics, and the life story of the stars) which indicate that the universe had a beginning. His purpose in writing this book was to show "how the astronomical evidence leads to a biblical view of the origin of the world;" and he relates how cosmologists have often shown feeling and emotion rather than reason in their reactions.

Most of the book's 136 pages are an exposition of the theory of the expanding universe, easily understood by persons having little knowledge of astronomy. Even those who are fully acquainted with modern cosmology will enjoy Jastrow's biographical and anecdotic account of the development of 20th-century cosmological thought.

The book's illustrations are, for the most part, informal photographs of prominent 20th-century cosmologists, many of them previously unpublished. Among the 47 illustrations are seven excellent full-page color plates of deep-sky objects, which add much to the cost as well as to the attractiveness of the book.

This interesting little book would be a welcome addition to any reflective person's library, for it challenges him to consider the full implications of modern cosmology.

* * * * * * * * * * * * * * *

MARS, by Percival Lowell. Originally published in 1895 by Houghton Mifflin Co. Special limited edition of 1,000 copies, History of Astronomy Reprint, 1978. 228 pages. Valdis Associates, 25 N. San Francisco, Flagstaff, AZ 86001. Price $16.50 plus 75 cents postage.

Reviewed by C. F. Capen, A.L.P.O. Recorder

Near the end of the last century a book was published bearing a singular title which was responsible for the shaping of Man's destiny and for directing his intellect toward the conquest of space. The title and subject was Mars, published in 1895. This was Percival Lowell's first book on the subject of Martians and their canals.

The philosophy and observational findings reported in Mars were augmented, at the time, by popular, public lectures and magazine articles as well as by newpaper reviews. The initial public reaction to Lowell's Martian ideas ranged from uncritical wonder to curiosity to skeptical but tolerant amusement. Almost everyone, lay person and scientist, was clearly interested and intrigued by the prospect of intelligent life elsewhere.

It is in this book that P. Lowell employed the terms "planetology" (scientific study of the Solar System family) and "areography" (the geography of Mars), which are in use today. He clearly stated that the dark maria were not vast areas of water and that the light ocher regions were not continents; instead, the visible surface of Mars was all desert, except for the salient bright polar caps, which were evidently frosts. In Mars Lowell presented a detailed description of each Martian region in order of increasing west longitude as observed with the 24-inch Alvan Clark refractor at Flagstaff, Arizona Territory, by A. E. Douglass, Prof. W. H. Pickering, and himself. A Martian atmosphere was empirically confirmed beyond doubt from the many different types of observed changes upon the disk, i.e.: dust clouds, white icy clouds, night chill fogs, and limb brightenings. Few if any changes would be noted on a planet without an atmosphere. Martian clouds were extremely well observed and recognized for what they were by these early observers at the Flagstaff Observatory. The section of the book reporting clouds is especially important reading today in view of the recent data obtained from the Mariner and Viking spacecrafts. The observations by A. E. Douglass of the high altitude terminator clouds and cloud capping of highlands (orogenic) is most interesting, indeed.

Mars has been reprinted in a limited edition of only 1,000 copies in a style befitting the original, complete and unabridged. Until now, acquiring the original edition has been both very difficult and very expensive. This handsome reprint with gold imprint upon its red cover preserves Lowell's eloquent classical style of communication, his color frontispiece drawing of Sinus Titanum made in November, 1894, and the controversial 1895 Mercator map of Mars with its Lowellian canals and oases for our present generation astronomers. Now you can read for yourself what Lowell said and judge for yourself the merits of his extensive and critical observational results and feel the electricity his publication Mars sent through the scientific and popular circles.

The book is well laid-out in six chapters: I General Characteristics, II Atmosphere, III Water, IV Canals, V Oases, and VI Conclusion, an appendix of five subjects and tables, an index of names on the map of Mars, and a General Index.

As a reviewer of Lowell's book, I am humbled and somewhat presumptuous since Percival Lowell lies at rest in a blue dome tomb sanctuary just outside the door of his favorite 24-inch Clark refractor that I use for observing the planets. Once you read his Mars you will understand the Red Planet as does only an observational astronomer. I think you will be surprised at Percival Lowell's foresight and his applications to modern planetology. The original publication of Mars became a classic collector's item. This new reprint is becoming a research tool and is already a collector's classic library addition. Other classic scientific works like this one should be reprinted for the use of the modern scientist and for the enjoyment of the amateur astronomer.

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Physical Processes in the Interstellar Medium, by Lyman Spitzer, Jr. John Wiley and Sons, 605 3rd Avenue, New York, N.Y. 10016. 1978. 318 pages. Price $15.95.

Reviewed by Dale P. Cruikshank

Books on astrophysical topics by Lyman Spitzer commonly become classics in their field, and his new book on the interstellar medium is already well along the way to such status. Although not a book for beginners, Physical Processes will take the reader having an understanding of calculus and basic atomic physics on an orderly and thorough path through the physics of the interstellar medium. This is basically a complete treatise on the gas and dust which inhabit the regions among and around the stars. The mechanisms for light radiation from the gas are considered in detail, as are the optical and physical properties of the dust grains. Motions of the grains and the gas caused by shocks propagated outward from stars are considered. Spitzer devotes considerable space to explosive motions in the interstellar medium, considering H II regions (local concentrations of ionized hydrogen) and supernova shells. The structure and stability of small dense concentrations of interstellar matter, presumed to constitute the precursors of new stars, are also treated in detail.

Readers with an understanding of intermediate mathematics, thermodynamics, and atomic physics will find this book to be an outstanding introduction to the nature of the gas and dust in space. It is rapidly becoming a standard text for graduate courses in the physics of the interstellar medium.

* * * * * * * * * * * * * * *

Man and the Stars, by Hansbury Brown. Oxford University Press, 200 Madison Avenue, New York, N.Y. 10016. 1978. 185 pages. 54 illustrations. Price $14.95.

Reviewed by Edwin F. Bailey

In explaining the relationship of astronomy to people, the author has produced a very popular story. Astronomy does touch everyone, even though many of us fail to appreciate that impact. In our hurried everyday life, pictures inform in sharp, rapid glimpses--like T.V. A third of this book is selected illustrations, which shortens the size of letterpress needed. A glossary, bibliography, and name and subject index make this book a fine introduction to elementary astronomy.

At the beginning of the year we scurry around looking for a new calendar--and give very little thought as to how or why the calendar exists. Many calendars omit the phases of the Moon--one of the main factors for setting up the seven-day week. An interesting first chapter in popular astronomy covers the history, lore, and development of this most common social contact.

Personally I have had a lifetime interest in timekeepers and read the second chapter happily. Here we meet old timepieces--nocturnals, shadowclocks and modern Riefler, and quartz and finally atomic counters. The long history of the Harrison development of the chronometer is a friendly story. Remember that each time you look at a clock you are asking: where is the Sun?

Chapter 3 brings back geography and navigation memories along with the four dimensions of space travel and ties together history, direction, and modern frontiers. It is a fascinating story of unfolding applied mathematical astronomy for the common man.

There is a long chapter about gravity, light, and relativity for the citizen. The history has biographies woven into a descriptive evolution of scientific astronomical development.

The final chapter covers the whole universe, being an all-inclusive look at cosmology. There are some names omitted and a few subjects skipped, but one has to keep inside the publisher's format. This detailed summing up appears almost to close the scientific history of our finite universe.

I like the style and suggest that you will also appreciate this beautiful book.

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The Runaway Universe, by Paul Davies. Harper & Row, Inc., 10 E. 53rd St., New York, N.Y. 10022. 1978. Hard Cover, Price $10.00.

Reviewed by Paul K. Mackal

This book is the only popular account now available of the creation of our universe in a collapsed superhole of primeval matter. It brings together several relevant fields of discourse, such as: (1) Einstein's unified field theory in light of new developments in quantum physics, (2) Hoyle's steady state theory modified to account for the Big Bang thesis, and (3) the cosmological assumption that in order for our own universe to be created, another older universe had to die!

Davies suggests in chapter 1 that the expanding universe is merely a region in a vaster physical continuum, including space-time, or that the horizon of the visible world may not be large enough to encompass the real universe at all. The theoretical limit to what we may see is thus limited to the speed of light, or any object in space whose red shift is such as to make it invisible. One of the chief reasons supporting the Big Bang thesis is a need to explain the source and origin of the heavy elements, which we now know cannot be formed in stellar interiors. Each era of chemical evolution in the primeval fireball is roughly comparable in activity, is governed by one or two simple physical laws, obeys the second law of thermodynamics, and is necessary for each succeeding stage of development.

Everything must be concentrated at the start in a singularity, or point so very small that even a large atom could not be situated there. This condition of collapse exists for only 10^{-43} seconds. This is the mysterious quantum era, in which laws of physics are somewhat modified or superseded by other laws of physics. This is followed by a space storm era of 10^{-22} seconds. Next come the hadron era of 1 microsecond and the lepton era of 1 second. Finally, during the plasma era helium is produced from hydrogen in a proportion of 7/93 for 2 to 4 minutes. Ostensibly a gigantic star is formed which lasts about 100,000 years, and cools down from 10^{6}°C to 10^{3}°C, once it blows apart. Heavier elements are formed as a result.

Interesting facts emerge throughout the text. During the hadron era matter and anti-matter were equally abundant. The 3°K background infrared radiation substantiates the hypothesis of a Big Bang. Ostensibly a large star would break down, something like a regular star! We know iron can be formed in a large supergiant, but no heavier elements can be formed since at 8×10^{9} °C the iron nuclei are turned back into helium. Hence, the pressure of a supergiant is insufficient for the creation of heavy elements, which require an alternative explanation for their creation. A collapsing galaxy, a rather rare event indeed, might be likened to a superhole or black hole star. A collapsing universe may be likened to a group of superholes plowing into each other at superfast speeds. Paul Davies concludes his thought-provoking scenario by suggesting the feasibility of the breakdown of the law of entropy (or 2nd law of thermodynamics) whenever the conversion of matter into energy equals or exceeds 37%.

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Sustaining Members and Sponsors. The persons listed below support the work of the A.L.P.O. by voluntarily paying higher dues, $30 per volume for Sponsors and $15 per volume for Sustaining Members. The generous assistance of these colleagues is gratefully acknowledged; it has been, and is, most valuable. If there are errors in these lists, the fault is wholly the Editor's; he expresses his regrets and would appreciate being informed of any needed corrections.

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New Addresses for Staff Members. The leader of the Minor Planets Section now receives his mail at: Richard G. Hodgson, c/o Virgin Islands National Park, P.O. Box 110, Cruz Bay, U.S. Virgin Islands 00830. Reverend Hodgson is on sabbatical leave for a year from his duties at Dordt College in Sioux Center, Iowa. We wish him pleasure in his tropical skies!

Our Saturn and Venus Recorder has had a recent change of employment. He should be addressed as: Julius L. Benton, Jr., P.O. Box 3933, Savannah, GA 31404. All current observations of Saturn and Venus should be mailed to this address.

Assistant Jupiter Recorder Ron Doel finds his personal affairs in a state of flux but requests that at present his mail be addressed to: Ron Doel, 1121 Church St., Evanston, IL 60201.

Notes from a Jupiter Recorder. Mr. Paul Mackal asks (April 7, 1979) that we tell our Jupiter observers that he is temporarily out of the disc forms, which are very convenient for drawing the Giant Planet. It is hoped that a new set can be printed soon. Co-Recorder Mackal further reports that the price of the 1976 Edition of the Jupiter Handbook is now four dollars per copy.

Invitation to Meteor Observers. Mr. Harold R. Povenmire, the Planetarium, 1040 Museum Blvd., Daytona Beach, Florida 32014 cordially invites A.L.P.O. members to participate in an extensive planned study of the Upsilon Pegasid meteor shower. Observations are to commence on July 18, 1979, continuing until bright moonlight interferes, then resuming and lasting until August 26. The Upsilon Pegasids are a recently recognized shower at least partially coinciding in its time of activity with the famous Perseids. Meteor watchers and others will enjoy Hal Povemire's article "The Upsilon Pegasid Meteor Shower Pre-History" in Astronomy West '78 (the Proceedings of last year's WAA-ALPO Convention), pp. 68-85.

Correction in Accreditation of Published Jupiter Photographs. Both Mr. John Marelli and Mr. Paul Mackal have informed us that the photographs of Jupiter published as Figures 27 and 28 in Journal A.L.P.O., Vol. 26, Nos. 9-10, pg. 189, May, 1977, and there credited to Mr. Stephen O'Meara, were in reality taken by Mr. J. Gomez of Barcelona, Spain. We are confused as to how this error occurred but are anxious to correct it.

The 1979 A.L.P.O. Convention: Astro-Northwest '79. The Astronomical League, the Western Amateur Astronomers, and the Association of Lunar and Planetary Observers will hold a joint National Convention on August 16-19, 1979 at the University of Portland in Portland, Oregon. The host is the Portland Astronomical Society. The Convention Chairman is Mr. Clifford L. Caplan, 2535 South West Edgemoor Avenue, Beaverton, Oregon 97005. The registration fee is $26.00 per registrant prior to August 1, 1979, this amount including all luncheons, the main banquet, and a discount for pre-registration. Lodging will be available from 4 P.M. on August 15 to noon on August 19, which is a Sunday. The price per day per person is $14.00 for single occupancy and $9.00 for double occupancy. The meeting is expected to emphasize such diverse subjects as a review of the total solar eclipse on February 26, 1979, art and astronomy, and new developments in the study of star formation. Astronomical tours planned for this meeting include the new Portland Public Astronomy Center, the Oregon Museum of Science and Industry, and the Goldendale Observatory at Goldendale, Washington. There will also be tours for non-astronomers. There will be a Star Party at Trillium Meadows, the customary Banquet, the presentation of the G. Bruce Blair Award, a photo contest, and a Wine and Cheese Reception. Invited speakers include Ralph Turner, a designer who executed NASA's model of Phobos, Henk Pander, an artist who did the cover for the January, 1979 Sky and Telescope, Daniel Lester, research astronomer at the Lick Observatory, and Judge George Joseph, Egyptologist and amateur astronomer.

Persons attending Astro-Northwest '79 should make their checks payable to the Portland Astronomical Society-Convention and should mail them to Robert E. Amos, Treasurer, 7831 Monument Drive, Grant's Pass, Oregon 97526.

The usual major contributions of A.L.P.O. members to meetings of this kind have been display items, primarily drawings and photographs, and papers for the program. The A.L.P.O. Exhibit is again being managed by Dr. John E. Westfall, Dept. of Geography, San Francisco State University, 1600 Holloway Ave., San Francisco, CA 94132. Members, and especially Section Recorders, are warmly invited to contribute display material of interest to Dr. Westfall; it will be returned. Correspondence about our exhibit should be with him. Correspondence about A.L.P.O. papers should be with Walter H. Haas, Box 3AZ, University Park, New Meixco 88003. A Proceedings to be published after the meeting will include abstracts of papers given. Typewritten abstracts on standard 8½ by 11 white paper and print ready should be mailed to Larry Mahon, 1990 S. E. Mulberry, Portland, OR 97214. Please hurry if your paper is to be included in the program. Abstracts may include tables, drafts, and equations and be up to four pages long (type one side only) but no photographs.

Other information may be obtained from Mr. Caplan at the address above.

New Assistant Mars Recorder. Mr. Robert Rhoads is giving up the post of Assistant Mars Recorder. We thank him for his help and his considerable assistance over the years. In truth, the existence of the A.L.P.O. has been possible only because of the devotion and enthusiasm of its volunteer staff members.

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The new Assistant Mars Recorder is Dr. Donald C. Parker, 12911 Lerida St., Coral Gables, Florida 33156. He is a very active observer whose name has often appeared in these pages; attentive readers will note who made most of the drawings in the Saturn Report in this issue and who executed the front cover drawing in our preceding issue (Vol. 27, Nos. 9-10). Dr. Parker is also a keen student of Jupiter and has made trips to Flagstaff, Arizona in order to observe Mars with Mars Recorder C.F. Capen. We warmly welcome our new staff member.

<u>A.L.P.O. Lunar Eclipse Handbook.</u> John Westfall has mentioned this 16-page guide, which he has authored, on page 225 of this issue. The amateur wishing to make useful and rewarding studies of lunar eclipses can scarcely find better guidance. The Handbook can be purchased for one dollar from Dr. Westfall at his address on the back inside cover. Unlike solar eclipses which few amateurs can pursue to far parts of the Earth, lunar eclipses can be watched by the stay-at-home at the rate of perhaps one good eclipse every two or three years(barring bad weather). Programs in photometry, photography, umbral contact timings, and searches for lunar changes are described, along with the proper instrumentation for each kind of program. Over two pages of references in the literature would alone make the Handbook most valuable to the student of lunar eclipses.

<u>Features in Our Next Issue</u>. Vol. 28, Nos. 1-2 of this journal is schedued to include a survey by Julius Benton of the imminent 1979-80 edgewise apparition of Saturn, when the Earth and the Sun will pass through the plane of the rings and will hence offer unusual opportunities to the observer. John Westfall will predict some mutual phenomena of the satellites of Saturn late this year. Very few past observations of such events exist. Richard Baum will discuss an old observation of Mercury in which the craters on its surface may have been glimpsed.

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DIAL THE SKY

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Now David Chandler of La Verne, California, has perfected the two-sided star dial shown here, so that you may view stars toward the north, east, and west on the first side of THE NIGHT SKY (upper picture), but when looking south you simply turn the dial over. Voila! Constellations below the equator now appear quite normal (lower picture), making it easy to match the chart to the sky for the time at which the planisphere is set.

THE NIGHT SKY has been computer designed to minimize sky distortion. For star groups at —30° and —40° declination, such as Scorpius and Sagittarius, the south-facing side of this planisphere has only about a tenth as much distortion as a traditional planisphere.

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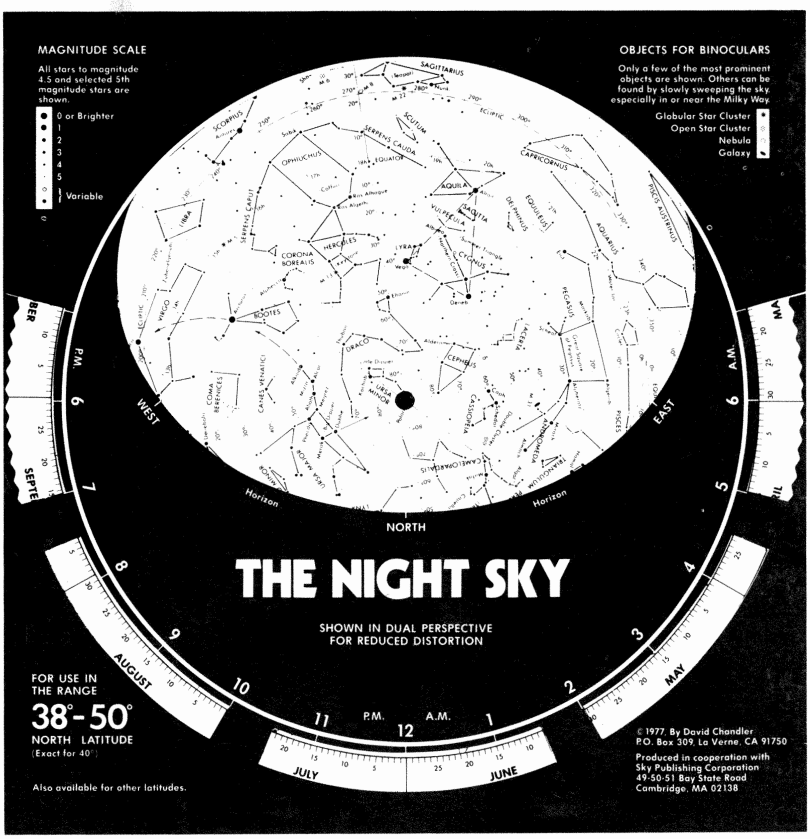

The two sides of the Chandler planisphere for 38°-50° at half size.

INSTRUCTIONS

□ Set the dial so that the appropriate day and time are matched. (If your clock is set for daylight saving time, first subtract one hour.) □ The front and back sides of the chart now show the stars visible to the north and to the south, respectively. □ As with any polar projection map, shapes become greatly distorted toward the edge. For this reason two projections are shown. Any constellation lying outside the circle marked "equator" on one side is shown with less distortion on the other side.

HINTS ON LEARNING THE NIGHT SKY

□ To help preserve your eyes' adaption to the dark, avoid white light. Star charts should be read with a small flashlight covered with red cellophane. □ Learn each constellation in relation to its neighbors. Each can serve as a stepping stone to the next. □ Very few constellations look like their namesakes. Don't worry about seeing Canis Minor as a dog or Andromeda as a beautiful girl. The ancients had vivid imaginations! The primary purpose of constellation figures is to help you recognize and remember permanent star patterns. Once you have identified the proper stars, use your own imagination. (What does Andromeda look like to you?) □ A number of other prominent star patterns, or "asterisms," are labeled in parentheses. These are not official constellations, but they are just as useful. □ Learn the brightest stars by name. These are "landmarks" in the sky that enable experienced observers to recognize groups of constellations at a glance. □ If you find a bright star out of place somewhere along the "ecliptic," you have probably found a planet. Mercury, Venus, Mars, Jupiter, and Saturn are usually as bright as first magnitude stars.