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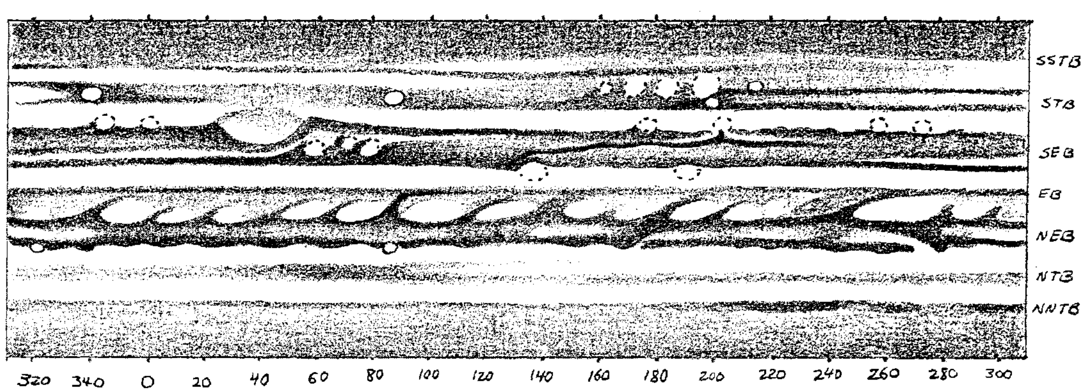

A montage of disk drawings that shows the entire visible surface of the planet Jupiter. Drawn by Mark S. Daniels with an 8-inch (20-cm.) telescope on May 16 and 19, and June 4, 6, and 8, 1983. South at top. See the report on the 1983 Jupiter Apparition on pages 141-158 of this issue.

THE ASSOCIATION OF LUNAR AND PLANETARY OBSERVERS
c/o Dr. John E. Westfall
P.O. Box 16131
San Francisco, CA 94116 U.S.A.

ASSOCIATION OF LUNAR & PLANETARY OBSERVERS
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IN THIS ISSUE

JUPITER IN 1983

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

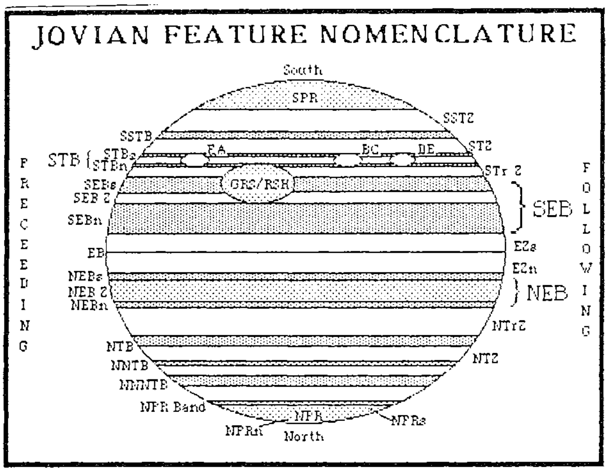
Abstract. --Beginning in 1980, the planet Jupiter has experienced small-scale changes, rather than large-scale. This fact has resulted in several "dull" apparitions that have required some patience, both on the part of the Recorder and of his readers. However, some changes did occur in the NEBs, NEBn, SEB, STrZ, and STZ. For example, there was a masked NEB Disturbance. Such an event takes place whenever the two components of that belt are so close together in their north latitude that they completely obscure the intervening zone (the NEB Z). This closeness produces a false single aspect that is due entirely to the reerupting components, rather than to a demise of the NEB. In addition, another STrZ Disturbance occurred, beginning in late June and early July, 1983. Finally,at about the same time, considerable activity was seen in the STZ in the vicinity of the long-enduring oval FA, consisting of a series of three bright white ovals. Altogether, A.L.P.O. observers submitted 303 full-disk drawings and photographs for the 1983 Apparition.

Introduction*

In order to clarify the references to Jovian features in this report, the diagram below gives the standard abbreviations that are used in it. Other abbreviations used are: "f." for "following" or "follows" (celestial east or Jovian west), "p." for "preceding" or "precedes" (celestial west or Jovian east), "f.e." for following edge, "p.e." for preceding edge, "CM" for central meridian, "Sys. I" or "I" for System I longitude, "Sys. II" or "II" for System II longitude, and "IR" for infrared. All dates and times quoted are in Universal Time (U.T.). Figures 1-42 are grouped together on pp. 151 - 158.

The "1983" Jupiter Apparition fell between the two successive solar conjunctions of 1982 NOV 13 and 1983 DEC 14. Opposition occurred on 1983 MAY 27, with Jupiter at declination 20°.4 S and possessing an equatorial disk diameter of 45".4. This report describes features in south-to-north order. Most features are described by chronological tables, although regions of special interest (the GRS, STrZ, and NEB-EZ-EB) are also described by narratives. The final section summarizes the intensity report submitted by A.W. Heath.

Twelve participants contributed the observations that were used in compiling this report, and are listed in Table 1 (p. 142). Unless stated otherwise, the instruments listed there are those used for all observations cited in this report.



Abbreviation Key:

S, s = South
N, n = North
E = Equatorial
P = Polar
T = Temperate
Tr = Tropical
B = Belt or Band
Z = Zone
R = Region

GRS = Great Red Spot
RSH = Red Spot Hollow

(FA, BC, and DE are long-term white spots. Their actual positions will differ from those used in this schematic diagram.)

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* With the exception of the list of observers on p. 142, this introductory section was written by the Editor in order to clarify the remainder of this report. Any errors here are the Editor's fault and not Dr. Mackal's.

Table 1. A.L.P.O. Jupiter Observers, 1983 Apparition.

Name	Location	Telescope Aperture	Observations
M. Adachi	Shiga, Japan	30 cm.	12 Disks
D. Barbany	Barcelona, Spain	20	10 Disks
C. Benninghoven	Burlington, IA	20	Verbal Report; 14 Disks
M.S. Daniels	Wichita, KS	20	Montage; 3 Strip Sketches; 20 Disks
J. Dragesco	Bénin, West Africa	36	79 Photographs and Disks
A.W. Heath	Nottingham, England	30	Intensity Report; 3 Disks
M.J. Morrow	Ewa Beach, HI	20	51 Disks
T. Osawa	Nara, Japan	32	5 Disks
D.C. Parker	Coral Gables, FL	32	88 Photographs
C.P. Sherrod	N. Little Rock, AR	36	2 Disks
D. Troiani	Chicago, IL	25	2 Strip Sketches; 12 Disks
G. Viscardy	L'Exereue, France	52	8 Photographs

NOTES: "Disks" represent whole-disk drawings; "Strip Sketches," detailed regional drawings; and "Montage" refers to a map of the entire planet assembled from a series of drawings. The photographs by Viscardy were kindly supplied by Régis Néel of Venissieux, France.

Table 2. Chronological Table: SSTB.

1983 Date	Person*	Description and Location**
FEB 25	Dragesco	The SSTB is altogether absent at 148° II (244X).
MAR 10	Dragesco	All zones south of the STB are obliterated by the SPR at 296°II (244X).
APR 08	Parker (P)	The SSTB is present at 166° II (S4).
APR 08	Adachi	His disk confirms the presence of the SSTB at 103°II (S4, 257X). [Fig. 6]
APR 24	Dragesco	A portion of the SSTB is displaced on the f. limb; CM 119°II (244X).

* (P) indicates a photograph; (P2), a second photograph, and so forth.
** When known, "S" gives seeing on the ALPO scale from 0 (worst) to 10 (best), and "X" gives the magnification.

Table 3. Chronological Table: STZ and STB.

1983 Date	Person*	Description and Location**
FEB 18	Parker (P)	There is a dark spot p. the GRS, and one end of the STB south of it at 034°II (S6). [Fig. 1]
FEB 19	Dragesco	The beginning of a gap in the STB is on the p. limb; CM 315°II (244X).
FEB 24	Dragesco	BC p. the GRS on the f. limb; CM 353°II (244X).
FEB 25	Dragesco	The STB is weak p. DE at 148°II (244X).

[Table 3 is continued on p. 143]

/Table 3--Continued./

1983 Date	Person*	Description and Location**
MAR 02	Benninghoven	BC is near the CM at 021°II (S3, 158X).
MAR 04	Dragesco	DE p. a strong STB f. the CM near 110°II (244X).
MAR 07	Parker (P)	BC p. the GRS at 029°II (S8).
MAR 08	Dragesco	Confirms that BC p. the GRS on the f. limb; CM 350°II (244X).
MAR 11	Dragesco	The GRS is flanked by a strong STB f. BC on the p. limb; CM 078°II (244X).
MAR 12	Parker (P)	DE is on the f. limb; CM 091°II (S7).
MAR 13	Dragesco	BC is slowly pulling away from the GRS at 021° II (244X).
MAR 26	Parker (P)	Confirms that BC is slowly pulling away from the GRS at 012°II (S7.5).
APR 05	Parker (P)	The STBn is absent from the p. limb up to 328° II (S7).
APR 08	Adachi	BC f. the CM near 103°II (S4, 257X). [Fig. 6]
APR 28	Parker (P3)	The STZ is mottled at 208°II and slightly f. (S7). [Fig. 11]
APR 30	Dragesco (P)	The STBn is absent from 283°II to the f. limb. [Fig. 12]
MAY 11	Dragesco	The STB is very strong at 152° II.
MAY 14	Dragesco (P)	The STZ is mottled at 185°II and slightly f. [Fig. 19]
MAY 15	Dragesco (P)	There is a dark spot in the STZ on the p. limb; CM 344°II. [Fig. 20]
MAY 16	Daniels	BC f. the CM near 342°II (S5.5, 191X).
MAY 17	Benninghoven	DE p. the CM near 104°II (S6, 260X).
MAY 20	Adachi	DE f. the CM near 088°II (257X).
MAY 30	Viscardy (P)	The STB is still strong at 140° II.
MAY 31	Dragesco (P)	The STZ is still mottled at 197° II and slightly f. [Fig. 24]
JUN 04	Viscardy (P)	Confirms that the STZ is mottled at 182° II and slightly f.; also, the STB is weak here.
JUN 06	Daniels	3 of 4 STZ white spots, plus FA, are shown near 185° II (S7.5, 191X). [Fig. 25]
JUN 06	Dragesco (P)	DE is on the p. limb; CM 130° II.
JUN 07	Dragesco (P)	4 of 4 STZ white spots, plus FA, are photographed near 174°II. [Fig. 26]
JUN 08	Parker (P)	DE f. the CM near 068°II (S7).
JUN 09	Dragesco (P)	4 of 4 STZ white spots, plus FA, are rephotographed near 192°II.
JUN 10	Benninghoven	Confirms that DE f. the CM near 051° II (S6, 260X). [Fig. 27]
JUN 12	Benninghoven	BC is on the f. limb; CM 331° II (S5, 210X).
JUN 13	Dragesco (P)	BC is on the p. limb; CM 012° II.
JUN 15	Benninghoven	Although it is brighter p. the RSH, the STZ is a dull white at 038°II (158X).
JUN 17	Parker (P2)	There is an absence of IR activity in the STB p. BC on the p. limb at 336°II (S7).
JUN 17	Parker (P3)	The STB is very strong from 015° II to the f. limb (S8).
JUN 19	Parker (P)	Both components of the STB are present at 277°II (S6).
JUN 20	Benninghoven	DE p. the CM near 091°II (S6, 260X).
JUN 21	Dragesco	FA is at 189°II (244X). [Fig. 29]
JUN 28	Parker (P)	The STZ is still mottled at 150°II and slightly f.(S6).

* (P) indicates a photograph; (P2), a second photograph, and so forth.
** When known, "S" gives seeing on the ALPO scale from 0 (worst) to 10 (best), and "X" gives the magnification.

Narrative: The Great Red Spot (GRS)

The GRS was fairly prominent throughout the 1983 Apparition, except for a brief interim from 1983 MAY 15 to MAY 20, when Phillip Budine suspected a minor eruption in the SEB Z just f. the GRS. The center of the GRS was at 039° II at Jupiter's opposition (1983 MAY 27), and both its p.e. and f.e. rotated with a period of 9 h 55 m 40 s. The B.A.A.intensity [brightness on a scale between 0 for the brightest possible feature to 10 for black] was usually 7.0, although it fell to 6.0 on June 30, according to A.W. Heath. This drop may have been due to the reappearance of the STrZ Disturbance in 1983.

In terms of the chronology of the GRS in 1983, on FEB 01 the STZ white spot BC was in conjunction with the GRS at 045°II, according to Regis Neel. On FEB 18, Parker photographed the GRS on the f. limb, its south side being stronger than its north [Fig. 1]. On FEB 22, Dragesco rephotographed the region on the p. limb, at which time the GRS appeared to be almost gone [Fig. 2]! However, on MAR 02, Benninghoven described the GRS color as orange. By MAR 19, Parker rephotographed the GRS on the p. limb [Fig. 4], which showed it as being faint and diffuse, as if the feature was periodically losing its color and darkness. On MAR 26, Parker rephotographed the GRS on the p. limb, and once again the south side was shown stronger than the north. By APR 15, Daniels depicted a much stronger feature [Fig. 8]. Then, on APR 20, Troiani described the GRS as pale reddish-brown (at a magnification of 374X), whereas Benninghoven saw a very light orange-yellow area (with a magnification of only 210X). On APR 22, Parker photographed a strong GRS; and Benninghoven detected the GRS on APR 24 without any difficulty. Finally, on APR 26, Dragesco rephotographed a feature much stronger than before [Fig. 10]. On MAY 05, Troiani described the GRS as reddish-brown, using a magnification of 374X. However, by MAY 11, Daniels saw it as pinkish in color, using a magnification of only 191X.

By MAY 16, Benninghoven called the GRS orange [his drawing is shown in Fig. 21]; but Heath, observing on the same date, saw it as a greyish region. Even though the feature was rather changeable in 1983, it is hard to say that these color impressions were indeed genuine! On MAY 19, Daniels noted a dusky feature over the south half of the GRS [Fig. 22]. Then again, on JUN 05, Parker photographed a faded GRS in which the p.e. was considerably fainter than the f.e.; this difference was confirmed by him with another photograph on JUN 08. On that same date, Heath once again described the feature as greyish, with a diffuse outline. Only the diffuse aspect could be confirmed on JUN 10 by Benninghoven [Fig. 27]. On JUN 15, Parker rephotographed the GRS in white light, which showed that it was reviving once again. However, one hour later, the feature was entirely absent in IR [Fig. 28]! For the IR photograph Parker used HIE-2481 Film, rather than the usual TP-2415, and with a Wratten 29 ("F") filter. On JUN 18, Heath again called the GRS grey; and he also suggested that it was displaced off center, with the GRS center f. the RSH center. On JUN 24, Benninghoven saw the feature as dull orange, while, on JUN 30, Heath yet again reported a greyish color, though somewhat shaded. On JUL 02, Parker photographed the feature again, which showed it as neither redder nor darker than before [Fig. 31]. On JUL 05, Dragesco rephotographed the region, confirming this same situation.

With the reappearance of the p.e. of the STrZ Disturbance on JUL 11, I had expected a diminution of the GRS intensity, with its reverting back entirely to its RSH aspect. But the feature did not do so! In August, September, and October, the GRS appeared to be redder than it had been before. The only conclusion that might be made is that the re-erupting STrZ Disturbance was not very strong at first and was somewhat transitory thereafter. Instead of fading away after AUG 01, the GRS simply returned to its normal appearance. However, on SEP 15, Osawa depicted the GRS as absent when it should have been on the p. limb. On SEP 29, the white spot DE was in conjunction with the GRS at 036°II, according to Regis Neel. Finally, on OCT 09, Dragesco detected a strong GRS!

Table 4. Chronological Table: STrZ.

1983 Date	Person*	Description and Location**
JAN 12	Troiani	STrZ residual activity on the p. limb; CM 272°II (S4, 283X).
JAN 31	Adachi	STrZ residual activity on the f. limb; CM 189°II (S4, 257X).
FEB 19	Benninghoven	The STrZ is fairly wide and bright white at 196°II (158X).
FEB 19	Dragesco	STrZ residual activity on the f. limb; CM 315° II (244X).
MAR 05	Dragesco	STrZ residual activity on both limbs; CM 265° II (244X).
MAR 07	Dragesco	STrZ residual activity on the p. limb; CM 202° II (244X).
MAR 09	Dragesco	STrZ residual activity just f. DE; CM 122° II (244X).
MAR 25	Benninghoven	The STrZ and the NTrZ are the two brightest features at 176°II (158X).
APR 21	Benninghoven	The white STrZ is the brightest feature at 188°II(210X).
APR 24	Benninghoven	The white STrZ is the brightest feature at 291°II(210X).
APR 29	Benninghoven	The STrZ is the brightest feature at 326°II (158X).
JUN 10	Benninghoven	The STrZ is fairly wide and bright white at 115°II (210X).
JUN 15	Benninghoven	The STrZ is dull white at 038°II (158X).
JUN 21	Dragesco	STrZ residual activity at 189°II (244X). [Fig. 29]
JUN 21	Benninghoven	The white STrZ is the brightest feature at 204°II(260X).
JUN 22	Benninghoven	The dusky STrZ is dull white from 352°II to the GRS region (260X).
JUN 24	Parker (P)	There is a mirror-image white spot north of BC in the STrZ; CM 347°II (S6.5). [Fig. 30]
JUN 26	Benninghoven	The STrZ is very bright white at 249°II (210X).
JUN 29	Parker (P)	There is a north-preceding festoon in the STrZ; CM 358°II (S8).
JUN 29	Dragesco (P)	Confirms the presence of the north-preceding festoon in the STrZ; CM 313°II.
JUL 02	Benninghoven	The white STrZ is the brightest feature at 119° II(158X).
JUL 09	Dragesco (P)	The p.e. of the STrZ Disturbance is on the p. limb; CM 292°II. [Fig. 33a]
JUL 09	Dragesco	Confirms that the p.e. of the STrZ Disturbance is on the p. limb; CM 293°II (244X). [Fig. 33b]
JUL 11	Sherrod	The p.e. of the STrZ Disturbance is on the p. limb; CM 310°II (S4, 330X). [Fig. 34].

* (P) indicates a photograph; (P2), a second photograph, and so forth.
** When known, "S" gives seeing on the ALPO scale from 0 (worst) to 10 (best), and "X" gives the magnification.

Narrative: The South Tropical Zone (STrZ)

Throughout the 1983 Apparition, residual activity in the STrZ could be seen just p. the GRS, where SEBs activity predominated. By mid-July, the STrZ appeared to be narrow and dull at this location, although it was wide and brilliant elsewhere. On JUL 30, Daniels perceived a small white spot well p. BC on the CM (at 326°II) as well as a dusky hump which obliterated the STrZ for several degrees just f. BC and the CM. This activity was in contrast to the featureless condition of the STrZ as photographed by Parker on AUG 03, in the region from 166° to 189°II [Fig. 35]. However, his photograph of AUG 04 showed a subdued STrZ near BC, which was virtually filled up with dusky material on the f. side of the CM at 308°II [Fig. 36]. About six minutes later, Daniels depicted the same situation on a full-disk drawing. An AUG 05 photograph showed an inactive STrZ f. the GRS at 080° II.

Then, on AUG 17, Morrow detected a dusky patch in the STrZ on the f. limb of the planet at CM 321°II. The end of a second disturbed section was somewhat more extended than the previous one and could be seen on an AUG 19 full-disk drawing by Barbany at CM 004°II [Fig. 37]. On AUG 29, a full-disk drawing by Osawa showed no such activity f. the GRS at 074°II [Fig. 39], which was the case on Osawa's SEP 03 full-disk drawing at 094°II [Fig. 40]. The original disturbed section was centered at 338°II as drawn by Osawa on SEP 07 [Fig. 41]. On SEP 12, he placed the end of the other disturbed section very close to the CM at 358°II [Fig. 42]. Ironically, Osawa also reported that the STrZ was brilliant between these two sections. Dragesco made a series of observations of dusky patches in the STrZ on OCT 09 (001° II), OCT 11 (301° II), OCT 21 (002°II), OCT 23 (299°II), and OCT 30 (272° II).

According to Phillip Budine, the mean rotation period for the four initial spots of the STrZ Disturbance was 9 h 55 m 35.3 s.

Table 5. Chronological Table: SEB.

1983 Date	Person*	Description and Location**
FEB 21	Dragesco	The SEBs is very dark at 268°II (244X).
FEB 22	Dragesco (P)	There is a zonal gap between the RSH and the p.e. of the SEBn at 056°II. [Fig. 2]
MAR 04	Parker (P)	The SEB is very wide at 320°II (S7). [Fig. 3]
MAR 08	Dragesco	The SEBs is darker than the SEBn at 350° II (244X).
MAR 12	Parker (P)	The p.e. of the SEBn is on the CM at 091° II (S7).
MAR 14	Dragesco	The SEB is very active at 178° II (244X).
MAR 15	Dragesco	The SEBs is very dark at 322° II (244X).
MAR 19	Parker (P)	Both components of the SEB are very weak at 058°II (S6). [Fig. 4]
APR 19	Dragesco	The SEBn is very dark at 099°II (244X).
APR 28	Parker (P2)	The SEB is as strong as the NEBs; CM 192°II/171°I (S7).
MAY 12	Parker (P)	There is IR activity in the SEBn from 085°II to the f. limb (S8).
MAY 13	Dragesco (P)	The f.e. of the SEBs is separated from the p.e. of the SEBn by three white ovals at 039°II. [Fig. 18]
JUL 04	Parker (P1)	The SEB is as strong as the NEB; CM 345°II/115°I (S6).
JUL 04	Parker (P2)	There is IR activity in both the NEB and SEB; CM 356°II/126°I (S6).
JUL 05	Dragesco (P1)	The SEB is as strong as the NEB; CM 041°II/183°I.
JUL 05	Dragesco (P2)	The SEB is as strong as the NEB; CM 084°II/226°I.
JUL 05	Dragesco (P3)	The SEB is as strong as the NEB; CM 120°II/262°I.

* (P) indicates a photograph; (P2), a second photograph, and so forth.
** When known, "S" gives seeing on the ALPO scale from 0 (worst) to 10 (best), and "X" gives the magnification.

Narrative: The North Equatorial Belt (NEB), Equatorial Zone (EZ), and Equatorial Band (EB)

On 1983 JAN 16, Benninghoven stated that the north edge of the NEB had a reddish tinge to it at 147°II. On FEB 24, Dragesco depicted a very active NEBn at 353°II. On FEB 26, Benninghoven reported a single aspect for the dark grey NEB from the p. limb up to the CM at 160°II. In contrast, at the same time, from the CM to the f. limb this belt was more disrupted and appeared to be separated into two components, which were yellowish or tan in hue. On a MAR 04 photograph, Parker recorded three dark festoon bases in the NEBs and two white spots in the EZ at 242°I [Fig. 3]. On MAR 07, he photographed another white spot in the EZ at 334°I. On MAR 08, Dragesco detected a break in the entire NEB on the p. limb (CM 300°I/350°II). In the f. direction, however, the NEB appeared to be more active! On MAR 12, Dragesco also noted a false EB at 244°I. Then, on MAR 14, he noticed that there were two weak components of the NEB (CM 174°I/178°II); the NEBs was divided on the CM, whereas the NEBn had a slight gap 5 degrees p. the CM.

On a photograph taken MAR 19, Parker recorded an anomalous single aspect for the NEB (CM 094°I/058°II) [Fig. 4]. However, this indicated a return of the NEB, rather than its demise! Indeed, this appearance indicated a masked disturbance, which occurs whenever there are two mildly active belt components so close together that they produce residual activity in the intervening zone. Undoubtedly, many such outbreaks in this belt have occurred in the past.

About one hour after Parker's photograph, Benninghoven depicted an orange cast to the NEBn at 212°II. On MAR 25, he detected an active NEBs at 268°I, which was confirmed by a black-and-white photograph by Parker taken only eight or nine minutes later [Fig. 5]. Parker's photograph also showed a brilliant EZ without any EB. The anomalous single aspect of the NEB was rephotographed twice by Parker; on MAR 26 (102°I/012°II) and MAR 27 (184°I/087°II). Then, on MAR 28, Daniels detected the beginning, or p.e., of the masked disturbance at 011°I (264°II). Also, on APR 05, he observed a very active NEBs at 200°I. On the same date, Parker rephotographed the anomalous single aspect of the NEB, along with a white oval in the EZn, just f. the CM near 132°I (328°II). Another photograph by Parker on APR 08 at 354°I (166°II) showed the same situation. In terms of activty, the NEB now compared favorably with the SEB! Similarly, on APR 13 Dragesco indicated an active NEBs at 190°I [Fig. 7]. On APR 14, he suggested a less-active NEBn at 119°II. By APR 15, Dragesco pinpointed the f.e. (or second point of eruption) of the masked disturbance near 076°I (196°II). Between the p.e. and the f.e., activity appeared between 270° to 175°II, with an intervening paler region that stretched from 180° to 265°II. In this last interval, the two components of the NEB were farther apart, allowing for a noticeable NEB Z. The appearance of the entire NEB is well shown on the montage prepared by Daniels from whole-disk drawings done on MAY 16 and 19 and on JUN 4, 6, and 8, as shown on the front cover of this issue..

On APR 16. Benninghoven noted some bluish-grey projections of the NEBs into the EZn at 048°I. On APR 17, Dragesco photographed the same Jovian longitude, locating the single aspect of the NEB at 152°II. On that date, Parker photographed a white oval in the EZn at 277°I. In fact, the NEB was just as active as the SEB. Dragesco spotted a dark NEBn at 206°II on APR 22, while on the same date Parker photographed IR activity confined to the NEBs at 272°I (337°II). On APR 23, Dragesco observed the NEB to be single at the same position [Fig. 9]. However, on APR 24 Adachi confirmed the fact that the NEB was just as active as the SEB at 161°I (182°II). Here, of course, the masked disturbance gave way to a regular eruption of the NEB because the intervening NEB Z was not obscured at all. On APR 25, Dragesco depicted the original site of appearance of the masked disturbance, along with an active NEBs (or EZn) at 227°I (271°II).

On APR 27 and 28 at 015°I and 151°I, respectively, Parker rephotographed the abnormal aspect of the NEB and showed IR activity in the NEBs, which Jose Olivarez associates with the blue-grey projections of this component. A theoretical interpretation is that these are relatively hot features that reveal the deep underlying heat source of the planet. The blue-grey columns and festoons are thus the warm shafts above hot bases, themselves slightly cooler than the rest of the component. This difference would be due to a downward convection above the NEBs that originates from the upward convection of the two flanking zones, the EZn and the NEB Z, making the belt appear to be cooler by comparison with the zones because their upward motions would lie alongside the heat sink, which itself would lie flush with the source. In other words, the downward motion would occur over the actual source of heat, with the cool heavy currents separating the warm lighter ones.

On APR 28, Parker rephotographed an active (normal) NEBs at 172°I, while, on APR 29 Benninghoven detected the f.e. of this double aspect of the NEB near 015°II. Then, on APR 30, Dragesco observed a weakened or diffuse NEBn at 283°II [Fig. 12].

On MAY 01, Dragesco photographed the p.e. of a darker segment of the NEB at 087°I (086°II). On MAY 02, Parker photographed a brilliantly white EZ at 359°I [Fig. 13]. Then, on MAY 04, he resolved more IR activity in the NEBs at 284°I [Fig. 14]. On MAY 05, Dragesco photographed a knot of activity in the NEB at 334°I (303°II). On MAY 06 and 09, Dragesco and Adachi both showed a strong masked disturbance at 154° II and 261° II, respectively. Also, on MAY 07, Dragesco depicted the p.e. of the MAY 05 eruption at 316°I (263°II), thereby demonstrating that the NEBs quite literally became the NEBn at this point [Fig. 16]! On MAY 12 and 14, Parker rephotographed IR activity in the NEBs in three photographs at 171°, 084°, and 120°I, respectively. Three observers caught various aspects of the NEB and its components on MAY 15. The first observation, a photograph, showed the NEB comparable to the SEB in activity (Dragesco; 092°I/344°II) [Fig. 20]. The second, also a photograph, showed an active NEBs with a large white oval on the CM (Parker; 282°I). The third observation was a disk drawing showing a fragment of the NEB on the CM (Daniels; 344°I/234°II). On MAY 16, Benninghoven described a f. section of the NEB, on the p. half of the disk, as double at 032°I (266°II). On MAY 17 and 18, respectively, Dragesco detected a huge festoon at 089°I and a lesser one at 199°I. On MAY 22, Parker photographed IR activity in the NEBs at 317° I, while Dragesco photographed an active NEB, which was comparable to the SEB, at 352°II, along with a white oval in the EZn on the CM at 160°I [Fig. 23]. On MAY 23, Parker photographed a faint NEB at 015°I (206°II). Also, Dragesco noticed a break in the NEB on the CM at 096°I (257°II) on MAY 26. Finally, on one of his photographs of MAY 31, there was little or no sign of the f.e. of the masked disturbance at 067°I (197°II) [Fig. 24].

On JUN 05, Parker photographed a stronger NEB in deep blue light at 338°I (068°II). In this case, he used a Wratten 47 (C-5) Filter with VR-1000, rather than his usual TP-2415, Film. On JUN 06, Daniels noted a vague remnant of the f.e. of the masked disturbance at 102° I (185°II) [Fig. 25]. On JUN 07, Parker photographed a white oval in the EZn on the CM at 210°I. However, on JUN 13, Dragesco photographed a faint EB at 347°I. Notwithstanding this, on JUN 14, Adachi again detected activity in the NEB comparable to that of the SEB at 261°I (280°II). On JUN 15 and 17, Parker rephotographed IR activity throughout the entire NEB at 044° I (059° II) [Fig. 28] and 336° I (336°II), respectively. On JUN 19, he photographed a white oval in the EZn on the CM at 292°I. On JUN 24, Viscardy photographed a very featureless EZ at 322°I. On JUN 26, Benninghoven described the NEB as a single dark bluish-grey belt at 318°I (249°II). On JUN 29, Parker photographed isolated IR activity in a festoon base at 080°I. On JUL 01, he photographed a single weak NEB on the p. limb, f. by a stronger belt (CM 000° I/253°II). A subsequent photograph by him in IR (600- 900 nm) confirmed this appearance. On JUL 2, Parker rephotographed two strong stable components of the NEB in the vicinity of the GRS's longitude at 178°I (063°II) [Fig. 31]. Benninghoven, who observed the NEB as double from 055° to 095°II on the same day, also described the NEBs as darker than the NEBn, with a fairly bright intervening NEB Z. All of Benninghoven's impressions were confirmed on a Dragesco photograph of the same date (CM 153° I/032°II). On JUL 03, Parker photographed a white oval in the EZn on the CM at 022°I. According to Adachi, it was still there just one Jovian revolution later. On JUL 06, Parker rephotographed the same white oval in the EZn at 016°I. On the same day, Benninghoven described the NEB as brownish-grey at 094°I (308°II). On JUL 07, Parker showed the EB as faint from the p. limb to the CM at 258°I.

By AUG 03, Parker also photographd a single active NEB at 164° I (166° II) [Fig. 35]. On AUG 04, he photographed a double NEB at 314° I (308° II) [Fig. 36]. The NEB began to grow weaker at about the same time that the STrZ Disturbance reappeared, although this may have been nothing more than a coincidence. On AUG 19, Barbany depicted a weakening NEB in the vicinity of the GRS at 004°II [Fig. 37]. By AUG 29, Osawa confirmed the weak aspect of the NEB in the region very near to the CM at 074° II [Fig. 39]. Then, on SEP 03, 07, and 12, he detected weaker appearances of the NEB at 094°, 338°, and 358°II [Figs. 40, 41, and 42, respectively]! According to Osawa, the situation remained the same on SEP 15 at 078° II. Yet, throughout the subsequent month of October, 1983, the NEB appeared to come back to life again. Did the NEB return to its original prominence, once the STrZ ceased to be so active? For the most part, Dragesco showed the NEB to be in its single aspect, although more active than might be expected during a period of fading out. His eleven NEB observations made during October are summarized in Table 6 on p. 149.

Table 6. NEB Observations by J. Dragesco, October, 1983.

1983 OCT	CM I °	CM II °	NEB Description	1983 OCT	CM I °	CM II °	NEB Description
03	305	196	Single, mildly active.	22	042	149	SIngle, mildly active.
06	049	277	Single, mildly active.	23	200	299	Single, inactive.
09	156	001	Double, mildly active.	24	355	086	Single, inactive.
10	314	151	Single, mildly active.	25	156	239	Single, active.
13	064	238	Single, inactive.	30	227	272	Single, mildly active.
21	248	002	Single, active.				

Table 7. Chronological Table: NTrZ and NTB.

1983 Date	Person*	Description and Location**
FEB 21	Dragesco	NTrZ residual activity p. the CM at 267°II (244X).
FEB 23	Dragesco	NTrZ residual activity f. the CM at 202°II (244X).
MAR 01	Benninghoven	The NTB is grey at 232°II (S5, 210X).
MAR 04	Dragesco	NTrZ residual activity at 110°II (244X).
MAR 05	Dragesco	NTrZ residual activity from the p.limb to 305°II (244X).
MAR 09	Dragesco	NTrZ residual activity from 112°II to the f.limb (244X).
MAR 10	Dragesco	NTrZ residual activity from the p. limb to the f. limb; CM 296°II (244X).
MAR 11	Dragesco	NTrZ residual activity from the p. limb to the f. limb; CM 078°II (244X).
APR 24	Benninghoven	The NTB is grey at 018°II (S4, 210X).
APR 26	Dragesco	There is a p.e. of a dark section of the NTB at 051°II. [Fig. 10]
APR 27	Parker (P)	NTB IR activity at 014°II (S5).
APR 28	Parker (P)	The NTB is absent on the p. limb and very faint on the f. limb; CM 192°II (S7).
APR 29	Dragesco (P)	The NTB is very weak at 146°II.
MAY 05	Benninghoven	The NTB is grey at 076°II (S4.5, 210X).
MAY 12	Parker (P)	There is a p.e. of a dark section of the NTB at 063°II (S8).
MAY 13	Dragesco (P)	The NTB is very weak at 039°II. [Fig. 18]
MAY 16	Benninghoven	The NTB is grey at 016°II (S6, 260X). [Fig. 21]
MAY 29	Dragesco (P)	The NTB is very weak at 293°II.
JUN 05	Dragesco (P)	The NTB is very weak at 231°II.
JUN 19	Parker (P1)	The NTB is very weak at 277°II (S6).
JUN 19	Parker (P2)	There is no IR activity in the NTB at 285°II (S6).
JUN 23	Viscardy (P)	The NTB is composed of a series of barges***; CM 108°II.
JUN 24	Viscardy (P)	The NTB is invisible at 263°II!
JUL 01	Parker (P)	Due to an absence of IR activty, the NTB is invisible at 256°II (S4).
JUL 03	Parker (P)	Confirms that the NTB is not visible at 259°II (S4).
JUL 05	Parker (P)	Confirms that the NTB is not visible at 242°II (S5).
JUL 06	Parker (P)	Confirms that the NTB is not visible at 232°II (S5).

* (P) indicates a photograph; (P2), a second photograph, and so forth.
** When known, "S" gives seeing on the ALPO scale from 0 (worst) to 10 (best), and "X" gives the magnification.
*** Elongated, roughly rectangular dark markings.

Table 8. Chronological Table: NTZ and North.

1983 Date	Person*	Description and Location**
JAN 31	Adachi	As in 1982, the NNTB is double; at 189°II (S4, 257X).
FEB 22	Dragesco (P)	There is a white spot on the border of the NPR at 056°II.
MAR 07	Dragesco	There is a p.e. of a dark NNTBs at 202°II (244X).
MAY 05	Dragesco (P)	The NNTB is very dark at 303°II. [Fig. 15]
MAY 06	Dragesco (P)	The region from the north edge of the NTB to the NPR is obliterated by a diffuse grey haze; CM 154°II.
MAY 13	Dragesco (P)	The region from the north edge of the NTB to the NPR is obliterated by a diffuse grey haze; CM 039°II. [Fig. 18]
JUN 14	Adachi	There is a white spot in the NNTB on the p. limb; CM 280°II (S4, 257X).
JUL 04	Sherrod	Confirms the diffuse grey haze at 044°II (S8, 320X).
JUL 04	Parker (P)	Confirms the diffuse grey haze at 052°II (S8).

* (P) indicates a photograph; (P2), a second photograph, and so forth.
** When known, "S" gives seeing on the ALPO scale from 0 (worst) to 10 (best), and "X" gives the magnification.

Intensity Estimates

[A.W. Heath made a large number of visual intensity estimates, which are here summarized in Table 9 , followed by Dr. Mackal's comments. Intensities are brightnesses on a 0 (black) to 10 (brightest possible) scale. "Duskiness" (given in parentheses) is simply the opposite of intensity (10 - intensity). "Red - Blue" is the result of subtracting the blue intensity from the red intensity; a positive value indicates a warm hue; a negative value, a cool hue. For each value, the number of estimates is given in brackets. Ed.]

Table 9. Intensity (Duskiness) Estimates by A.W. Heath.

Feature	Integrated Light	Red Light	Blue Light	Red - Blue
SPR	6.9 (3.1) [15]	7.5 (2.5) [12]	6.0 (4.0) [12]	+1.5 [12]
STZ	8.4 (1.6) [14]	8.3 (1.7) [12]	6.7 (3.3) [12]	+1.6 [12]
STB	5.5 (4.5) [15]	6.2 (3.8) [12]	5.3 (4.7) [9]	+0.9 [9]
STrZ	9.3 (0.7) [15]	9.4 (0.6) [12]	7.4 (2.6) [12]	+2.0 [12]
SEBs	4.6 (5.4) [15]	5.5 (4.5) [12]	2.5 (7.5) [12]	+3.0 [12]
SEBn	5.0 (5.0) [13]	5.8 (4.2) [12]	2.5 (7.5) [12]	+3.3 [12]
EZ	8.6 (1.4) [15]	9.0 (1.0) [12]	7.5 (2.5) [12]	+1.5 [12]
NEB	4.9 (5.1) [15]	5.8 (4.2) [12]	2.5 (7.5) [12]	+3.3 [12]
NTrZ	8.4 (1.6) [15]	8.5 (1.5) [12]	6.8 (3.2) [12]	+1.7 [12]
NTB	6.6 (3.4) [5]	7.2 (2.8) [3]	--- --- --	---- --
NPR	7.0 (3.0) [15]	7.5 (2.5) [12]	6.0 (4.0) [12]	+1.5 [12]

In comparing different features, note that the SPR was very slightly darker than the NPR. The STZ was comparable to the NTrZ in white light, although both zones were relatively deficient in blue light. On the other hand, the STrZ was comparable to the EZ in blue light only, despite the fact that the STrZ showed a (Red - Blue) index of +2.0 and the EZ had a (Red - Blue) index of only +1.5. The color of the STrZ was described as yellowish, while the EZ was off-white or yellow. The SEBs, SEBn, and NEB were consistently brownish. However, both the SEBn and NEB appear to have been redder and more active than the SEBs. Ideally, the NTB should be compared to the EB in white, red, and blue light but this could not be done in 1983. Finally, note that the STB was more comparable to the SEBs than to the NTB.

SELECTED A.L.P.O. JUPITER SECTION DRAWINGS AND PHOTOGRAPHS, 1983 APPARITION.

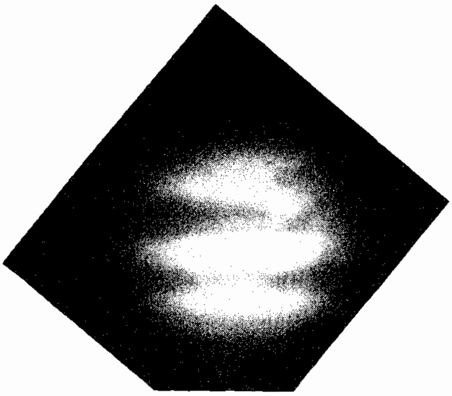


Fig. #1: Don Parker.
Feb. 18, 1983; 11:29
UT. 209°I, 34°II.

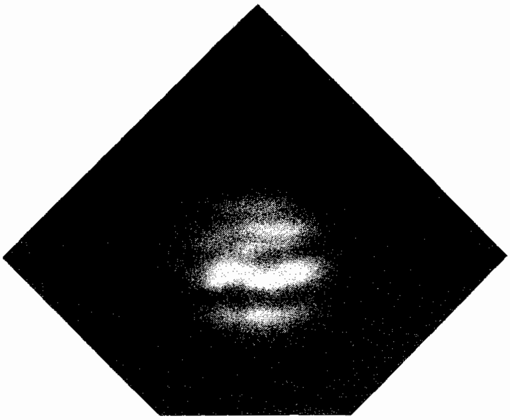


Fig. #2: Jean Dragesco.
Feb. 22, 1983; 5:27 UT.
260°I, 56°II.

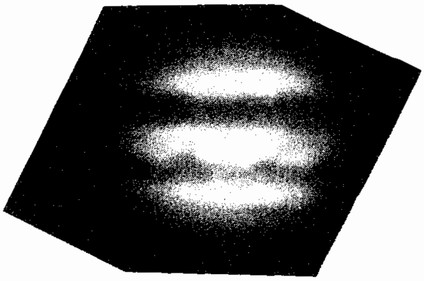


Fig. #3: Don Parker.
March 4, 1983; 11h
UT. 242°I, 320°II.

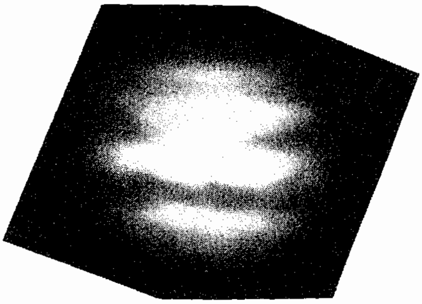


Fig. #4: Don Parker.
March 19, 1983; 11:06
UT. 94°I, 58°II.

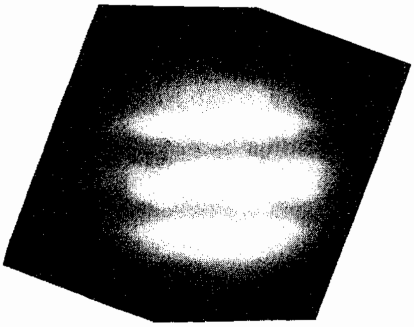


Fig. #5: Don Parker.
March 25, 1983; 10:29
UT. 300°I, 218°II.

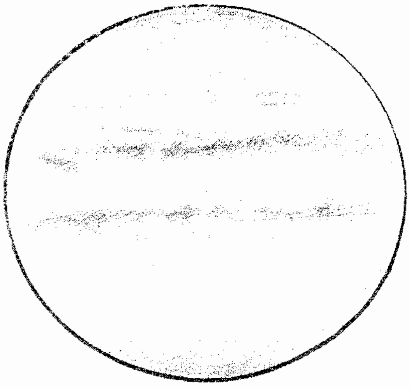


Fig. #6: Makoto Adachi.
April 8, 1983; 18:46 UT.
294°I, 103°II.

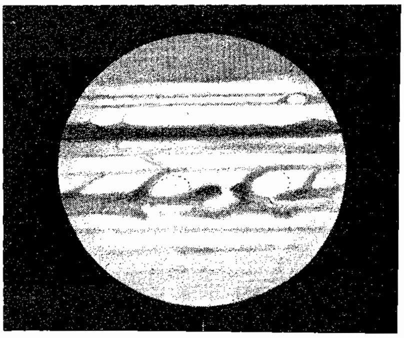


Fig. #7: Jean Dragesco. April 13, 1983; 4:10 UT. 190°I, 325°II.

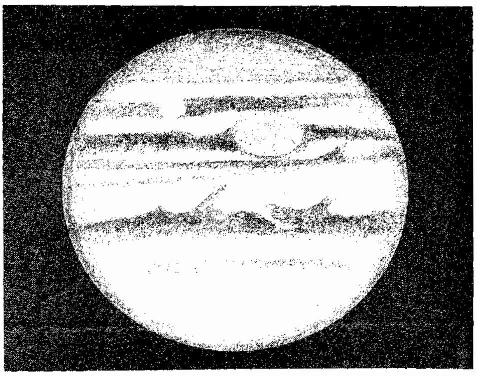


Fig. #8: Mark Daniels. April 15, 1983; 7:40 UT. 274°I, 33°II.

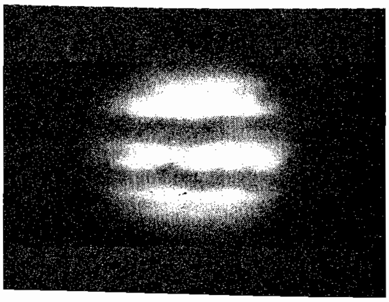


Fig. #9: Jean Dragesco. April 23, 1983; 2:30 UT. 269°I, 329°II.

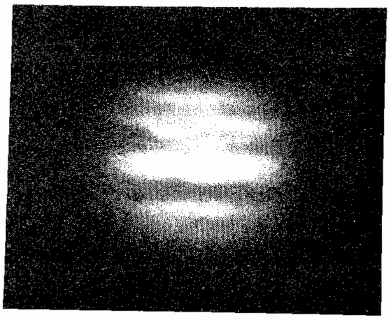


Fig. #10: Jean Dragesco. April 26, 1983; 2:15 UT. 14°I, 51°II.

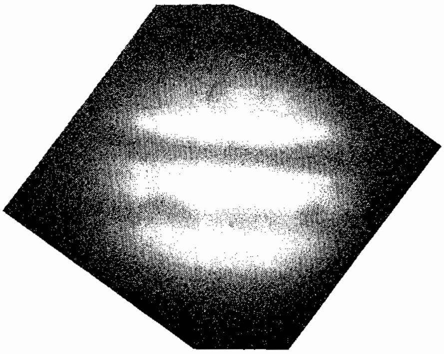


Fig. #11: Don Parker. April 28, 1983; 8:13 UT. 188°I, 208°II.

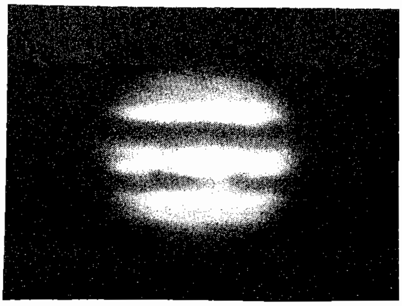


Fig. #12: Jean Dragesco. April 30, 1983; 1:59 UT. 276°I, 283°II.

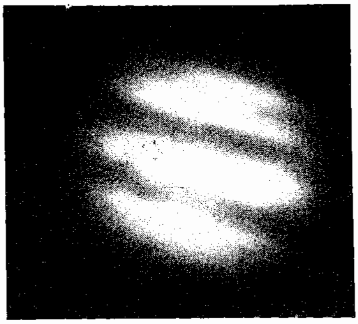


Fig. #13: Don Parker.
May 2, 1983; 5:27 UT.
359°I, 349°II.

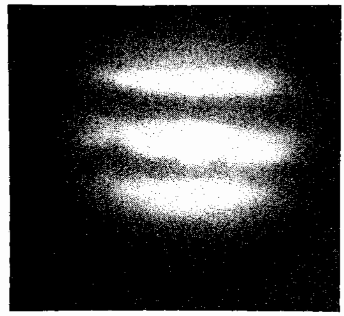


Fig. #14: Don Parker.
May 4, 1983; 4:36 UT.
284°I, 259°II.

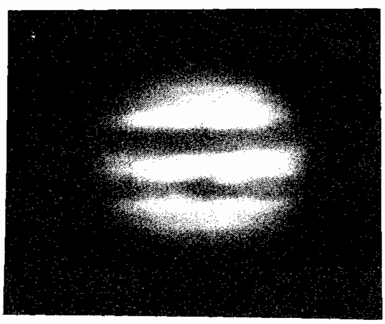


Fig. #15: Jean Dragesco.
May 5, 1983; 1:39 UT.
334°I, 303°II.

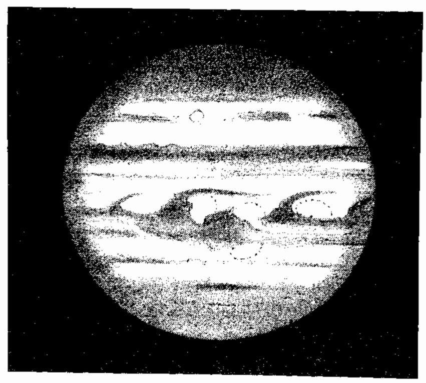


Fig. #16: Jean Dragesco.
May 7, 1983; 22:02 UT.
316°I, 263°II.

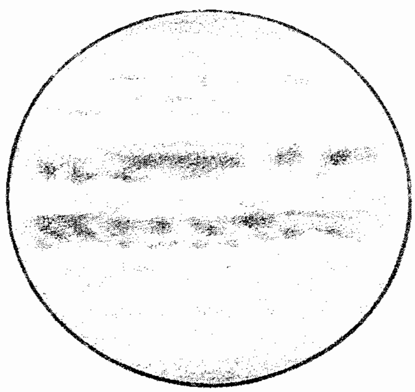


Fig. #17: Makoto Adachi.
May 9, 1983; 13:41 UT.
327°I, 261°II.

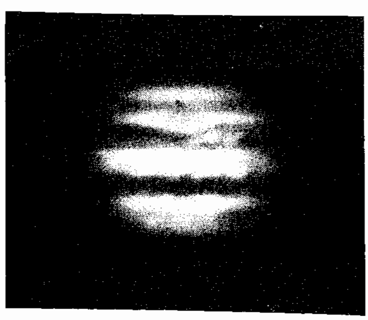


Fig. #18: Jean Dragesco.
May 13, 1983; 0:55 UT.
132°I, 39°II.

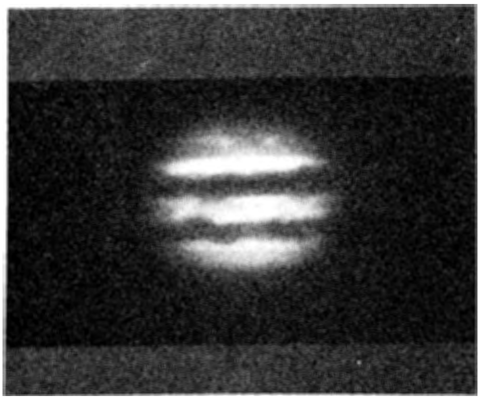


Fig. #19: Jean Dragesco. May 14, 1983; 0:47 UT. 285°I, 185°II.

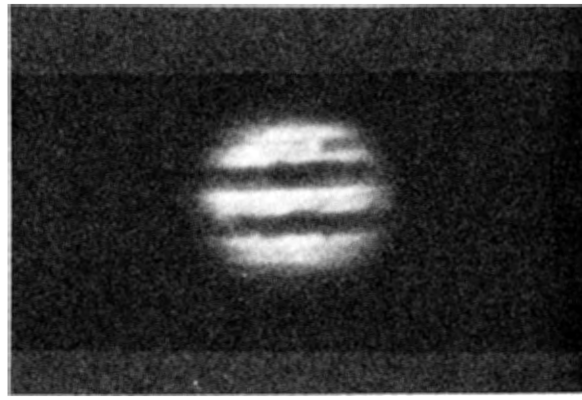


Fig. #20: Jean Dragesco. May 15, 1983; 1:02 UT. 92°I, 344°II.

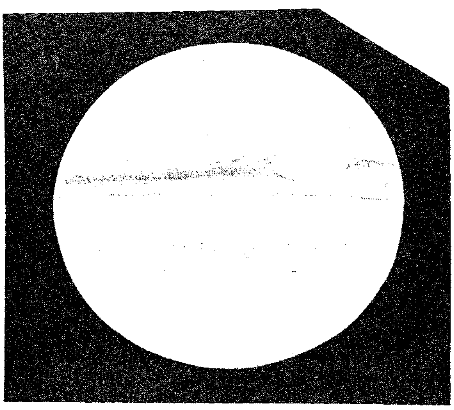


Fig. #21: Claus Benninghoven. May 16, 1983; 7:43 UT. 135°I, 17°II.

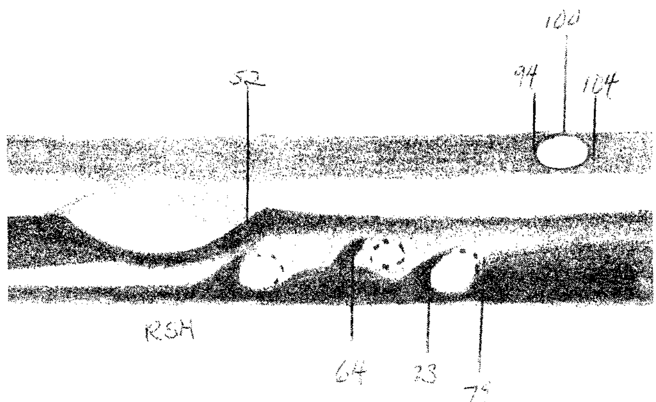


Fig. #22: Mark Daniels. May 19, 1983; 6:30 UT. 204°I, 64°II.

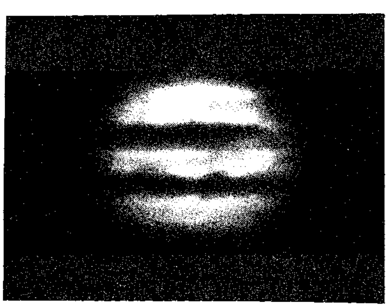


Fig. #23: Jean Dragesco. May 22, 1983; 21:51 UT. 160°I, 352°II.

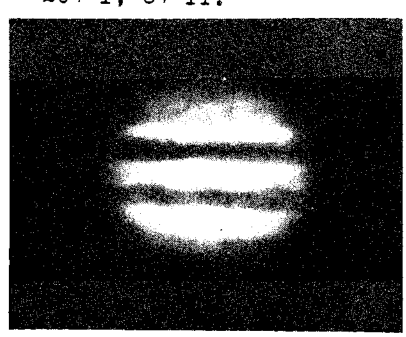


Fig. #24: Jean Dragesco. May 31, 1983; 0:06 UT. 67°I, 197°II.

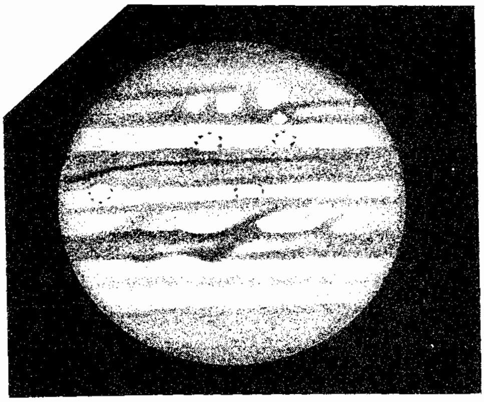


Fig. #25: Mark Daniels. June 6, 1983; 4:40 UT. 102°I, 185°II.

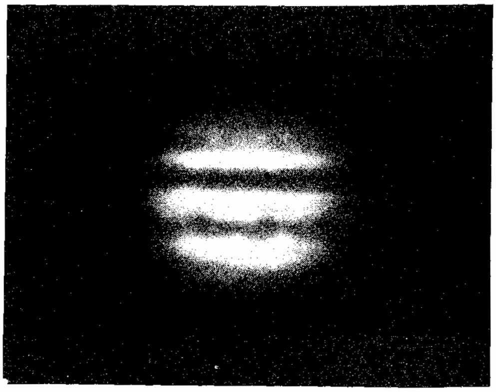


Fig. #26: Jean Dragesco. June 7, 1983; 0:13 UT. 97°I, 174°II.

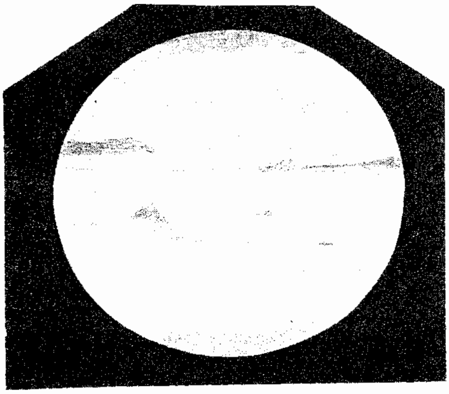


Fig. #27: Claus Benninghoven. June 10, 1983; 4:14 UT. 358°I, 51°II.

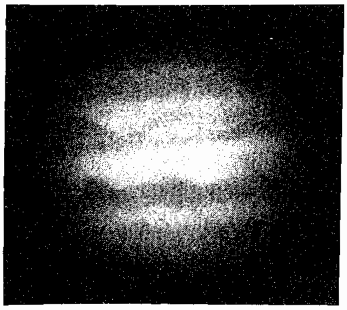


Fig. #28: Don Parker. June 15, 1983; 3:35 UT. 44°I, 59°II. IR.

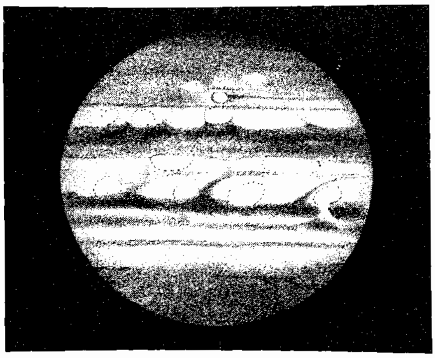


Fig. #29: Jean Dragesco. June 21, 1983; 22h UT. 226°I, 189°II.

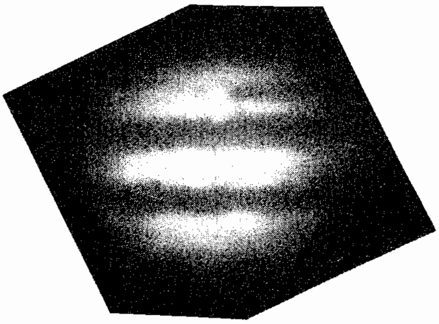


Fig. #30: Don Parker. June 24, 1983; 3:59 UT. 40°I, 346°II.

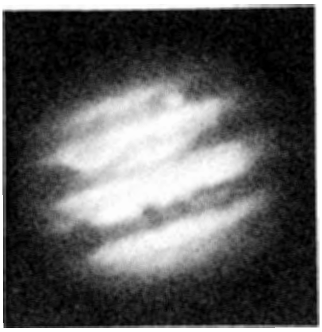


Fig. #31: Don Parker. July 2, 1983; 2:43 UT. 178°I, 63°II.

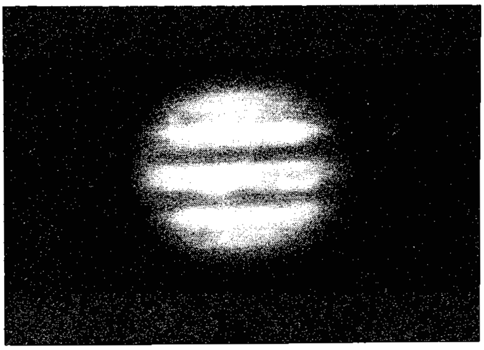


Fig. #32: Jean Dragesco. July 5, 1983; 21:38 UT. 263°I, 120°II.

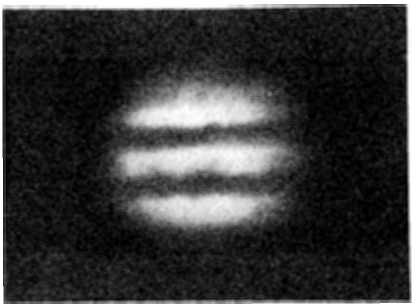


Fig. #33a: Jean Dragesco. July 9, 1983; 19:44 UT. 105°I, 292°II. Cf. #33b.

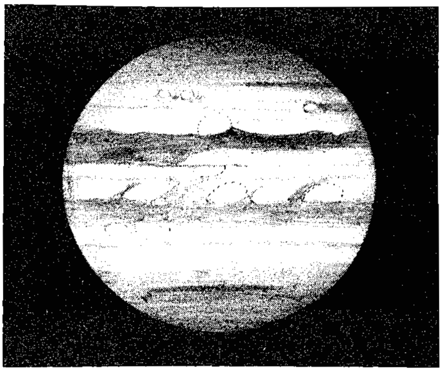


Fig. #33b: Jean Dragesco. July 9, 1983; 19:46 UT. 106°I, 293°II.

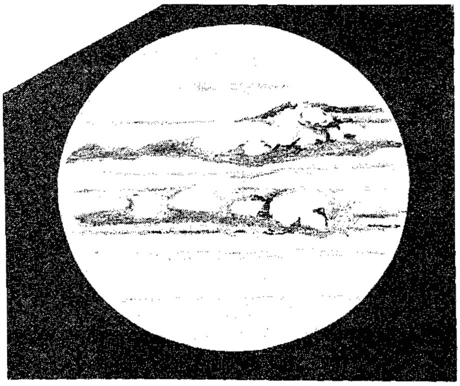


Fig. #34: Clay Sherrod. July 11, 1983; 2h UT. 133°I, 310°II.

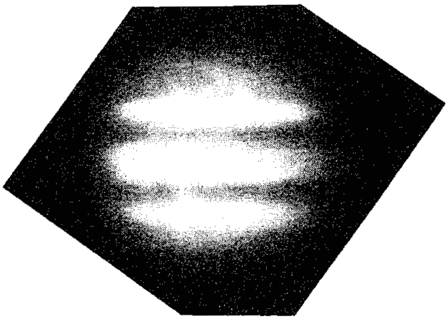


Fig. #35: Don Parker. August 3, 1983; 2:02 UT. 164°I, 166°II.

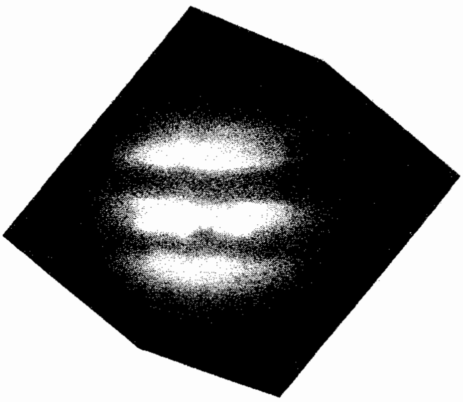


Fig. #36: Don Parker. August 4, 1983; 1:49 UT. 314°I, 308°II.

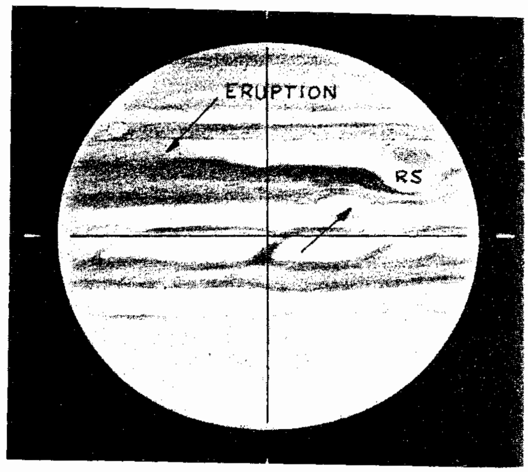


Fig. #37: Domener Barbany. August 19, 1983; 20:40 UT. 130°I, 4°II.

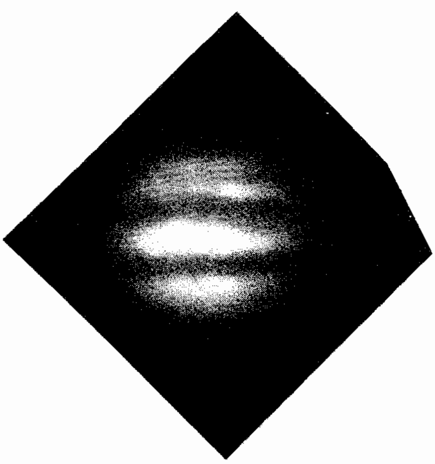


Fig. #38: Don Parker. August 26, 1983; 1:27 UT. 172°I, 358°II.

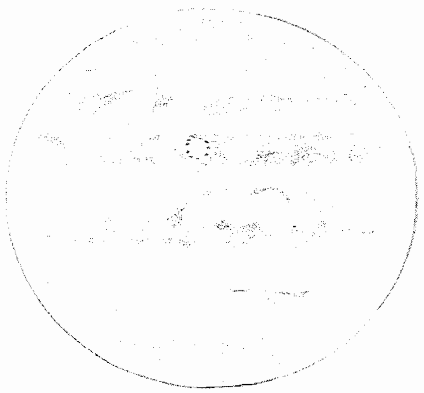
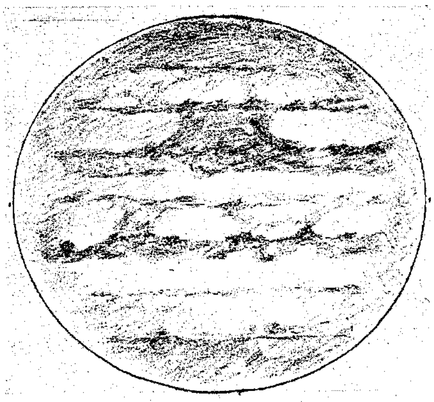
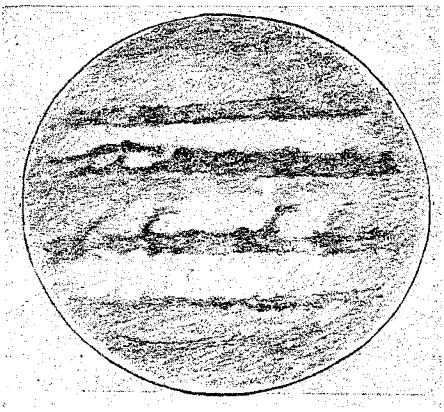


Fig. #39: Toshihiko Osawa. August 29, 1983; 11h UT. 274°I, 74°II.





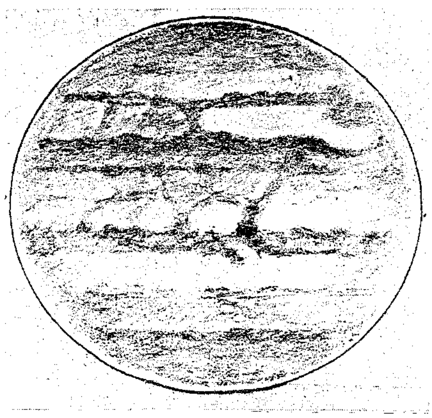


Fig. #40 (upper left): Toshihiko Osawa. September 3, 1983. 10:42 UT. 332°I, 094°II.

Fig. #41 (upper right): Toshihiko Osawa. September 7, 1983. 10:48 UT. 246°I, 338°II.

Fig. #42 (left): Toshihiko Osawa. September 12, 1983. 10:30 UT. 304°I, 358°II.

THE 1988 PERIHELIC APPARITION OF MARS

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

Abstract. --This paper presents the seasonal aspects, and observational characteristics and prospects, for the 1988 Martian Perihelic Appariton. It also discusses the predicted behavior of the polar regions, meteorology, and surface changes of Mars, giving several useful graphs and charts and a calendar of predicted Martian events.

Introduction

The 1988 Periphelic Apparition of Mars will prove to be one of the most favorable of the Twentieth Century. Of the 47 apparitions of Mars from 1901 FEB 22 through 1999 APR 24, only thirteen can be considered as favorable apparitions. We define a "favorable apparition" as one that offers the observer the best possible prospects for either observing the planet visually, recording it electronically or on film, or both. The length of time that Mars remains in a desirable position for observing is considered. We might select an apparition in which Mars reaches its largest apparent size, or when it is highest in the sky, not only for observers in the Northern Hemisphere, but for those in the Southern Hemisphere as well. For those who devote much of their time to photographing, or photometrically measuring the brightness of, Mars, we must consider exposure times and the effects of the Earth's atmosphere when the Red Planet is low in the sky. We might even consider the relative weather conditions where the majority of observers live.

Using the previous factors, this Recorder has selected 13 favorable apparitions. The particular aspects considered were the planet's declination, its surface brightness, and its apparent size. Based on these considerations, it appears that the 1956 Apparition meets all the above requirements and thus should be considered the best. Even though Mars presented a larger apparent diameter in 1924 (25".10), its southerly declination then (-17°.68) places that year in second place. This author has concluded that 1988 will be remembered as the third-best apparition in this century, at least for the majority of observers. The thirteen favorable Twentieth-Century apparitions of Mars are summarized in Table 1, below. [1]

Table 1. Thirteen Favorable Twentieth-Century Mars Apparitions. (A total of 47 Mars Apparitions will have occurred between 1901 and 1999 inclusive.)

U.T. Date of Opposition	Apparent Diameter* "	Geocentric Declination °	Apparent Visual Stellar Magnitude
1907 JUL 06	22.97	-27.98	-2.65
1909 SEP 24	24.03	- 4.22	-2.81
1922 JUN 10	20.53	-25.93	-2.34
1924 AUG 23	25.10	-17.68	-2.93
1926 NOV 04	20.40	+14.45	-2.37
1939 JUL 23	24.13	-26.40	-2.80
1941 OCT 10	22.80	+ 3.50	-2.67
1954 JUN 24	21.88	-27.68	-2.51
1956 SEP 10	24.76	-10.13	-2.89
1971 AUG 10	24.91	-22.25	-2.90
1973 OCT 25	21.47	+10.30	-2.51
1986 JUL 10	23.19	-27.73	-2.69
1988 SEP 28	23.85	- 2.12	-2.78
Minimum	20.40	-27.98	-2.34
Maximum	25.10	+14.45	-2.93

* Apparent diameter at date of closest approach to Earth.

Mars will exceed 23".8 in apparent diameter between 1988 SEP 19 and SEP 26. This value is 96 percent of the maximum of 24".9 diameter attained during the most recent of the most "favorable" apparitions; that of 1971. Most noteworthy is the fact that in 1988 Mars will reach 95 percent of its maximum diameter for this century, which was 25".1 on 1924 AUG 22. During the 1924 apparition, Mars came within 55.8 million km. (34.6 million mi.) of Earth, closer than at any previous time in at least the last 6000 years! The Red Planet will be only 3.0 million km. (1.9 million mi.) farther away in 1988!

What makes the 1988 Apparition so favorable is that Mars will be only one arcsecond smaller than it was in 1971, but will be 20 degrees higher in the sky for the Northern Hemisphere, giving most observers much more favorable observing conditions. Also, being near the celestial equator, Mars will be favorably placed for observers in the Southern Hemisphere as well.

Mars' orbit is highly eccentric (e = .0933), so that its distance to Earth at opposition can vary considerably. In a perihelic opposition, Mars is near its perihelion (closest point to the Sun) near the date of opposition. The 1988 Apparition is considered perihelic because opposition occurs only 30 heliocentric degrees after perihelion passage. Perihelion occurs on 1988 AUG 11 TD (Terrestrial Date), with the areocentric longitude of the Sun (L_s) equal to 250°. Figure 43 (p. 160) plots the orbits of the Earth and Mars, giving the Terrestrial and Martian (MD) Dates for different orbital positions. The Martian Dates are, of course, fictitious, but help to interpret the Martian seasons. They conform to a Martian calendar, patterned after the terrestrial Gregorian Calendar, stretched over one Martian year (687 terrestrial days) such that, at the same dates on each planet, the geocentric and areocentric longitudes of the Sun are equal; Table 2 (p. 160) gives some important Martian seasonal dates.

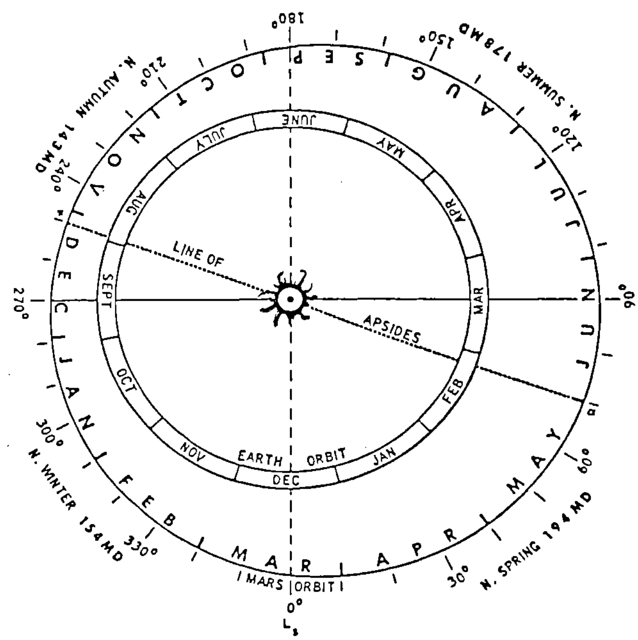


Figure 43. Heliocentric chart of the orbits of Mars and Earth, showing the relative seasons of both planets in the planetocentric longitude system L_S. Drawn by C.F. Capen.

Apparition Characteristics

Oppositions of Mars occur at average intervals of 2 years and 50 days, or 780 TD, defining the mean synodic period of revolution between Earth and Mars. As Spring, 1988, begins on Earth, Mars will appear as a 6".36 disk low in the pre-dawn sky (at 22°.8 S declination). From MAR 21 on, Mars will appear to move north by 0.6 per week, and will linger within one degree of the celestial equator from the first week in August through the first week in September. From JUL 6 through DEC 16, Mars will be within 5 degrees of the equator, a relatively good position for observers in both the Northern and Southern Hemispheres. At opposition, Mars will be at declination 2°.1 S and will move slightly farther south before beginning to move steadily north, as is diagrammed in Figure 44 (p. 161). The 1988 Mars Opposition is at 03h 23m U.T. on SEP 28, at an areographic (Mars-centered) orbital longitude of 280° (L_S), with an apparent disk diameter of 23."7. Mars' closest approach to Earth will be at 03h 18m U.T. on SEP 22, with a distance of 58.7 million km. (36.5 million mi.). Tables 2 and 4 (below and p. 165) give calendars of Martian events.

Table 2. Martian Seasonal and Orbital Calendar.

Terrestrial Date (TD)	Martian Date (MD)	Southern Hemisphere Season
1988 JAN 23	AUG 06 (135° L_S)	Mid-Winter
APR 18	SEP 23 (180° L_S)	Spring Equinox
JUL 02	NOV 07 (225° L_S)	Mid-Spring
AUG 11	DEC 02 (250° L_S)	[Perihelion]
SEP 12	DEC 22 (270° L_S)	Summer Solstice
SEP 22	DEC 28 (276° L_S)	[Closest Approach]
SEP 28	JAN 01 (280° L_S)	[Opposition]
NOV 25	FEB 04 (315° L_S)	Mid-Summer
1989 FEB 16	MAR 21 (000° L_S)	Autumn Equinox

The axial rotation of Mars is slower than that of the Earth, completing one sidereal revolution in 24h 37m, or 350°.89 in 24 hours. Hence, a Martian mean solar day is about 40 m longer than for the Earth, and a Martian feature observed at a particular time will be observed the same time on the next night 9°.11 closer to Mars' west [celestial east] limb. This Martian longitude lag amounts to a full retrograde rotation in about 40 terrestrial days, allowing all longitudes to be seen in this interval from any one location on Earth.

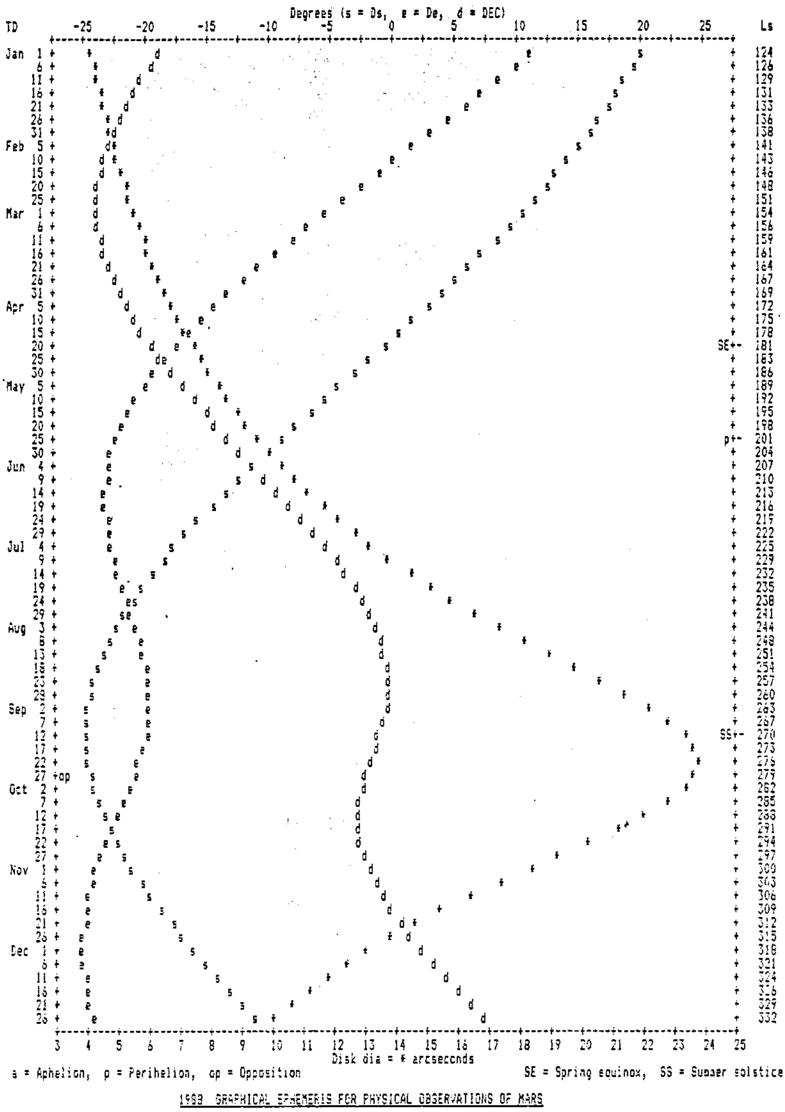


Figure 44. A graphical ephemeris for physical observation of Mars in 1988. The top line gives the areographic latitude of the Sun (s) and the Earth (e) and the geocentric declination of Mars (d), all in degrees. The left column gives the terrestrial date (TD; 0h U.T.); and the right column shows the areocentric longitude of the Sun (L_s; in degrees, defining the Martian Date). The bottom line shows the apparent Martian disk diameter in arcseconds. Prepared by J.D. Beish.

Useful visual observations can be made during most of 1988, as Mars presents a disk diameter of 6".0 or larger from the second week in March through mid-January, 1989. Photography is practical when the disk diameter exceeds 10".0; from MAY 30 through DEC 27. Fine Martian surface details and faint atmospheric phenomena can be seen when the apparent disk diameter exceeds 12".0, or between JUN 21 and DEC 09. Observation of very fine details, such as the large volcanoes in the Elysium and Tharsis regions, or even the large Martian craters or the great canyon Valles Marineris, may be possible when Mars is 20".0 or more in apparent diameter. Mars is above this size from AUG 19 through OCT 24. For more information on this subject, read the article, "Hunting Martian Astroblemes," by C.F. Capen, in the September, 1986, issue of Astronomy magaine (pp. 65-69). Also see Table 3 (below), which gives the telescopic resolution of Martian topographic features. This table assumes Mars' maximum 1988 disk diameter of 23".8, and an equatorial diameter for Mars of 6794.5 km.

Table 3. Areographic Resolution as a Function of Telescope Aperture.

Telescope Aperture		Areographic Resolution		
cm.	in.	Arc* (°)	km.	mi.
15	6	3.7	217	135
20	8	2.7	163	101
25	10	2.2	130	81
32	12.5	1.8	104	65
36	14	1.6	93	58
41	16	1.4	81	50
61	24	0.9	54	34
107	42	0.5	31	19
240**	94.5	0.24	14	9

* Areocentric arc; degrees of latitude or of longitude at the equator.
** Hubble Space Telescope.

Remember that these disk-diameter limitations are only approximate. Some A.L.P.O. astronomers using high-quality 30-cm. (12-in.) or larger telescopes can achieve useful observations even with smaller disk diameters. Also, these observers have taken time during previous apparitions to sharpen their observing skills and to reacquire that acute eye for observing Mars that is lost during its conjunction with the Sun. Many interesting and challenging observational opportunities for Mars are possible during 1988. Table 4 (p. 165) lists early apparition possibilities for both Martian meteorological and albedo changes in 1988.

Polar Regions

The Martian South Pole will be tilted toward Earth throughout the 1988 Apparition. Beginning at -8° in the second week of March, 1988, the areocentric declination of the Earth will decrease to -23° in mid-June, vary between -23° and -20° until late August, and then decrease to -25° in late November (see Figure 44, p. 161). This southerly orientation will allow the observation of antarctic hazes and the Spring-Summer shrinking of the South Polar Cap (SPC). As the Martian South Pole emerges from the darkness of Winter at the time of the southern Spring Equinox, the dull-grey South Polar Hood (SPH) will begin to retreat poleward and to reveal the brilliant white edge of the cap. The grey, hazy hood will linger above the the SPC for several weeks, giving the cap the appearance of a "Life-Saver" that should be seen and photographed from the second week in June through the end of that month. The composition of the SPC is chiefly CO_2 ice; and once free from the polar hood and exposed to direct sunlight, the SPC sublimates rapidly, shines brilliantly, and undergoes spectacular changes during the rapid phase of spring thaw.

In the last weeks of May, 1988, the SPC should be sufficiently clear of its hood that one can begin micrometer measurements. [2] Several bright, white projections will begin to detach from the SPC near this time (210° L_s), and a number of dark rifts in the SPC will become apparent. The locations of these rifts are shown in Figure 45 (p. 163). One of the first of them to become evident should be the Magna Depressio (270°W, 80°S). [When referring to Martian positions, note that east and west are in the IAU directional scheme, and are opposite the celestial directions. Ed.] Near 215° L_s (JUN 16 TD), a dark rift, Rima Australis, should appear between 290°W and 350°W, connecting with Magna Depressio. Also, the SPC should develop a bright projection from 010°W to 020°W in Argenteus Mons. Starting near 220° L_s (JUN 24 TD), a bright projection, Novissima Thyle, should develop at 300°W to 330°W; and a dark drift, Rima Angusta, should appear at 300°W to 060°W. The Novissima Thyle is the famous recurrent cap remnant located to the south of Hellas, also known as the "Mountains of Mitchel," discovered in 1845 by O.M. Mitchel at the Cincinnati Observatory. Once Novissima becomes detached from the cap edge, it is known as Novus Mons ("New Mountains"). In the 1988 Apparition, look for Novus Mons to become detached from the cap edge during the first week in July near 225°-230° L_S, and to disappear in late August. By late May, the SPC will be shrinking rapidly; and its brilliant whiteness will contrast with its dark rifts, making the South Cap the most salient and beautiful feature on the Martian globe.

By using color filters, such as orange (Wratten 23A), yellow (W15), and green (W57), the observer will enhance the contrast of the brilliant cap and its projections.

Figure 45. An orthographic south polar projection reference map of the Martian South Polar Region, showing albedo features and their names. Drafted by J.D. Beish. See also text (pp. 162-163).

Meteorology

The meteorology of Mars has been a subject of great interest to the Mars Section of the A.L.P.O. for the last two decades and will be of prime importance for study in the upcoming apparition. The late Chick Capen was especially fond of writing about the Martian weather and about how to observe its atmospheric phenomena. The special interest that he had in the study of Martian meteorology was an indication of its importance in the understanding of our Solar System. His ability to explain the modern science of planetary astronomy was probably his greatest attribute, and the author finds it hard to write this Mars report without often paraphrasing him. The next several paragraphs are exerpts from Chick's last paper in the J.A.L.P.O., "A Martian Observer's Menu for 1986" (Vol. 31, Nos. 9-10 [July, 1986], pp. 183-189), with appropriate additions and modifications. That paper was coauthored by D.C. Parker and this author.

It is well known that the Martian atmosphere is very dynamic, exhibiting several types of salient condensates that are easily detected with the aid of color filters using modest-sized telescopes. White water clouds, local yellow dust storms, global dust storms, bluish limb hazes, and bright surface ice-fogs and frosts have been studied with increased interest in the past two decades. Observations of these meteorological features indicate that their behavior and occurrence are most often coupled with the seasonal sublimation and condensation of polar-cap material. An intensive statistical meteorology study is now in progress at the Institute for Planetary Research Observatories, utilizing quality visual and photographic observations obtained during each apparition by the A.L.P.O. International Mars Patrol (IMP).

Near local Martian noon, discrete white orographic clouds, identified as water clouds by the Mariner 9 spacecraft, are seen in the summer, forming on the upper slopes of the large volcanoes (Olympus Mons [133°W, 18°N], Ascraeus

Mons [105°W, 11°N], Pavonis Mons [112°W, 00°], Arsia Mons [120°W, 09°S], and Elysium Mons [213°W, 25°N]), and between Tharsis Tholus and Valles Marineris (080°-100°W, 04°N). These seasonal clouds (called "W Clouds" because of their shape) were well observed during northern Summer in 1984 (120°-160°L_s) and in northern Autumn in 1986 (204°-209°L_s), well after rapid thawing of the North Polar Cap (NPC) had begun. In the 1988 Apparition, it will be valuable to learn if the orographic clouds occur twice each Martian year, which may be the case because they originate in the equatorial region of the planet. Look for them after the large southern basins, Hellas and Argyre, have lost their whiteness and have returned to a dark-ocher hue, and during the rapid retreat of the South Polar Cap (SPC) from southern mid-Spring until Summer (235°-270° L_s), from mid-July through mid-September (TD). Because of the observed appearance and seasonal behavior of the great southern basins, the author suspects that they act as "cold traps" during Mars' southern Autumn and Winter, thus controlling the water vapor in that hemisphere. Because orographic clouds are best seen through blue and violet filters, they are well-elevated and are probably generated by mechanical uplift, and grow by convection.

A planetary wind-uplift system of faint white clouds with variable shapes and opacities, known as the Equatorial Cloud Band (ECB), is occasionally seen extending across Mars' disk. Because the ECB is detected best in ultraviolet and violet light, it resides at a chilly high altitude, and is probably composed of CO_2-ice crystals. Because the ECB is equatorial, it too may occur twice each Martian year, appearing with the sublimation of each polar cap. Thus, watch for it during Martian southern Spring and Summer, from April through November, 1988.

Limb Haze appears as a bright misty arc of light on the sunrise or sunset limb of Mars, and is caused by the observer's oblique view through the equivalent of several Martian atmospheres of aerosols, which may consist of CO_2 crystals, fine dust, cirrus-type water clouds, or a mixture of these. Consequently, the observation of the Limb Haze's color and density, and its global location, as determined with color filters, is a very sensitive method of diagnosing the global system of Martian weather and unusual polar phenomena, and in detecting dust storms that have begun on the averted side of the planet.

Limb Haze may be seasonal or nonseasonal, and it disappears around local 8 to 9 A.M. because it does not rotate with the planet. It is best seen in violet light if at a high altitude, or in blue light if at mid-altitudes.

A most delicate and challenging test for observers is the detection of volatiles at the boundary between the Martian atmosphere and its surface. In this volatile regime, ice-fogs and frosts , both often called bright patches , can be distinguished from elevated clouds by means of comparing their relative brightnesses and boundary definitions as seen with the aid of blue, blue-green, green, and yellow filters. If the suspect bright feature appears brighter in blue light than it does in green or yellow, it is an atmospheric cloud. If it is brighter and better defined in blue-green light than in blue or in yellow light, it is probably ice-fog next to the surface. If the patch appears brighter and with sharper boundaries in green and yellow light, and is not well seen in blue light, it can be identified as surface frost. A boundary-layer volatile's diurnal behavior and its location also help to distinguish it from clouds and limb haze. Fogs and frosts form in the chill of the Martian night, rotate with the planet, sublimate in the morning sunlight, and usually disappear by local noon. Fogs normally form in valleys, in fossae (linear depressions), in basins, and on upper slopes. Frosts are usually noted on cool, light albedo features, plana (plateaus), montes (mountains), and on the floors of large craters. Because these volatiles are topographically controlled, the discovery of their locations and seasonal occurrence is most important to the study of Martian weather patterns and topography.

A few selected areas in the Martian deserts that may show whitenings during the 1988 Apparition of Mars are: Aram (015°W, 05°S), Ophir (068°W, 08°S), Sinai (065°W, 18°S), Thaumasia (075°W, 35°S), Tharsis (100°W, 08°N), Nix Lux (112°W, 08°S), Nix Olympica (133°W, 18°N), Memnonia (142°W, 20°S), Zephyria (190°W, 00°), Elysium (215°W, 25°N), Isidis Regio (280°W, 20°N), Neith Regio (275°W, 35°N), Nymphaeum (305°W, 08°N), Hammonis Cornu (315°W, 10°S), and along Deucalionis Regio (345°W, 18°S). [3,4,5]

Table 4 (p. 165) predicts the dates near which seasonal phenomena will be seen on Mars in 1988.

Table 4. Predicted Seasonal Phenomena for Mars in 1988.

This table applies to the Martian Southern Hemisphere during the periods of Spring and early Summer. The first column gives the Terrestrial Date (TD); the second lists the areographic longitude of the Sun in degrees (L_s); the third gives the aerographic declination of the Earth in degrees (D_e); the fourth, the apparent disk diameter in arcseconds; while the final column, "phenomena," describes seasonal events and possible other phenomena for study.

TD (1988)	L_s °	D_e °	Disk Dia. "	Phenomena
APR 01	170	13 S	6.8	Late southern Winter. SPH present and edge of NPH visible. Hellas frost covered? W-clouds present?
APR 19	180	17 S	7.6	Southern Spring Equinox. SPC clear of phase terminator. SPH thinning.
MAY 06	190	20 S	8.5	SPH Thinning. Eastern Syrtis Major fading? White areas brighter?
MAY 23	200	22 S	9.6	Syrtis Major thinner and darker? Surface details increasing in contrast. Hellas bright?
JUN 08	210	23 S	10.8	SPC develops dark Magna Depressio (270°W, 80°S). Syrtis Major very thin?
JUN 16	215	23 S	11.5	Is the Rima Australis visible in SPC (290°-350°W)? SPC bright projection Argenteus Mons (010°-020°W). Is SPC projection Novissima Thyle (300°-330°W) present? Look for possible small yellow clouds in Serpentis-Hellespontus.
JUN 24	220	23 S	12.4	Novissima Thyle detached from cap? Rima Angusta (270°-060°W) across SPC? Yellow clouds in Hellas and Noachis?
JUL 10	230	23 S	14.0	Novissima Thyle detached from SPC, becoming Novus Mons or "Mountains of Mitchel." Rifts on SPC broad and well defined?
JUL 26	240	22 S	16.4	SPC in rapid retreat. Bright spot appears on SPC (155°W)? Rifts in SPC wide and dark? Martian atmosphere clear of clouds, haze, and dust clouds?
AUG 11	250	21 S	18.9	Mars at perihelion. SPC in rapid retreat. Orographic clouds present? Elysium and Arsia Mons bright? Frost in bright deserts?
AUG 27	260	20 S	21.5	Novus Mons smaller. Hellas bright. White areas in bright areas? Watch for initial dust clouds in south.
SEP 12	270	20 S	23.4	Southern Summer Solstice. SPC diameter 14°. Yellow dust clouds in south? Atmosphere clear of blue clouds? White areas in deserts?
SEP 22	276	21 S	23.8	Closest Approach to Earth (03h 18m U.T.).
SEP 28	280	21 S	23.7	Opposition (03h 35m U.T.). NPH extends to 50°N? White clouds rare.
OCT 14	290	23 S	21.8	W-clouds present?
OCT 31	300	24 S	18.5	SPC very small. White areas?
NOV 16	310	25 S	15.6	Is SPC remnant visible? Antarctic hazes present. Check for W-clouds and violet clearing.
NOV 25	315	25 S	14.1	Mid-Summer. Photography still possible.

Records of observations of Mars indicate that yellow dust storms usually occur around the time of southern Summer Solstice (270°L_s), soon after perihelion passage (250°L_s); see Table 5 (p. 166). During the two perihelic apparitions immediately prior to 1986, an initial dust cloud was sighted in the Serpentis-Noachis region on 1971 SEP 21 (259°L_s), having developed overnight, while another one appeared in morning light next to Solis Lacus on 1973 OCT 12 (299°L_s). Each bright cloud soon evolved into a global obscuration that persisted for several months. When a great dust storm has reached maturity, Mars' disk appears bright orange, and few, if any, surface features can be identified. Two "planet-encircling" dust storms were recorded by the Viking Orbiter and Lander on 1977 FEB 15 (204°L_s) and on 1977 MAY 27 (268°L_s) in the Solis Planum region of Mars. [8]

Table 5. Martian Dust Storms, 1877 - 1986.

Terrestrial Date (First Detection)	L_s Range of Visibility (°)	Initial Location	Type	Sources
1877 SEP --	ca. 265	Syrtis Major-Ganges	Major	1
1892 JUL 11	213-218	Hellespontus-Noachis	Transient	3
1894 OCT 10	297-317	Eridania-Argyre	Major	3
1903 MAY 26	123-125	Chryse	Transient	3,5
1909 JUL --	ca. 231	Hellas-Noachis	Major	1
1909 AUG 22	256-286	Eridania-Hellespontus	Major	1,2,3
1911 OCT 11	312-320	Hellas-Noachis	Major	1,2,3
1911 NOV 03	325-015	Southern Hemisphere	Major	3
1914 FEB 10	036-042	Phaethontis-Eridania	Transient	3
1922 JUL 09	190-193	Margaritifer Sinus	Major	3,6
1924 DEC 19	317-346	General; planet-wide	Global	3
1925 OCT 25	310-312	Libya-Moeris Lacus	Transient	2
1926 FEB 09	156-158	Yaonis Regio	Transient	3
1929 AUG 23	115- ?	Trivium Charontis	Major	4
1937 MAY 25	153- ?	Xanthe-Candor	Major	5
1939 MAY 25	180- ?	Utopia-Umbra	Major	1
1939 JUL --	ca. 210	Solis Lacus	Major	1
1941 NOV 12	312-327	Libya-Phaethontis	Major	1,2,3
1943 OCT 03	310-315	Hellas-Libya	Major	2,3,5
1956 AUG 19	250-294	Hellespontus	Global	1,3,5,6
1958 OCT 12	305-311	Libya-Isidis Regio	Transient	2,3,5
1959 MAR 27	033-036	Libya	Transient	3
1961 JAN 19	019-021	Casius-Aetheria	Transient	5
1967 MAY 23	134- ?	Casius-Aetheria	Transient	5
1969 MAY 28	162-168	Hellespontus	Transient	3,5,6
1969 JUN 10	170-173	Zephyria	Transient	3
1971 JUL 10	213-224	Hellespontus	Major	1,3,5,6
1971 SEP 22	260-019	Hellespontus	Global	1,3,5,6
1973 JUL 16	244-273	Hellespontus	Major	3
1973 OCT 13	300-359	Solis Planum	Global	1,3,5,6
1977 FEB 15	204- ?	Solis Planum	Global	6
1977 MAY 27	268- ?	Solis Planum	Global	6
1981 JUN 14	ca. 330	Chryse	Transient	8
1981 NOV 20	048-050	Hellas-Yaonis Regio	Major	7
1982 MAY 12	124-126	Hellespontus	Major	7
1983 NOV 27	070-080	Xanthe-Candor-Thaumasia	Transient	7
1984 JAN 05	086-091	Chryse-Xanthe	Transient	7
1984 JAN 29	097-105	Isidis Regio-Libya	Major	7
1986 MAY 28	178-181	Hellas	Transient	7
1986 AUG 05	218-222	Hellas	Transient	7

Sources:

(1) Mars Scientific Model, JPL Documnent 606-I, Sec. 4.1, 10-12 (1972).
(2) G. de Vaucouleurs, Memorandum of August 24, 1971.
(3) R.A. Wells, Geophysics of Mars, 66-67 (1979).
(4) E.M. Antoniadi, The Planet Mars, 53-57 (1930).
(5) C.F. Capen files, 1900-1973.
(6) L.J. Martin, "Clearing the Martian Air," Icarus , 57 (1984), 313.
(7) A.L.P.O. Mars Section Files, 1980-1986.
(8) Viking-1/JPL photograph, Astronomy , 10 , May, 1982, 66.

Anticipating dust storm activity during the 1986 Apparition, the Mars Recorders alerted observers when yellow dust clouds were visually observed and photographed in Hellas from 1986 MAY 19 (173°L_s) through JUN 08 (184°L_s). Second and third periods when yellow clouds were seen and photographed in Hellas were from 1986 AUG 05 through AUG 24 (219°-230°L_s) and from 1986 SEP 11 through SEP 21 (242°- 248°L_s). Subsequently, Mars passed through the period of highest probability for dust storms without further alerts.

In the 1988 Apparition, the Martian windy season can be anticipated to occur about a month before opposition, from mid-August through September (TD). Look for a streak northwest of the Hellas Basin, passing across Serpentis-Noachis (320°W, 30°S), or in the "Eye of Mars" (the Solis Lacus region; 090°W, 30°S), or perhaps this year within the Chryse Basin (040°W, 10°N); the last because dust clouds were reported in Chryse during the two apparitions immediately prior to 1986; in 1982 and 1984. [6,7] The discovery of new dust-cloud sensitive areographic locations is most important to future Martian exploration missions. To detect dust clouds, use red, yellow, and magenta filters. Refer to Table 5 (p. 166) for a brief history of reported Martian dust storms and their initial locations. [7,8]

For a thorough discussion of how to observe various Martian atmospheric phenomena, see references 3, 9, 10, and 11. For the latest color photography technique, see reference 12.

Martian Surface Albedo Features

One of the most active areas on Mars is the Hellas Basin (292°W, 50°S), due not only to its dynamic meteorlogy but also to its never-ceasing albedo changes. This area merits special attention during the upcoming apparition. Hellas will be covered by a dull-grey haze hood in the early month of the apparition, becoming clear during April, 1988. Erratic behavior should be expected from then on, with bright frost patches in the southern regions of the Basin, merging with the South Polar Hood (SPH). Later in the Martian Spring, Hellas should be clear of any ice or frost patches, and its floor will darken to a rich yellow-ocher color. Surface structure will become apparent when the Basin's darker center (Zea Lacus) extends its arms (or "canals") to the north (Alpheus), and connects Mare Hadriacum (265°W, 40°S) and Yaonis Regio (318°W, 43°S) through the east-to-west "canal" Peneus. As the Martian Southern Hemisphere Summer Solstice approaches, during September, the Basin is expected to become flooded with dust, if and when a violent storm begins.

Light and dark surface features tend to change in albedo and color contrast diurnally and, more slowly, with the seasons. Seasonal variations are usually predictable; but secular, or long-period, changes are not. Several regions that display seasonal changes are: Syrtis Major-Aeria (300°W, 10°N), Pandorae Fretum (345°W, 25°S), Nilokeras-Lunae Lacus (060°W, 25°N), Candor-Tharsis (090°W, 10°N), Elysium-Trivium Charontis (210°W, 22°N), Mare Australe (090°W, 65°S), and Aonius Sinus (105°W, 47°S).

Areas that have been observed to undergo secular changes during recent perihelic apparitions are: Nodus Laocoontis-Amenthes (245°W, 10°N), Nepenthes-Thoth (268°W, 08°N), Thoana Palus (256°W, 35°N), Moeris Lacus (278°W, 08°N), the Antigones Fons-Astaboras complex (298°W, 22°N), Margaritifer Sinus- Hydrae Palus (030°W, 02°S), Solis Lacus (085°W, 26°S), Nilokeras-Lunae Lacus (060° W, 25°N), and Acidalius Fons-Tempes (060°W, 58°N). [3,4,5]

Recent investigations have revealed a possible secular change occurring in the Trivium Charontis region (210°W, 22°N) of Mars during the 1982 Apparition. This area appears to have been covered over with dust during February and March, 1982. A somewhat "washed out" appearance was observed in this region during the remainder of that appariton, and the region has been reported low in contrast ever since. [6] Dust storms during 1983 and 1984 appeared again to lower the contrast of the Elysium and Trivium Charontis region. Dust settled farther to the west, in Nepenthes-Thoth (268°W, 08°N), further changing the overall appearance of Mars over a long period. [7] These areas remained low in contrast for observers during the 1986 Apparition as well.

Another region of Mars that is subject to radical change is the Thaumasia-Solis Lacus ("Eye of Mars") area (090°W, 30°S). Be sure to check this area and to report any apparent change to the A.L.P.O. Mars Recorders as quickly as possible. Many of the areas to watch are shown on the Mars chart in Figure 46 (p. 168).

Finally, remember that the 0 - 10 scale for relative intensity estimates for Martian albedo features now agrees with the standard A.L.P.O. scale, where 0 is the lowest intensity (darkest) and 10 is the highest intensity (brightest). For more information on the celestial position of Mars and on the physical ephemeris of the planet, the A.L.P.O. Solar System Ephemeris for the next calendar year is available from the A.L.P.O. each Fall. [See p. 183 for ordering information.]

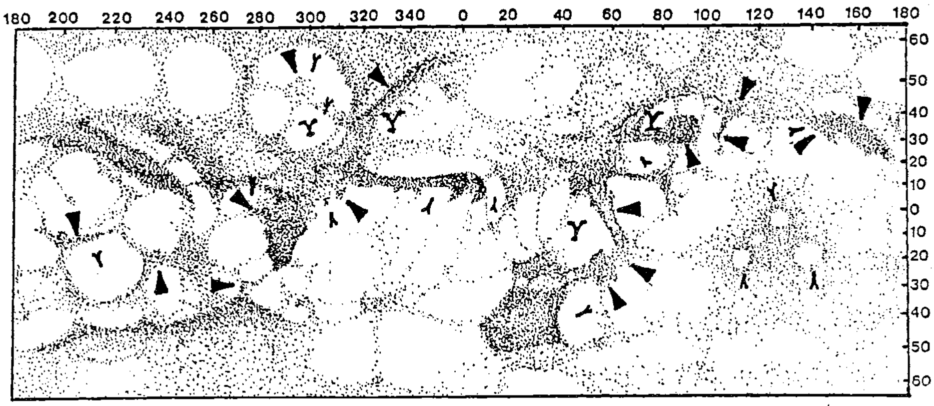


Figure 46. Mars chart on the Mercator Projection, showing possible seasonal and secular changes on Mars for the 1988 Apparition. The large arrows indicate dark-albedo features where recent contrast changes have been observed. The small arrows mark light-albedo areas that are known to exhibit seasonal bright, white patches. Lastly, "Y" symbols show where yellow dust clouds have been observed to originate during Martian local Summer. Chart drafted by J.D. Beish, with features added from 1986 A.L.P.O. observations. South is at top.

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AN AUTOMATED APPROACH TO LUNAR HEIGHT CALCULATIONS

By: Harry D. Jamieson

Many amateurs would like to make accurate lunar height and depth measurements. One of the first things that Galileo did after discovering the craters and mountains of the Moon was to measure their elevations, and this work remains important today. However, some observers are reluctant to try this type of work because they are unsure of the procedures they should follow, or are afraid that the observations or mathematics involved might be too difficult. This paper describes some of the current observational methods, offering readers free access to a computer program which will do all of the mathematics.

When making telescopic observations, or working with a photograph, in order to obtain a height or a depth, the primary goal is to determine the length of the shadow being cast by the feature being measured. This sounds simple; and so it is, with a little care and practice. Let's take the entire process step by step.

1. Obtain shadow-length measurements for those peaks for which you wish to compute heights. These lengths may come from either of two sources.

   A. Visual Observations. There are many techniques for those wishing to obtain their measurements visually, and here are a few of them.

      a. Simple Visual Estimates. Here, one notes that the peak's shadow length is some fraction of the unforeshortened diameter [i.e., parallel to the limb; Ed.] of a nearby comparison crater of known size. Accuracy should be improved by making a number of estimates for the same shadow, using different craters and computing an average. Magnifications should be as high as your telescope and seeing permit.

      b. Direct Reticle Measurement. Reticles from companies such as Jaegers, Meade, or Edmund can be used to measure the shadow length and crater diameters directly, and a micrometer can be used for even more accurate results. In either case, a good clock drive, accurate polar alignment, and your highest practical magnifications are required. [Also, due to the Moon's rapid motion in both right ascension and declination, good slow motions are needed. Ed.]

   B. Photographic Measurements. Photographs are measured directly using a finely divided ruler. Remember, though, that very small-scale photographs are useless, as are those that have been enlarged to the point that one has trouble telling the shadow tip from the grain. The highest possible quality photographs must always be used.

2. Obtain the feature's position from a chart. There are several fine atlases available today that can be used for doing so. [1,5] Note that coordinates should be accurate to 0.001 lunar radii or better, and a finely divided ruler should be used to make the measurements.

3. Bring your computer up and load the program. Run it and enter your measured feature position and shadow length, as well as the Universal Date and Time of your observation or photograph. Your results will appear on the screen and may also be printed.

Vertical studies are one of the few areas remaining open for the amateur who wants to make a really worthwhile contribution to our knowledge of the Moon's topography. There are literally thousands of mountain heights and crater depths that are as yet unmeasured, and these measurements may now be made easily and in quantity by almost anyone. Also, because the heights obtained are relative heights [i.e., differences in elevation between summits and the ground upon which the shadow tips fall; Ed.], it can be seen that it is not difficult to obtain the vertical profile of the ground along the path of an elevation's shadow tip when several measurements are made at various solar altitudes and the results are plotted on a graph. The references at the end of this paper (p. 169) describe the mathematics used in the program. [2-4,6,7]

The computer program mentioned above was written for the Commodore 64 and, while I retain commercial rights to it, it is offered free of charge to anyone sending me a C64-formatted diskette and a return postage mailer. Persons having other types of computers may receive a listing (about 350 lines) by sending me a SASE with 39 cents postage on it. My address is: Harry D. Jamieson, 907 Birdsong Street, Heber Springs, AR 72543.

[Note that the observer should record the time of his measurement or photograph to 1-minute accuracy. If the absolute apparent shadow length is measured, rather than that relative to a crater diameter, one needs to know the micrometer or reticle constant and to take into account the Moon's varying apparent diameter. A small inaccuracy is caused by the program's using the geocentric lunar position rather than that relative to the observer; this will be serious only near Full or New Phase. Ed.]

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A.L.P.O. CONVENTION REPORT--UNIVERSE'87

By: David H. Levy

Held on July 11-16, 1987, at the campus of Pomona College, in Claremont, Southern California, the 37th Convention of the Association of Lunar and Planetary Observers was one of the busiest meetings that we have had in years. This was the 40th anniversary of the founding of our association; and we celebrated this occasion with a number of other astronomical societies, including the Astronomical League, the Western Amateur Astronomers, the Astronomical Society of the Pacific, the International Amateur-Professional Photoelectric Photometry Group, the International Occultation Timing Association, and the Planetary Society.

The meeting was a stunning success. Breaking the pattern of most meetings, the banquet was held on the evening of the first day. The A.L.P.O.'s Walter H. Haas Award for an outstanding observational career went to Jean Dragesco. A French citizen, Jean spends most of his time in central Africa, with summertime returns to France. His best-known contribution to amateur astronomy is his planetary and lunar photography; many of his views of Mars and Jupiter are among the best ever taken from the Earth. He also draws and, frequently, writes--besides many papers, he is a co-author of La Photographie Astronomique d'Amateur. Walter Haas himself presented the award which, in Jean's absence, was accepted for him by Don Parker, the 1986 recipient. This award's name, of course, commemorates Walter Haas, and we were all moved to see him so honored on the 40th anniversary of his founding of the A.L.P.O.

Most of the A.L.P.O. papers were given on Monday, July 13th. We met early that morning for a panel discussion between three comet hunters who have been successful in recent years--Don Machholz, Bill Sorrells, and the author. Other papers that morning concentrated on the planet Mars, with Jeff Beish and Don Parker explaining the results of the 1986 Apparition and looking forward to the 1988 one. It was especially pleasant to note the length of observational coverage of the past apparition, with A.L.P.O. founder Walter Haas providing the last observation just three weeks before we gathered to discuss Mars. [The evening before, the Planetary Society hosted a symposium about "Mars Watch '88," in which our Mars Section is participating. Other A.L.P.O. speakers were John Hewitt, "Supernova-Triggered Comet Showers;" Julius Benton, "The A.L.P.O. Lunar Selected Areas Program;" and John Westfall, "Galilean Peregrinations." David Levy modestly did not mention that he was the Convention Keynote Speaker, delivering "In the Shadow of Kitt Peak: The Special Joy of Amateur Astronomy." Ed.]

The afternoon of July 13, the A.L.P.O. had its annual Workshop. This year's emphasis was on the presentation and reporting of data; a discussion moderated by John Westfall. Afterwards we were treatd to an outstanding planetary photography show by Don Parker. The remaining Association events were the annual Business Meeting and our traditional exhibit.

Any meeting held in Southern California would not be complete without tours to all the observatories. This meant Mount Palomar, Mount Wilson, Big Bear Solar, Goldstone, and Table Mountain Observatories, plus the Jet Propulsion Laboratory! Unfortunately, the tours competed with the paper sessions, so that some people who had travelled across the country to attend were forced to miss some of the papers they had come to hear in order to visit the places they had come to see. Caveat emptor; we can't have everything!

Figure 47. A major drawing card of any convention is the opportunity to renew acquaintances. From left to right are Mars Recorder Jeff D. Beish, past Saturn Recorder Thomas Cragg, Comets and Meteors Recorder David Levy, and Mars Recorder Donald Parker.

Figure 48. The Jet Propulsion Laboratory's Table Mountain Observatory. From left to right are the domes of the 16-in. Cassegrain, 10-in. Schmidt, and 24-in. Cassegrain telescopes. The Cassegrains were used extensively in the 1960's by the late A.L.P.O. Mars Recorder Chick Capen.

I took advantage of Tuesday's tour to Big Bear Solar Observatoru, situated in its namesake lake in the San Gabriel Mountains. The choice of a high-altitude lake for its location appears to have succeeded in improving at least the daytime seeing. Although such a site at night would be subject to dew, the telescopes are used only for the daily Sun patrol.

My Thursday, July 16, tour went to Mount Palomar, with its 200-inch telescope. I marvelled at how beautiful and proud this telescope looks. In a sense, great marvels of engineering, like bridges and telescopes, are all wonderful sights, but the 200-inch is something special. Amateur astronomers feel a further kinship with this instrument, designed as it was by Stellafane's Russell W. Porter. I feel an extra-special kinship because its birth in May of 1948 was at almost the same time as mine.

Six days of meetings, camaraderie, trips, observing, the company of those who love the sky... The memories make this meeting especially worthwhile.

A.L.P.O. SOLAR SECTION OBSERVATIONS FOR ROTATIONS 1784 - 1786 (1987 JAN 03 TO 1987 MAR 27)

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

The period covered by this report is both short and relatively inactive. At present, we are unable to cover Rotations 1787 and later due to a request for those data by NASA-Goddard. The inactivity exhibited in this period is even now ending as their data request clearly shows. Further comments about increasing solar activity are given at the end of this report.

While sunspot minimum occurred in September, 1986, according to Patrick McIntosh of the Space Environmental Services Center of the National Oceanic and Atmospheric Administration (NOAA/SESC), some of the lowest counts per rotation were seen in this period. In one case, the count was the second lowest during the last few years. The highest daily count of sunspots for these three rotations was only 25, while the count was 0 for nearly half the days. The changes in sunspot numbers are graphed in Figure 49 (p. 172).

In this report, the term "group" will mean only white-light collections of sunspots, while "region" will refer to areas in all wavelengths. Regions are numbered by NOAA/SESC in Boulder, Colorado. All times are given in Universal Time (U.T). All directions are heliographic and are abbreviated (N, S, SE, etc.). Other terms are defined in The Handbook for the White Light Observation of Solar Phenomena, available from this Recorder for $US 6.00.

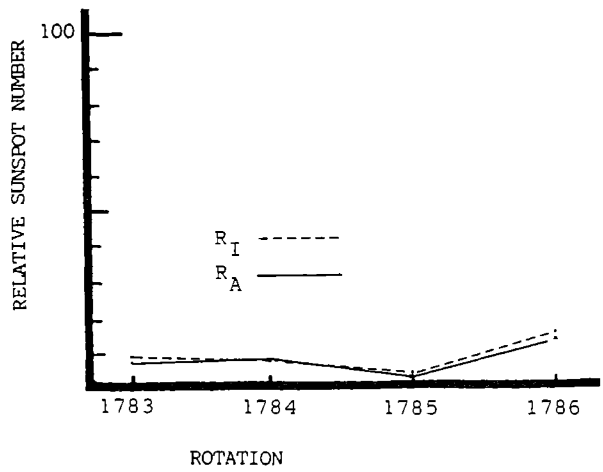


Figure 49. Graph of rotation means of R_I (the International Sunspot Number) and R_A (the American Sunspot Number) for Solar Rotations 1784 - 1786.

The observers who contributed to this report are:

Observer	Telescope: Aperture (cm.)	f-ratio	Type	Stop (cm.)	Location
Garcia, G.	20	f/10	Schmidt-Casssegrain	--	Illinois, U.S.A.
Hill, R.	6	f/13	Refractor	--	Arizona, U.S.A.
Maxson, P.	15	f/13.3	Refractor	--	Arizona, U.S.A.
" "	28	f/10	Schmidt-Cassegrain	14	" "

Rotation 1784 (1987 01 03.73 to 1987 01 31.07)

Sunspot Number [1]	Mean	Maximum (date)	Minimum (dates)
R_I	8.5	23 (01/23)	0 (8 days)
R_A	8.8	20 (01/23)	0 (9 days)

The activity for this rotation was low; and 30 percent of the days had no spots at all, but it was not the lowest for this recording period. [1,2]

As the rotation opened, SESC 4763 was on the decline and well past the central meridian (CM). In the closing days of the previous rotation, Hill and Maxson had observed a leading spot with a rudimentary penumbra and with some umbral spots following. As this rotation began, on 01/04 Garcia noted only a trace of a penumbra and found the following umbral spots gone. However, in Hydrogen-Alpha light, he noted a dark filament following the region. On 01/05, the remaining spot had lost all its penumbra and was only 3 or 4 granules in size. As this feature left the disk on 01/07, it was only a small umbral spot.

Another region was originally designated "Boul. 485," but was changed to SESC 4765 and then, just before it dissolved completely, "RAMEY 007." Here we shall use the single designation of SESC 4765. This region was born on the CM on 01/21. The next day was its best; Hill and Maxson observed a penumbra around the leading spot, with a dozen umbral spots following. On the 23rd, the penumbra was gone; and the region was reduced in extent. Though the spots were gone by 01/26, many bright faculae were noticed as the area went around the limb.

As SESC 4765 was leaving the disk, SESC 4767 was just entering. The first observations recorded a small grouping of umbral spots of Zurich Class B [a small spot group with no penumbra; Ed.]. SESC 4767 never developed beyond this point and died on the disk on 01/30.

Rotation 1785 (1987 01 31.07 to 1987 02 27.40)

Sunspot Number [2]	Mean	Maximum (dates)	Minimum (dates)
R_I	3.9	19 (02/27)	0 (16 days)
R_A	2.6	12 (02/09 & 25)	0 (20 days)

This rotation had the lowest mean sunspot counts since June, 1986! Well over half the days were entirely spotless. [2,3] Only one observation showed any activity, and that was only one spot. Even as seen by Garcia in Hydrogen-Alpha, things were quiet.

Rotation 1786 (1987 02 27.40 to 1987 03 26.72)

Sunspot Number [3]	Mean	Maximum (dates)	Minimum (dates)
R_I	14.8	24 (03/05 & 07)	0 (03/12 & 13)
R_A	13.3	25 (03/06)	0 (03/12 & 13)

Activity increased somewhat with this rotation. It could hardly go lower! Two regions were of note, SESC 4778 and SESC 4781. [3,4]

SESC 4778 was first observed by Maxson, on 03/07. At that time, it consisted of a leading spot group with a main spot that had a penumbra, and a following group made up of numerous umbral spots and pores. Garcia noted a possible rudimentary penumbra later that day, with a dark filament connecting the two collections of this bipolar group. On 03/09 and 03/10, Hill observed that only a single spot remained, with a symmetrical penumbra.

On 03/20, Maxson observed that the disk was spotless. By the following day, he made the first observation of SESC 4781, noting it as a leading spot with a penumbra, followed by a collection of umbral spots. On 03/22, the following collection had formed an arc oriented NE-SW, while the leading spot increased in size and had added several following umbral spots. This apparent organization was gone the next day because the following group was then no longer an arc. However, one of the following spots had developed a penumbra by then. This was to be the maximum development of the region as, by 03/24, all penumbrae were gone. As it went around the limb on the 25th, this region was reduced to two small collections of umbral spots.

Due to the low activity during this reporting period, it appears that many observers have temporarily been put off from making observations. We encourage them to get back quickly into the routine because, in our latest conversation with Patrick McIntosh of NOAA/SESC, he informs us that, by Summer, 1988, we can expect sunspot counts of over 100! The time for practice and refinement of technique is over, and the work is about to begin in earnest. For more details, see the announcement at the end of this report.

I am pleased to note that the latest compilation in the ALPO Solar Section Catalog of Data has shown that, for a limited number of rotations, we are approaching our first goal of one photograph and one drawing in white light and in Hydrogen-Alpha for each U.T. day. We are indebted to Recorder Paul Maxson for his hard work in assembling this catalog for the Section. The observers are also to be congratulated for their perseverance in making the over 2000 observations that the catalog contains. [This 41-page catalog is available for $3.25 from Paul Maxson, 8839 N. 30th Ave., Phoenix, AZ 85051. Ed.]

SPECIAL SOLAR ACTIVITY ALERT--Rapid Rise of Solar Cycle

The following is an excerpt from "Special Solar Activity Alert #3," by Patrick McIntosh:

> "The October [1987] radio flux value confirms that the present rate of rise to the solar cycle exceeds all previous radio cycles of record, including the record cycle of the 1950's. At the present rate of increase, solar activity will attain conditions equivalent to the maximum of Cycle 20 (1968) within 6 months. Conditions equivalent to the maxima of Cycles 18, 19, and 21 may be reached early in 1989. Monthly solar indices are expected to rise rapidly during the next year, especially by January and possibly beginning this month [November, 1987]."

References

1.) Solar-Geophysical Data (prompt reports), Part I, No. 510, February, 1987.
2.) ________, No. 511, March, 1987.
3.) ________, No. 512, April, 1987.
4.) ________, No. 513, May, 1987.

COMET NOTES: XII. REPORTING COMET OBSERVATIONS

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

If I didn't know how to observe comets, I would still have a way of knowing when a bright comet was coming by. Gradually, the mail increases, and inside the envelopes are drawings and other observations of a brightening comet.

Comet Bradfield 1987s was a real treat right from the start; its discovery on 1987 AUG 11 by William Bradfield marks the first time in this century that a comet hunter has found more than 12 comets. The first A.L.P.O. observation received was from Jim Scotti, who estimated the comet at $M_1 = +9.1$ on 1987 AUG 13, where M_1 is the total apparent visual magnitude. It then had a fairly strong degree of condensation (DC = 4; see below), indicating a well-developed inner coma. A.L.P.O. observers reported its dramatic behavior in a number of ways. Kermit Rhea has submitted a regular series of observations; on 1987 NOV 18, he reported a tail 7 degrees long, as seen through his 7X50 monocular. Two nights later, he noted that the coma had become smaller and more condensed.

The changing coma diameter of a comet can be reported easily and quantitatively on a ten-point scale called "Degree of Condensation" (DC). Ranging from 0 to 9, a report of DC = 0 would indicate a diffuse object without the slightest hint of condensation and DC = 9 would mean a starlike central condensation. Note that, if you see a high DC, you still are not seeing the comet's nucleus. You are seeing a brightness condensation around the nucleus, or "nuclear condensation." The only comet nucleus that has been observed with certainty is that of P/Halley, imaged by the Vega and Giotto spacecraft.

In the case of Comet Bradfield, the DC changed from night to night, with most A.L.P.O. observers reporting it as between 4 and 7, inclusive, indicating the changing activity of dust jets that erupt as different areas of the rotating nucleus are exposed to sunlight. A strong jet eruption is also known as an "outburst," and we can record such events visually using two factors; a suddenly increasing DC, and a brightening total visual magnitude (M_1). An outburst can cause a comet's DC to increase by 3 or 4 points from one night to the next and the M_1 to rise by a whole magnitude or more. Observations received from Gary Nowak of Vermont record the changing brightness of Comet Bradfield. To make his estimates, he compared the brightness of 1987s to that of several stars whose brightnesses he knew.

Magnitude estimates are often made by the Sidgwick method, in which you begin by memorizing the brightness of the coma. If the DC is high, with a great variation in intensity from the center to the edges of the coma, determining the "average" brightness of the coma is difficult and requires practice. You need to memorize this brightness because your comparison stars will not be in the same eyepiece field. Then, defocus a comparison star to the size of the coma when it was in focus, and compare the star's brightness to that of the coma. Keep up the process until you can interpolate the comet's brightness between those of two or more defocused stars.

During the evening of 1987 DEC 21 U.T., Dean Ketelson of Tucson photographed the appearance of a strong antitail stretching more than 1 degree in front of Comet Bradfield, at position angle 240 degrees [between southwest and west; Ed.], while Charles Morris of California detected some 8 degrees of main tail. Two nights later, I observed the antitail visually through both a 8-cm. refractor and my 41-cm. reflector, when this feature appeared to stretch 1.5 degrees in a sunward direction.

Accompanying this article is the A.L.P.O.'s "Visual Observation Report Form" for comets (Figure 50, p. 175). Following it (Figure 51, p. 176) is the "Explanation of Visual Report Forms" needed to fill out the form itself. The Comets Section has encouraged the use of this form, but we have not had much success in getting our observers to record their data on it. The form was originally designed for use with the International Comet Quarterly (ICQ), and

[Text continued on p. 176.]

VISUAL OBSERVATION REPORT FORM

Observer ______________ Comet ______________

UT Date and Time	M. M.	Coma (Total) Magnitude	Chart No.	Instrument Aperture	Instrument Type	Instrument f/	Magnification	Coma Dia.	D.C.	Tail Length	Tail PA	Faintest Star	Dark Adapted	Site	Notes

Figure 50. The "Visual Observation Report Form" recommended for the recording and submission of visual observations to the A.L.P.O. Comets Section.

Explanation of Visual Report Forms*

Coma Dia. - The coma diameter observed in minutes of arc.   long and short dimensions of an elliptical coma.

Coma (total) Magnitude - The coma's estimated magnitude should be reported to the nearest 0.1 magnitude. If the magnitude is based on stars whose magnitudes are underlined, underline your estimate.

Dark Adapted - Indicate Y (yes) or N (no) if you were dark adapted when the comet observation was made.

D.C. - Give the degree of condensation of the coma.

Faintest Star - Give the magnitude of the faintest star visible to the naked eye (to within 0.5 magnitude) on the star chart containing the comet's position for the night of the observation. M, T, C or Z should be included with the stellar magnitude when moonlight, twilight, city lights or zodiacal light, respectively, interfere with the observation.

Filter(s) Used - List the filters used when the drawing was made.

Instrument - For Aperture, give the objective diameter in centimeters. Type describes the optical system (refractor, Newtonian, Cassegrain, Schmidt-Cassegrain, binoculars, etc. and f/ is the focal ratio of the instrument.

Magnification - Found by dividing the telescope focal length by the focal length of the eyepiece used for the observation.

Magnification(s) Used - List of magnification(s) used when the drawing was made.

M.M.- The magnitude estimation method used.

B = Bobrovnikoff, S = Sidgwick, M = Morris

Observer - Each individual observer should use his/her own observing report form, complete with his/her name.

PA - Position angle of tail(s). For a curved tail give the distance from the nucleus where the measurement applies. Give the method used for determining it (plot, clock face, calibrated eyepiece). P.A. is defined to be 0° for due north and increases through 90° due east, 180° due south and 270° due west. In the field of view, with the clock drive off, the last portion of an object drifting out of the field of view is the eastern piece. Thus, PA is well defined even in circumpolar regions of the sky.

Seeing - Estimation of the seeing quality in seconds of arc or describe seeing in some other standard manner.

Site - Give the name of your observing site used for the reported observation. If the site is not one listed on your Observer Index form, include the longitude, latitude and altitude. Longitude, latitude and altitude are available on topographic maps available at appropriate government offices and some sporting goods and map stores. If these coordinates are not available, give the nearest town, village or major landmark and its distance and direction from the site.

Tail Length - Reported in degrees and tenths of degrees. Use two lines if two tails are visible.

UT Date and Time - Local dates and times should be converted to UT. Times given in UT should be accurate to ±0.005 day.

Chart No. - Here indicate type of chart for reference stars, where AC equals AAVSO chart, AA equals AAVSO atlas, NP equals North Polar Sequence, etc.

*Explanation and Report Forms duplicated from *International Halley Watch Amateur Observers' Manual for Scientific Comet Studies, Part I.* NASA JPL Publication 83-16, Part I

Figure 51. Explanation of terms used on the "Visual Observation Report Form" of the A.L.P.O. Comets Section that appears in Figure 50 (p. 175). See also text.

[Text continued from p. 174]

was adapted somewhat by the International Halley Watch. It asks for the important information of magnitude, coma diameter, degree of condensation, and tail length and position angle; and the information is recorded in a way that can be transferred easily to a machine-readable database. The Comets Section will forward only those visual observations to the ICQ that are completed in this format.

OBSERVING METEORS: XII. GETTING STARTED WITH METEORS

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

Did a meteor start your interest in astronomy? Is it possible that a falling star plummeted toward Earth one evening, and in its fall attracted your attention and awakened you to the night sky?

That happened to me one Fourth of July, sometime in the late 1950's. Our summer camp in Vermont had finished celebrating, and the sky was filled with stars. I noticed a particular star high overhead, probably Vega. Just then, a faint "star" appeared. It was gone in a few seconds, leaving a short trail. It did not come back, nor did the sky lose a star; but the event did leave a seed in my mind that would grow years later.

A meteor is not an object but an event. The actual particle in space, called a "meteoroid," may be no larger than a grain of sand. It is seen directly only if it is large enough to survive its fall and actually hit the Earth's surface. (We call what hits the Earth a "meteorite.") Many of these particles, travelling in swarms, cross the Earth's orbit; when one of them enters our atmosphere, the resulting air resistance causes it to glow.

We look for meteors at certain times of the year, when they appear in greater numbers. These "meteor showers," as they are called, occur as the Earth passes through large streams of particles that travel in a comet's wake. Meteor showers appear to come from points in the sky called "radiants." Toward the end of April, and culminating on April 22, the Lyrid meteors occur. Each Lyrid can be traced back to a point in the constellation of Lyra. This convergence is actually an effect of perspective. When the Earth crosses a meteor stream, where all the meteors travel in the same orbit, the meteors obviously come from the same direction, like the two rails of a railroad track. Just as you look down a track and see the rails appear to converge, the distant meteors offer the same effect.

The Lyrids can be a surprising shower. On the average, these meteors usually have been observed at a rate of about 15 per hour under a dark sky when the radiant in Lyra is nearly overhead. However, in 1982 the Earth passed through an unusually dense part of the stream, and one observer recorded a rate of 80 per hour. [Note that conditions for viewing the Lyrids will be favorable in 1988, because the 5-day old Moon will have set when Lyra is high in the sky. Ed.]

In early May comes another shower, radiating from Aquarius. Particles of this "Eta Aquarid" stream, best seen in the morning sky, come each year from Comet Halley as we cross its orbit. Although the shower is active from April 21 until May 25, it reaches a strong peak just before dawn on May 3. [Unfortunately, in 1988 the 16-day old Moon will be up throughout the peak date of the shower, its light drowning out the fainter meteors. Ed.]

Of more and more interest in the past few years are the Geminids, whose increasing numbers have made this shower the year's best. On a clear moonless night, a single observer should see some 75 meteors per hour when the radiant is near the zenith. Although this shower is within a quarter of its maximum rate for about 2.6 days on either side of the December 14 maximum, it is best to observe it on the 14th between midnight and dawn. [In 1988, the 5-day old Moon will have set by then. Ed.]

In 1987, several observers noted a clumping effect for the Geminids, sometimes seeing nothing for up to 5 minutes, followed by a burst of four or five meteors within a minute. Thus, the 62 meteors that I saw in a 75-minute period appeared in such bunches that at times the sky appeared to be drizzling meteors.

Do shower nights offer the only chance to see meteors? Not by a long shot—meteors can appear on any hour of any night. The mystery of observing meteors lies in their uncertainty, in that they are never quite reliable enough to appear without surprises. With this in mind, some observers watch the sky every night in the hope of catching a previously undetected stream.

Several times every year. some dedicated—or lucky—observer enjoys a night during which meteors fall from a radiant where no meteors had been seen before, or sees an unusually strong shower from a previously known radiant. The more often you are out under the stars watching meteors, whether or not a shower is predicted, the greater is your chance of being lucky and seeing something new.

Imagine a night towards the end of November, 1966, when observers set up to watch the Leonid shower. Every 33 years, the Earth travels through a very dense part of that stream; the part near where the parent comet, Tempel-Tuttle 1866 I, is. A group of dedicated observers on the East Coast of the United States even rented an airplane to carry them over the clouds in hopes of seeing something; after all, in the previous two years the rates of the usually mild shower--15 per hour--had increased dramatically. The group in the airplane was not disappointed. As dawn brightened the sky, bright meteors were appearing every minute, with the rate increasing rapidly.

The sky was still dark in the American Southwest, where under crystal-clear conditions, people stared at a sky blazing with meteors. The rate was 40 meteors per second ! At any time at the height of the storm, the sky was filled with bright meteors.

Quite a difference, wouldn't you say? From the rare experience of a meteor storm to the all-too-common sight of a single meteor dropping out of the sky--just one meteor that is enough to launch a career in astronomy, meteor observing is something special. Go out tonight, meteor shower or not. Take a walk and see if a meteor accompanies you. See if two or three might identify a shower. When you watch meteors, you become a part of our planet's lazy journey around the Sun, picking up particles as it goes.

COMING SOLAR SYSTEM EVENTS: MARCH - MAY, 1988

These notes are intended as brief reminders of forthcoming astronomical events. For more information, consult more detailed sources such as the 1988 edition of the A.L.P.O. Solar System Ephemeris. All dates and times given here are in Universal Time (U.T.). It is clear that a considerable variety of celestial events takes place in these three months!

Planetary Visibility. --The only planets in the evening sky for most of this period will be Venus and Jupiter. This evening apparition of Venus is a very favorable one for Northern Hemisphere observers, with the planet at its farthest north (+27°.7 on MAY 06) for several decades. Greatest Eastern Elongation (46°) occurs on APR 03, Dichotomy (predicted half-phase) on APR 05, and Greatest Brilliancy (Mag. -4.5) on MAY 06. During the period MAR 01 - MAY 31, Venus' phase decreases from 67 percent to 6 percent illuminated, while its apparent diameter grows from 17" to 53". Jupiter will be observable in the southwest in the evening until mid-April, when it will move too close to the Sun (conjunction being on MAY 02). Venus and Jupiter will pass 2° apart on MAR 06. Mercury will appear in the evening skies in late May, reaching Greatest Elongation East (22°) on MAY 19; an apparition favorable for our Northern Hemisphere.

In the morning sky during this period, Mercury will be visible in early March, and will be at its Greatest Elongation West (27°) on MAR 08. This apparition will be most favorable for Southern Hemisphere observers. Mars will be moving slowly westward from the Sun, rising 3-4 hours before the Sun and being near the meridian at sunrise. Its disk diameter will increase from 5".7 to 10".2 during the March-May period, so that useful drawings can be made for almost all of this interval, and photography can begin in late May. [Predictions of Martian meteorological events are given in the article by J.D. Beish in this issue on pp. 158-168.] Saturn is also a pre-dawn object, located to the west of Mars, rising well before midnight by late May, and should be a striking sight in the telescope because its Ring System is inclined 26° to our line of sight. The outer planets Uranus and Neptune are in the same area of the sky as is Saturn. On MAR 07, Mars will pass 1°.4 south of Neptune, which will help in finding the latter. Then, for those who want a real challenge, Pluto will be in opposition to the Sun on MAY 01, at 14th magnitude.

During this three-month period, there will be four occultations by planets of stars listed in the Smithsonian Astrophysical Catalog (SAO); here, visual magnitudes are given in parentheses: (1) MAR 05, 09h--Mars (+1.0) occults SAO 187025 (+9.3); for 207 seconds in the eastern United States, West Indies, and South America. (2) MAY 07, 06h--Venus (-4.5) occults SAO 77478 (+8.0); for 30 minutes in southern Canada, the northern United States, and Hawaii. (3) MAY 11, 20h--Venus (-4.5) occults SAO 77675 (+4.6); for 43 minutes in Western Europe. (4) MAY 18, 01h--Mars (0.0) occults SAO 164817 (+8.0); for 344 seconds from Europe, North Africa, and the Middle East.

The Moon. --The chief lunar events are two eclipses. On MAR 03, a very "shallow" partial umbral lunar eclipse occurs, of magnitude 0.003. The predicted times of eclipse events are: First Penumbral Contact, 13h 43.6m; First Umbral Contact, 16h 06.1m (at Position Angle 205°, as measured from celestial north to the east); Middle of the Eclipse, 16h 12.7m; Last Umbral Contact, 16h 19.5m (Position Angle 211°); Last Penumbral Contact, 18h 41.9m. These times mean that the entire eclipse will be visible from southern, central, and eastern Asia, and Australia. Western North America and the Pacific will see the beginning phases only; while Africa, Europe, and the Middle East will see the ending phases only.

Then, just two weeks later, a total solar eclipse occurs on MAR 18. This eclipse has a maximum duration of 3m 51s, the longest since 1983, but the path of totality touches land only in Indonesia and the Philippines (southern Mindanao), then crosses the northern Pacific, ending slightly south of the Aleutians. The partial phases of this eclipse will be seen throughout the northern Pacific, from Alaska, and from northern Australia and southern and eastern Asia.

Besides occulting the Sun, the Moon passes in front of three planets: (1) Mercury (+0.1); MAR 16, 05h--26° W of the Sun; seen from Indonesia, New Guinea, and northern, central, and western Australia. (2) Venus (-4.4); APR 20, 00h--45° E of the Sun; from Scandinavia and the northern Soviet Union. (3) Mars (+0.1); MAY 09, 06h--87° W of the Sun; from southeast South America and Madagascar. The busy Moon also passes through the Pleiades star cluster on MAR 22 (12h, 23-percent phase; seen from northern Asia and Japan) and APR 18 (22h; 7-percent phase; seen from the North Atlantic and the British Isles). It should also briefly be mentioned that the Moon will occult the bright stars Spica (on MAR 07, APR 03, APR 30, and MAY 27) and Antares (MAR 10, APR 06, MAY 04, and MAY 31) during this same period.

Meteor Showers. --We shall have favorable conditions for viewing two meteor showers. There will be a New Moon for the maximum of the Sigma Leonids on APR 17, although this shower actually lasts from MAR 21 to MAY 13. Then, the Moon will be only 5 days old for the Lyrids, a major shower peaking on APR 22. This shower has a peak zenithal rate of 15 per hour and lasts only 2 days. Unfortunately, a third shower, the Eta Aquarids, will be seriously affected by moonlight. They peak on MAY 03 when the Moon will be two days past full.

BOOK REVIEWS

Coordinated by J. Russell Smith

To Utopia and Back: The Search for Life in the Solar System. By Norman H. Horowitz. W.H. Freeman and Co., 41 Madison Avenue, New York, NY 10010. 1986. 192 pages, 23 Illus. Price $17.95 cloth (ISBN 0-7167-1765-4); $11.95 paper (ISBN 0-7167-1766-2).

Reviewed by David McDavid

As the former head of the Jet Propulsion Laboratory's Bioscience Section for the Mariner and Viking missions to Mars, Norman Horowitz speaks with compelling authority when he summarizes this book with the statement: "Since Mars offered by far the most promising habitat for extraterrestrial life in the solar system, it is now virtually certain that the earth is the only life-bearing planet in our region of the galaxy." A truly utopian reader might take solace in the section of the book which recounts the overturning of many theories concerning the nature of Mars which were widely accepted in their day, but the factual evidence against life presented here appears overwhelming.

Being a fanatical student of astronomical literature who routinely skips the biochemistry articles in Science, I found it very refreshing to be led by an expert through a comprehensive but not taxing review of the chemical basis for the existence of life. While covering the essentials such as the genetic code and the properties of water, Horowitz finds room for entertaining diversions about bizarre desert animals and an Antarctic pond which remains liquid at -24 degrees Celsius.

I highly recommend this book to those like myself who are interested in the subjects of planetology and extraterrestrial life, but rarely study them technically because of preoccupation with other aspects of astronomy. I was very pleased to find a complete history of the investigation of Mars and a wealth of detailed and up-to-date results from the Mariner and Viking missions presented in such a concise and palatable form. Finally, one of the strongest points of To Utopia and Back is that it was written by an official who was directly involved in the highest level of Mars research, which provides assurance that the information is representative of our very best current knowledge.

Guide to the Stars: Exploring the Sky with Binoculars. By Leslie C. Peltier. Astromedia, Kalmbach Publishing Co., 1027 North 7th Street, Milwaukee, WI 53233. 1986. 185 pp., Illus., index. Price $11.95 paper plus $1.00 shipping/handling (ISBN 0-913135-04-6).

Reviewed by Alain C. Porter

Each of us who knows well the night sky has fond memories of our earliest guidebooks; beginners' star maps from which, perhaps, we no longer learn anything new, but which taught us the constellations. Leslie Peltier's Guide to the Stars is such a book, and will generate many such memories.

The layout of the text is direct and sensible. Assuming the role of a trail guide, Peltier starts with the circumpolar Big Dipper as a reference constellation, and gives some sound advice on choosing binoculars. He then proceeds through the constellations season by season, for that is how people who stay interested learn them. That done, he presents chapters on the Milky Way, variable stars, novae, the Sun, the Moon, planets, comets, and meteors. Appendices listing bright stars and constellations are formatted so that readers can log their first observations there. The index appears reasonable in size, containing about 120 entries.

I found very little to quarrel with in this book. I thought that some constellations didn't get quite a fair shake; even Hercules is described as "difficult." The traditional misstatement that Messier 31 is the most distant object visible to the naked eye is repeated. I accepted the emphasis on variable stars, except when comet hunting was called a "forlorn prospect," made obsolete by photography. This is an odd statement from a man who discovered a dozen comets in 30 years, especially after an enthusiastic chapter on nova hunting. Two references to darkened glasses slip into the text after a warning never to observe the Sun directly.

These points, however, are minor when compared to the book's strengths. I have already praised its organization. The sky maps are presented both as drawings (black background) and sketches (white background), which complement one another very well. The drawings of the Moon, held at a distance, look like photographs. Curious facts hold the reader's interest. Although I spoke of not learning new things, this book reminded me that Polaris still almost two lunar diameters from the north celestial pole, that the period of R Hydrae has decreased by 100 days since its discovery, and that Rigel is about 150,000 times as luminous as the Sun.

The main feature that distinguishes this book from the generic beginner's guide is Peltier's style. It is steeped in his love of terrestrial as well as celestial nature, from his associations of the birds with the constellations of Spring to his quotations from poets such as Whittier and Tennyson. Better, the writing makes the reader feel noticed. I put down this book with a feeling of having listened to a tape of the author's voice.

The best use for Guide to the Stars is to spark someone's interest in astronomy. I recommend it highly to anyone who is thinking of trying to turn a friend into a fellow stargazer. But if you do buy it for someone else, browse through it yourself first!

NEW BOOKS RECEIVED

Notes by J. Russell Smith

Stars. By Seymour Simon. William Morrow and Co., 105 Madison Avenue, New York, NY 10016. 1986. 28 pp., Illus. Price $13.00 cloth (ISBN 0-688-05855-8).

The author describes different kinds of stars and has included many good color photographs to aid his description. The text is elementary and easy to read, which makes this book a fine choice for beginners in astronomy. The author explains in simple terms the cause of red giant stars, which is seldom done in elementary texts. As a retired teacher of astronomy, I certainly recommend this excellent text.

<u>The Sun.</u> By Seymour Simon. William Morrow and Co., 105 Madison Avenue, New York, NY 10016. 1986. 26 pp., Illus. Price $13.00 cloth (ISBN 0-688-05857-4).

This text describes the Solar System, shown in a large drawing. Simon describes the Sun as something like an "endless hydrogen bomb," with a core temperature of 27 million degrees Fahrenheit. <u>The Sun</u> is illustrated with excellent color photographs. I recommend it for any beginner in astronomy.

<u>Envoys of Mankind.</u> By George S. Robinson and Harold M. White, Jr. Smithsonian Institution Press, P.O. Box 4866, Hampden Station, Baltimore, MD 21211. 1986. 292 pp., bibliography, index. Price $19.95 cloth, plus $1.50 postage and handling (ISBN 0-87474-820-8).

This book's chapters are "Embryonic Astronauts," "From Argonauts to Astronauts," "From the Right Stuff to the Appropriate Stuff," "Spacekind: The Transition Species," "Spacekind: A New Definition of Humankind," "Astrolaw and Space Law," "Space Law and Government," and "Metalaw."

<u>Thunderstones and Shooting Stars.</u> By Robert T. Dodd. Harvard University Press, 79 Garden St., Cambridge, MA 02138. 1986. 196 pp., Illus., references, index. Price $24.95 cloth (ISBN 0-674-89137-6).

This book's eleven chapters are "Target Earth," "Meteorite Recovery," "Types of Meteorites," "Three Perspectives on Chondrites," "Sources of Meteorites," "Chondrite Parent Bodies," "When Planets Melt," "Iron Meteorites and Pallasites," "Achondrites and Their Parent Bodies," "Meteorites and the Early Solar System," and "Meteorites and Life on Earth." If you have an interest in this subject, you will want this excellent book on your shelf.

<u>The Tucson Meteorites. Their History from Frontier Arizona to the Smithsonian.</u> By Richard R. Willey. Smithsonian Institution Press, P.O. Box 4866, Hampden Station, Baltimore, MD 21211. 1986. 45 pp., Illus., index. Price $8.95 paper, plus $1.50 postage and handling (ISBN 0-87474-983-2).

After a Preface, one finds the following chapters: "Anvils from Heaven," "Tucson: The Middle of Nowhere," "Don Ramon's Whalebone," "Lieutenant Irwin's Coup," "The Grand Deception," and "Missed by Only a Foot." There follows an "Appendix: Facts and Physical Characteristics," "Notes," and the index. I recommend this book to those interested in meteorites.

<u>Satellites.</u> Edited by Joseph A. Burns and Mildred Shapley Matthews. University of Arizona Press, 1615 E. Speedway, Tucson, AZ 85719. 1986. 1021 pp., Illus. with color and map section, bibliography, Glossary, index. Price $55.00 cloth (ISBN 0-8165-0983-2).

This book is up to date, with 18 chapters and 45 collaborating authors. There is some advanced mathematics, but you needn't be a mathematician to enjoy this book. The color section is excellent.

<u>ANNOUNCEMENTS</u>

<u>ALCON'88.</u> --As announced in the last issue, the Astronomical League and the Association of Lunar and Planetary Observers will meet together at Council Bluffs, Iowa, on July 27-30, 1988. This will be our 38th Convention, and we invite all members to come and to participate. We'll have a paper session, as well as a workshop; and it is certainly not too early to begin preparing a paper. Papers can be read <u>in absentia,</u> and printed in the <u>Proceedings,</u> if they

have been received beforehand. A.L.P.O. speakers should send their paper titles, with brief descriptions, to the A.L.P.O. Director (P.O. Box 16131, San Francisco, CA 94116) by May 15, followed by camera-ready copy by July 1. The A.L.P.O. will have an exhibit; and, if you have work to display, either bring the materials with you or send them to our Exhibits Coordinator, Julius L. Benton, Jr. (whose address as Saturn Recorder is given on our inside back cover), by no later than July 15. Finally, it is important that A.L.P.O. members attending ALCON'88 also come to our Business Meeting because this is their only chance to discuss and to vote on issues important to our entire organization. The A.L.P.O. Paper Session will be held on Thursday morning, July 28, and our Workshop that afternoon; our Business Meeting will be scheduled later.

Doings with the Mars Recorders. --In anticipation of an increased workload during the favorable 1988 Mars Apparition, a new Assistant Mars Recorder, Carlos E. Hernandez, has been appointed. Mr. Hernandez has been an enthusiastic Mars observer for many years. He, and the other Mars Recorders, Donald C. Parker, M.D. and Jeff D. Beish, request that mail be sent to their post office box address: ALPO Mars Recorders, P.O. Box 97-0469, Miami, FL 33197-0469.

Mars Watch '88. --The A.L.P.O. is cooperating with the Planetary Society in "Mars Watch '88." This program will coordinate amateur and professional observations of Mars during the highly favorable 1988 Apparition and will also involve astronomy educators in teaching the public about the Red Planet. Part of this cooperation is the forthcoming publication by the Planetary Society of the A.L.P.O. Mars Section's Mars Observer's Handbook. It is available for $US 5.00 from: Planetary Society, 65 N. Catalina Avenue, Pasadena, CA 91106.

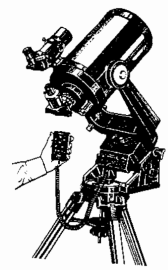
Although not done as a part of "Mars Watch '88," a related publication has been released by the Astronomical Society of the Pacific; their "Mars Kit" contains six color slides of Mars, a 36-page booklet, and a list of readings and audio-visual aids. This publication may be ordered for $11.50 (which includes postage and handling; add $US 2.50 if outside the United States) to: A.S.P., Mars Kit Dept., 1290 - 24th Ave., San Francisco, CA 94122.

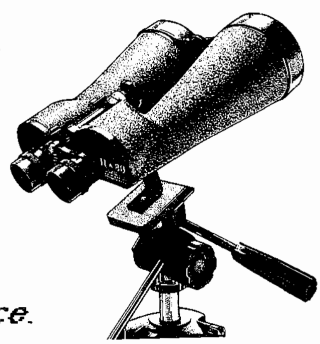
Solar Catalog. --Paul Maxson, Solar CoRecorder, has recently completed the ALPO Solar Section Catalog of Data, and can provide a copy for $US 3.25 (this includes postage); write to him at his address on the inside back cover. This 45-page catalog describes 2072 solar drawings and photographs received by the A.L.P.O. Solar Section by 1987 SEP 12, beginning on 1979 APR 13. Each entry gives the Carrington rotation number, U.T. date and time, SESC Region, type of observation (white-light or Hydrogen-Alpha), observer, size of print (if a photograph), availability, and the Rotation Report where the data originally appeared.

The Ashen Light of Venus. --The period from January to November, 1988, is a golden opportunity for solving the mystery of the "Ashen Light," an intermittently observed illumination of the planet's dark hemisphere which has been reported for centuries. The A.L.P.O., in cooperation with three other groups of Solar System observers, will join Pioneer Venus-Orbiter scientists in a mutual study of the Ashen Light. Amateur astronomers will provide the direct observational support for this program, and here is an opportunity for interested enthusiasts to contribute something of real value to science. Interested observers are invited to write Julius L. Benton, Jr., the A.L.P.O. Venus Recorder, whose address appears on the inside back cover of this publication.

The Io Patrol. --It is well known that the Voyager space missions found active volcanoes on Jupiter's satellite Io. It is less well known that these volcanic eruptions have been detected at infrared wavelengths by earthbased observers. Because of limited observing time, it is unfortunately likely that many such eruptions have been missed. However, large-scale eruptions may well "resurface" such large portions of Io that its (B - V) color index could be locally changed. What we need to detect such color changes is (B - V) photoelectric photometry, which, for Io, can be done with amateur-size telescopes. This will be a joint amateur-professional project, with the amateurs observing at visual wavelengths and the professional observing in the infrared. Those interested in participating in this program, and who have access to a photoelectric photometer, B and V filters, and at least a 20 cm. (8-in.) telescope, should write for further information to Assistant Jupiter Recorder, John E. Westfall, whose address is given on the inside back cover.

Foreign Membership Fund. --Our "Foreign Membership Fund," announced in the last issue, is intended to aid deserving amateur astronomers who would like to join the A.L.P.O., but who live in countries where dollars are not available. This fund now contains $60.00, thanks to the generosity of H.W. Kelsey, David H. Levy, and Darryl J. Davis.





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STAFF