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The planet Jupiter, captured with a charge-coupled device image on 1990 JAN 05, 20h 42m 30s U.T. Taken in red light with the 1-meter Cassegrain reflector of Pic du Midi Observatory. The team that produced this image included P. Laques, Ch. Buil, and A.L.P.O. member Jean Bourgeois. See also pp. 80-81 of this issue. South at top, Jovian west to the right; CM(I) = 069°.2; CM(II) = 157°.0. Note the "missing" South Equatorial Belt, considerable activity in the Equatorial Zone, satellite Ganymede (to the upper left), and Ganymede's shadow to the right of the satellite.

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THE 1987-88 APPARITION OF SATURN: VISUAL AND PHOTOGRAPHIC OBSERVATIONS

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

ABSTRACT

Visual and photographic studies of the planet Saturn and its Ring System were carried out by 18 A.L.P.O. Saturn Section observers between 1988 FEB 14 and 1988 NOV 28 with instruments ranging from 7.6 to 105.0 cm in aperture. Saturn showed a slight increase in its atmospheric activity when compared with the 1986-87 observing season. The inclination of the Rings to our line of sight, **B**, reached a maximum of +26°.936 during 1987-88; exposing the Northern Hemisphere of the Globe and the north face of the Rings to our inspection. This report is accompanied by references, drawings, photographs, graphs, and tables.

INTRODUCTION

A meaningful variety of visual and photographic observations of the planet Saturn and its Rings was contributed throughout the 1987-88 Apparition, constituting the basis of this analytical report. The observing season covered by these data was from 1988 FEB 14 to 1988 NOV 28; and the observer participation, as well as the incidence of simultaneous observations, was about the same in 1987-88 as it had been in the 1986-87 Apparition. Selected drawings and photographs accompany this report in order to enhance the reader's understanding of the text and tables. [Note that all dates and times in this report are in Universal Time, or "U.T."]

Table 1, below, gives pertinent geocentric data for the 1987-88 Apparition of Saturn. Note that the saturnicentric latitude of the Earth, **B**, referred to the ring plane and positive when north, varied from +26°.126 on 1988 APR 15 to +26°.936 on 1988 SEP 26, while the saturnicentric latitude of the Sun, **B'**, ranged from +26°.730 on 1988 FEB 14 down to +26°.251 on 1988 NOV 28. [4]

Table 1. Geocentric Phenomena for Saturn in the 1987-88 Apparition. [4]

Conjunction	1987 DEC 16, 03^h
Opposition	1988 JUN 20, 09
Conjunction	1988 DEC 26, 12

Opposition Data:

Visual Magnitude	+0.0
B	+26°.483
B'	+26°.598
Declination of Saturn	-22°.301
Globe Diameter: Equatorial	18".33
Polar	16".75
Rings: Major Axis	41".58
Minor Axis	18".54

Table 2, to the right, lists the 18 persons who submitted a total of 200 observations to the A.L.P.O. Saturn Section for the 1987-88 Apparition, together with their observing sites, number of dates of observation, and descriptions of their telescopes.

Table 2. Contributing Observers, 1987-88 Apparition of Saturn.

Observer & Location	No. of Obser.	Telescope Data*
Julius L. Benton, Jr.	13	8.3cm (3.3in) REFR
Wilmington Island, GA	11	15.2cm (6.0in) REFR
Paul H. Bock, Jr.	3	15.2cm (6.0in) REFR
Sterling, VA	1	7.6cm (3.0in) REFR
Jean Bourgeois	1	105cm (41.3in) CASS
Pic du Midi, France		
Donald H. DeKarske	5	10.2cm (4.0in) REFR
Colorado Springs, CO		
Marc A. Gelinas	1	15.2cm (6.0 in) REFR
Quebec, Canada		
David L. Graham	10	15.2cm (6.0in) REFR
Brompton-on-Swale, U.K.		
Francis G. Graham	3	17.8cm (7.0in) REFR
East Pittsburgh, PA	1	25.4cm (10.0in) NEW
Walter H. Haas	33	31.8cm (12.5in) NEW;
Las Cruces, NM	2	20.3cm (8.0in) NEW
Charles B. Haun	8	44.5cm (17.5in) NEW
Morristown, TN	43	33.3cm (13.1in) NEW
Alan W. Heath	9	30.5cm (12.0in) NEW
Nottingham, U.K.		
Frank J. Melillo	1	20.3cm (8.0in) S-C
North Valley Stream, NY		
Woodie F. Morris	2	25.4cm (10.0in) NEW
Manahawkin, NJ		
Gary T. Nowak	3	22.9cm (9.0in) REFR
Essex Junction, VT	1	20.3cm (8.0in) NEW
	1	10.8cm (4.25in) NEW
Tim Robertson	2	15.2cm (6.0in) NEW
Palmdale, CA		
Robert Robotham	7	15.2cm (6.0in) NEW
Springfield, Ontario	5	8.3cm (3.3in) REFR
Richard W. Schmude	3	25.4cm (10.0in) NEW
College Station, TX	1	20.3cm (8.0in) S-C
	9	15.2cm (6.0in) NEW
Michael E. Sweetman	19	26.2cm (10.3in) CASS
Tucson, AZ		
Cristofol Tobal	2	22.0cm (8.7in) NEW
Barcelona, Spain		

Total Observations 200

Total Observers 18

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

Overall, observer participation, as well as the incidence of simultaneous observations, was about the same in 1987-88 as in the immediately preceding apparition. *Figure 1*, below, gives the distribution of observations by month in 1988, showing that 85 per cent of the observations were for the months of May through September, 1988, with a perceptible decline in frequency on either side of this peak. Also, *Figure 2*, below, shows that 29.5 percent of the observations were made before opposition, 1.0 percent on the date of opposition, and 69.5 after that date. It is usual that the maximum observational coverage of Saturn falls near, or slightly after, opposition, as in 1987-88. This of course creates observational bias; and we encourage all observers to try to maintain a consistent surveillance of Saturn, starting as early in each apparition as possible, and continuing until Saturn nears the time of conjunction with the Sun.

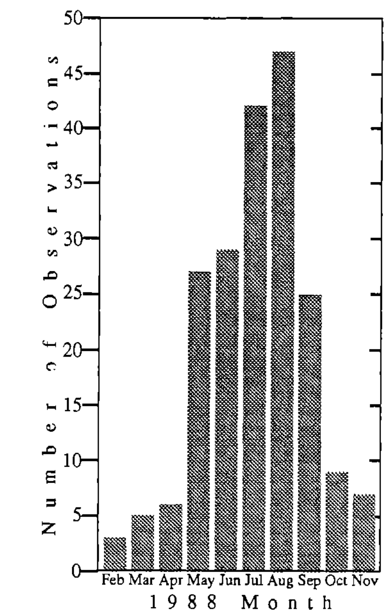

Figure 1. Distribution of observations of Saturn by month during the 1987-88 Apparition (200 observations total).

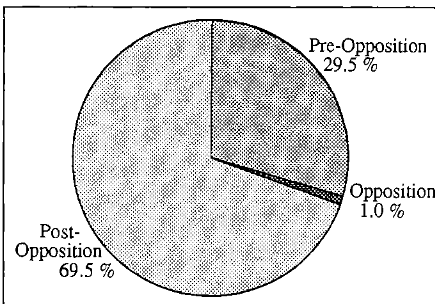

Figure 2. Distribution of observations of Saturn for the 1987-88 Apparition in relation to opposition date.

Figure 3, below, depicts our observer base in terms of nation of observation; usually also nation of residence. About one-third of our observers were located outside the United States, chiefly in Canada and Europe, which demonstrates the continuing international scope of our work. *Figure 4*, also below, shows the geographical distribution of the observations themselves, which shows a somewhat stronger bias towards the United States, which supplied four-fifths of the observations.

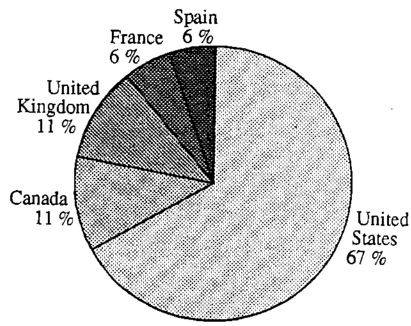

Figure 3. Distribution of Saturn observers by nation of observation for the 1987-88 Apparition.

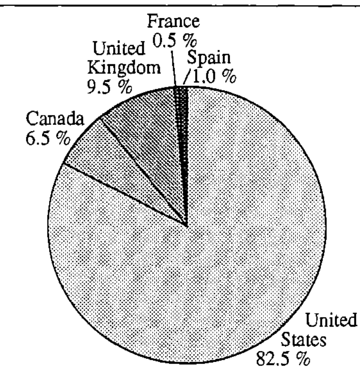

Figure 4. Distribution of observations of Saturn by nation of observing site for the 1987-88 Apparition.

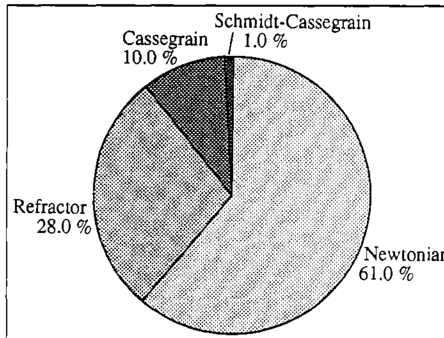

Figure 5. Distribution of Saturn observations for the 1987-88 Apparition in terms of type of telescope.

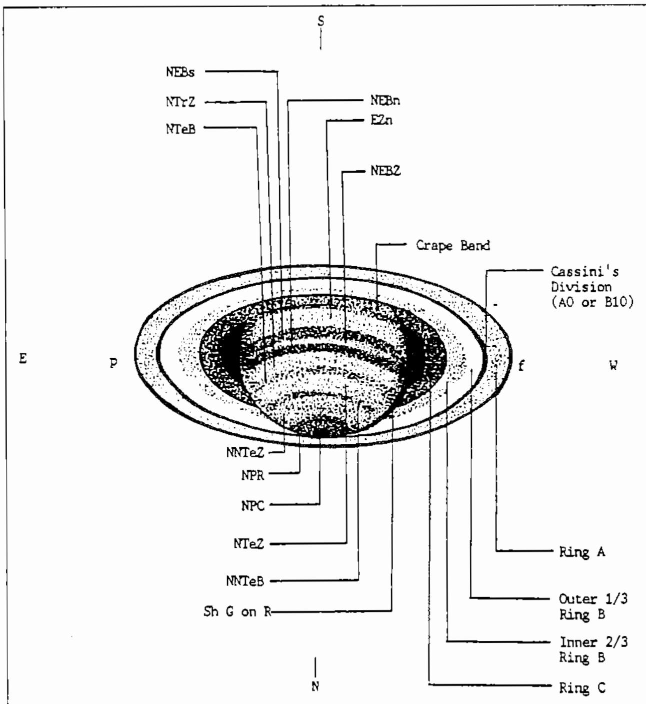

Figure 6. The general appearance of Saturn near opposition (1988 JUN 20), with nomenclature of the major Globe and Ring features that were easily detected with moderate apertures in good seeing. South is at the top and global features move across the planet from right to left in this normal inverted view (i.e., as seen in an astronomical telescope near culmination in the Earth's Northern Hemisphere without a prismatic diagonal or other device that would reverse the image). East (E) and West (W) are shown in the International Astronomical Union (IAU) convention; in the celestial convention, East would be to the right. The numerical value of **B** is about +27°. The text discusses the Globe and Ring features shown here. Some minor features that are not depicted include the: North Polar Belt (NPB), encircling the NPR; Shadow of the Rings on the Globe (Sh R on G); Terby White Spot (TWS), adjacent to the shadow of the Globe on the Rings (Sh G on R); Encke's Division (A5), when detected midway between Cassini's Division (A0 or B10) and the outer edge of Ring A; and any intensity minima in several Ring components, mentioned in the text. The easternmost and westernmost extensions of the Rings are called the ansae. "p" stands for preceding and "f" for following. **[1, 2]**

Finally, *Figure 5* graphs the 1987-88 observations by type of instrument. Once again, telescopes of classical design dominated the scene, due chiefly to their overall proven performance and soundness of design and consistent favorable image contrast and resolution; all desirable for planetary work. Also, seven-eighths of the observations were made with instruments of 15 cm. (6 in.) aperture or greater, and over half with instruments larger than 25 cm. (10 in.).

During the 1987-88 Apparition, seeing conditions averaged about 5.0 on the A.L.P.O. Seeing Scale, which ranges from 0.0 for the worst possible seeing to 10.0 for perfect conditions. Atmospheric transparency, expressed as the magnitude of the faintest star visible to the unaided dark-adapted eye near the object being observed, averaged about +4.0 during the same period.

The writer expresses his warmest gratitude to all the dedicated colleagues mentioned in *Table 2* who carried out their observations as part of the A.L.P.O. Saturn Section. We are continuing to encourage and coordinate more intense and comprehensive coverage of Saturn in coming apparitions. The cooperation of the A.L.P.O. with such groups as the British Astronomical Association (BAA) and the Royal Astronomical Society of Canada (RASC) continues, along with the potential of enlisting regular exchange of data between the A.L.P.O. and groups in Belgium, Germany, Spain, Hungary, and Australia. We are attempting to establish and maintain a growing worldwide observer base in the coming years by using standardized and comparable methods of data acquisition. We heartily invite interested observers to join us, regardless of experience or nationality.

THE GLOBE OF SATURN

The descriptions that follow have been derived from an analysis of the reports contributed to the A.L.P.O. Saturn Section throughout the 1987-88 Apparition. For the purpose of brevity, except when the identity of an individual is judged to be pertinent to the discussion, the names of observers are not given in the text. Numerical tables, graphs, drawings, and photographs accompany the text and readers should refer to them while reading this report. Features on the Globe are discussed in north-to-south order and can be identified by the nomenclature diagram in *Figure 6.* above. Southern Hemisphere features are not described because most of that portion of the Globe was hidden from view by the Ring System in 1987-88. Also, a few individuals conducted central meridian (CM) timings of atmospheric detail on Saturn, although none of the features persisted long enough for confirmation or for reliable rotation rates to be derived.

Northern Portions of the Globe.—The Northern Hemisphere of Saturn showed limited activity during the 1987-88 Apparition, and it is evident that there was about the same frequency of recurrent local phenomena when compared with the immediately preceding observing season. The detail recorded in the Northern Hemisphere of Saturn was mostly ill-defined in 1987-88, but there were instances when discrete features could be seen fairly easily in such regions as the NTeB (North Temperate Belt), NTrZ (North Tropical Zone), NEB (North Equatorial Belt), NEB Z (North Equatorial Belt Zone), and EZ (Equatorial Zone).

The following summary of the Northern Hemisphere atmospheric features compares data between apparitions, as in prior Saturn observing reports, in order to help the reader to appreciate the subtle but recognizable variations that may be underway, both seasonally and long-term. **[3]** It is often felt that the varying tilts of Saturn's rotational axis with respect to the Sun and the Earth play a rather significant role in any recorded changes in belt and zone intensities, such as are given in *Table 3* (p. 54). The intensity scale used here is the A.L.P.O. Standard Numerical Relative Intensity Scale, where 0.0 is total black and 10.0 is the brightest possible condition; this scale is normalized by setting the outer third of Ring B at a standard brightness of 8.0. The sign of an intensity change is found by subtracting a feature's 1986-87 intensity from its 1987-88 intensity.

All of the belts observed in 1987-88 were reported as slightly darker than they had been in 1986-87. Note that a change of only ±0.1 mean intensity points is considered to be of no significance. [More precisely, a change is not likely to be significant unless it is greater than about 3 times its standard deviation. Ed.] The zones, however, stayed at about the same intensity between the two apparitions, except for a slightly brighter NTeZ (North Temperate Zone) and EZn, and a darker NEB Z.

North Polar Region (NPR).—The brightness of the diffuse, greyish NPR remained essentially the same between 1986-87 and 1987-88, with a difference of +0.1 mean intensity points. The intensity of the NPR was mostly uniform throughout except for a few localized features, and no clearly discernible NPC (North Polar Cap) was detected in the extreme north. The NPB (North Polar Belt), sometimes seen encircling the NPR, was rarely reported in 1987-88; and when seen, the NPB was linear, somewhat fragmented along its entire circuit, and dark greyish in color. No truly abnormal activity was noted in association with any of these features in 1987-88.

With color filters, the NPR was only slightly brighter in yellow (W12) and green (W58) light than in integrated light (+0.2 mean intensity points); where the filter designation "W" means the Eastman Kodak Wratten series, followed by the standard filter number. The NPR was seen at its brightest when using the W80A (light blue) Filter (+0.5 mean intensity points). [Note that it is in theory impossible for a feature to appear consistently brighter or darker throughout all or most of the spectrum than in integrated light, although such was reported for several Saturnian features in 1987-88. It is possible that the particular filters used enhanced the visual contrast and thus appeared to increase their brightness or darkness. Ed.]

North North Temperate Zone (NNTeZ).– The NNTeZ was sighted only twice in 1987-88; as a light yellowish-white region, quite diffuse and uniform in intensity from limb to limb. The NNTeZ and the NTrZ were nearly equal in intensity in 1987-88.

North North Temperate Belt (NNTeB).— During 1987-88, the NNTeB was described as a very thin, continuous linear feature, dusky yellowish-grey in hue, and devoid of detail or intensity variations. It was slightly darker in 1987-88 than in 1986-87; by -0.4 mean intensity points. Comparing IL (integrated light) and color-filter views, the NNTeB was -0.3 darker in red light (W25), but considerably brighter (+1.2 intensity points) and less conspicuous as a belt in light-blue light (W80A).

North Temperate Zone (NTeZ).—Observers described the yellowish-to-yellowish-grey NTeZ throughout 1987-88 as a distinct zone showing occasional intensity differences, although these were transient and poorly defined. The NTeZ was second only to the EZn in being the brightest zone, and showed an increase in brightness of +1.0 mean intensity points from 1986-87 to 1987-88. In terms of color-filter impressions, the NTeZ was slightly darker in yellow light (W12; -0.3 mean intensity points) and considerably darker in light-blue light (W80A; -1.8 mean intensity points) in relation to IL.

North Temperate Belt (NTeB).—This belt was frequently reported as narrow, usually uniform, very dusky yellow to yellowish-grey, and extending from one limb to the other. This belt was slightly darker in 1987-88 compared with 1986-87 (-0.3 mean intensity points), continuing a darkening trend that started in 1985-86. Compared with IL, the NTeB was slightly brighter in red light (W25; +0.2 mean intensity points), but more so in green (W58) and light-blue light (W80A; by +0.4 mean intensity points in each case).

North Tropical Zone (NTrZ).—The NTrZ in 1987-88 exhibited little if any change in brightness compared with 1986-87 (+0.1 mean intensity points). Observers assigned a yellowish-white color to this zone in 1987-88, and it was usually constant in intensity from limb to limb throughout the observing season. When compared with IL, the NTrZ was +0.3 mean intensity points brighter in red light (W25), green light (W58), and yellow light (W12); and was +0.4 mean intensity points brighter with a light-blue filter (W80A).

North Equatorial Belt (NEB).—The greyish-brown NEB was often seen in 1987-88 as differentiated into the NEBn and NEBs, where

n refers to the North Component and **s** to the South Component, separated by the NEB Z (North Equatorial Belt Zone). This aspect was common in 1987-88, but the NEB was just as often seen as a single feature. As a whole, the NEB was slightly darker in 1987-88 than in 1986-87 (-0.4 mean intensity points), and was actually the darkest belt on Saturn in 1987-88. In comparison with IL, the NEB was lighter in red light (W25; +0.6 mean intensity points) and slightly brighter in green light (W58) and light-blue light (W80A; by +0.3 mean intensity points for both).

The dark greyish-brown NEBn showed a decrease in mean brightness by -0.7 mean intensity points from 1986-87 to 1987-88. Observers detected several discrete features within the NEBn, but none lasted long enough for CM transit timings.. Using a yellow filter (W12), the NEBn was -0.4 mean intensity points darker than in IL.

The greyish-brown NEBs was the darkest belt on the Globe of Saturn in 1987-88, which had been the case in 1986-87 and for several other recent apparitions. The NEBs showed a reduction in overall intensity by -0.6 mean intensity points since 1986-87. This belt component was slightly diffuse at its edges and showed a mainly uniform overall intensity across the Globe for much of the 1987-88 observing season. Nevertheless, several diffuse and vague features were seen in the NEBs, but all were short-lived. The intensity of the NEBs showed no real variation from IL when viewed with color filters.

The NEB Z was dull yellowish-grey during most of 1987-88, showing a mean intensity decrease of -1.1 since 1986-87. As in the immediately previous apparition, the NEB Z had the distinction of being the darkest zone on Saturn in 1987-88. While these two factors might suggest that this zone would be troublesome to see in contrast with its environment, particularly as the Globe north of the Rings was the same average intensity as the NEB Z, the location of this zone between the darker NEBn and NEBs made it possible to distinguish the feature. Some very subtle festoon activity was reported in 1987-88, but persisted only for a short time. Otherwise, the NEB Z was uniform in intensity during the observing season. When seen in yellow light (W25), the NEB Z was -1.0 mean intensity points darker than in IL, while the zone was +1.5 points brighter in green light (W58).

Equatorial Zone (EZ).—Unless otherwise specified, this report concentrates on the EZn, which was pale yellowish-white in 1987-88, and showed a very slight brightness increase of +0.5 mean intensity points as compared with 1986-87. The EZn was the brightest global feature on Saturn in 1987-88, and indeed brighter than any portion of the Rings other than Ring B and the Terby White Spot (TWS). No definite features were sighted within the EZn during 1987-88 other than vague suspicions of a few whitish spots and wispy festoons that faded rapidly. Thus, the intensity of the EZn remained fairly constant throughout the 1987-88 observing season, except that Haas recorded a subtle brightening trend in this region from late July through the end of November, by which time Saturn became poorly placed for observation.

The Equatorial Band (EB) was detected infrequently during the 1987-88 Apparition; and when seen well, the EB was yellowish-grey in hue, very narrow, linear, discontinuous along its extent across the Globe, and slightly darker in overall mean intensity as compared with 1986-87 (by -0.8 intensity points).

Shadow of the Rings on the Globe (SH R on G).—The Shadow of the Rings on the Globe of Saturn was not described by any of the observers who submitted data to the A.L.P.O. Saturn Section in 1987-88. [Due to the values of **B** and **B'**, it should have overlapped the Crape Band at this time. Ed.]

Shadow of the Globe on the Rings (SH G on R).—The shadow of the Globe on the Rings was seen as a greyish-black feature in 1987-88, regular in form. Any deviation from the true black condition (intensity 0.0) can be attributed to poor seeing. [Scattering of light in our atmosphere, the telescope, and even the observer's eye probably also play a role. Ed.]

LATITUDES OF SATURN'S BELTS

Benton, Schmude, and Haas were the only observers during the 1987-88 Apparition to submit visual latitude estimates for features on the Globe of Saturn, using the method developed by Haas many years ago. In this method, estimates are made of the fraction of the polar semidiameter of the planet's disk that is subtended on the central meridian (CM) between the limb and the belt whose latitude is sought. [Note that this method was complicated by the fact that Saturn's south limb was hidden by the Rings in 1987-88. Ed.] This method is easy to use, and its results compare well with similar values obtained by filar-micrometer measurements. After mathematical reduction, the resulting latitudes appear in *Table 4* (p. 55). It must be remembered, however, that it is often risky to place too much confidence on data from only a few observers; but Haas particularly has been using this technique for a number of years with good, usually reliable results. Other persons are strongly urged to employ this simple procedure whenever it is possible, even if a filar micrometer might be available. This advice is given because data from both methods would be useful for comparison. A full discussion of this visual technique can be found in the *Saturn Handbook.* **[2]**

THE RINGS OF SATURN

This section covers the analysis of the observations of Saturn's Ring System that were submitted throughout the 1987-88 Apparition, together with a continuing comparative study of the mean intensity data as has been done for previous apparitions. As noted in the Introduc-

Table 3. Visual Numerical Intensity Estimates and Colors: Saturn, 1987-88.

Globe/Ring Feature	Relative Intensity (1987-88) Number of Estimates	Mean and Standard Deviation	Change Since 1986-87	"Mean" Derived Hue (1987-88)
ZONES:				
NPR	68	4.1 ±0.44	+0.1	Greyish
NNTeZ	2	6.0 -------	-0.1	Light yellowish-white
NTeZ	18	6.3 ±0.26	+1.0	Dusky yellowish-grey
NTrZ	53	5.9 ±0.78	+0.1	Yellowish-white
NEB Z	19	4.0 ±0.98	-1.1	Yellowish-grey
EZn	64	7.2 ±0.39	+0.5	Pale yellowish-white
Globe North of Rings	52	5.3 ±0.42	-0.1	Dusky yellowish-grey
BELTS:				
NPB	2	3.8 -------	--	Greyish
NNTeB	5	4.3 ±0.44	-0.4	Dusky yellowish-grey
NTeB	31	4.1 ±0.54	-0.3	Yellowish-grey
NEB (entire)	43	3.4 ±0.28	-0.4	Greyish-brown
NEBn	25	3.4 ±0.14	-0.7	Greyish-brown
NEBs	32	3.1 ±0.14	-0.6	Greyish-brown
EB	5	4.4 ±0.58	-0.8	Yellowish-grey
RINGS:				
Ring A (entire)	64	5.9 ±0.76	0.0	Dull white
Ring A (outer half)	4	6.8 ±0.07	+0.6	Dusky white
Encke's Division (A5; ansae)	1	4.0 -------	+0.5	Greyish
Ring A (inner half)	4	6.5 ±0.07	0.0	Dusky white
Cassini's Division (A0 /B10; ansae)	36	0.9 ±0.50	0.0	Greyish-black
Ring B				
Ring B (outer third)	64	8.0 **[Standard]**		White.
Ring B (inner two-thirds)	38	7.2 ±0.72	+0.3	Yellowish-white
Intensity Minimum (B1; ansae)	2	2.9 -------	-0.6	Dark grey
Ring C (ansae)	45	0.9 ±0.57	-0.3	Greyish-black
Crape Band	48	2.7 ±0.61	+0.6	Very dark grey
Sh G on R	44	0.6 ±0.26	0.0	Greyish-black
TWS	19	7.7 ±0.14	+0.3	Yellowish-white

Notes: For nomenclature see text and *Figure 6* (p. 51). A letter with a digit (e.g., A5) refers to a location on the Ring specified in terms of units of tenths of the distance from the inner edge to the outer edge. Visual numerical relative intensity estimates (visual surface photometry) are based upon the A.L.P.O. Intensity Scale, where 0.0 denotes complete black (shadow) and 10.0 refers to the most brilliant condition (very brightest Solar System objects). The adopted scale for Saturn uses a reference standard of 8.0 for the outer third of Ring B, which appears to remain stable in intensity for most Ring inclinations. All other features on the Globe or in the Rings are compared systematically using this scale, described in the *Saturn Handbook*, which is issued by the A.L.P.O. Saturn Section. [2] The "Change Since 1986-87" is in the sense of the 1986-87 value subtracted from the 1987-88 value, "+" denoting an increase in brightness and "-" indicating a decrease (darkening). When the apparent change is less than about 3 times the standard deviation, it is probably not statistically significant.

Table 4. Latitudes of the Belts of Saturn in the 1987-88 Apparition.

	Form of Latitude (All are North; change from 1986-87 in parentheses)					
Saturnian Belt	Planetocentric		Eccentric		Planetographic	
	°	°	°	°	°	°
South edge NPB	80.5 --	-------	81.6 --	-------	82.6 --	------
South edge NPR	77.4±2.4	(-3.9)	78.7±2.1	(-3.5)	79.9±1.9	(-3.1)
Center NTeB	34.2±2.2	(-4.2)	37.2±1.9	(-4.4)	40.2±2.3	(-4.7)
North edge NEB	22.4±1.3	(-1.3)	24.8±1.5	(-1.4)	27.3±1.5	(-1.6)
South edge NEB	16.9±1.3	(+1.2)	18.8±1.4	(+1.3)	20.9±1.6	(+1.4)

Notes: For nomenclature see *Figure 6* (p. 51). The latitude calculations assume a tilt, **B**, of +26°.5, although it varied approximately ±0°.4 from this during the apparition. Planetocentric latitude is the angle between the equator and the feature as seen from the center of the planet. Planetographic latitude is the angle between the surface normal and the equatorial plane. Eccentric, or "Mean," latitude is the arc-tangent of the geometric mean of the tangents of the other two latitudes. The change is the result of subtracting the 1986-87 latitude value from the 1987-88 latitude value.

tion, the northern face of the Rings was very well presented to our view during the 1987-88 observing season.

Ring A.—Considered as a whole, Ring A was dull white during 1987-88, maintaining the same mean intensity as in 1986-87. There was only rare sightings of Encke's Division (A5) made during the apparition, at the Ring ansae in favorable seeing, and there were no other intensity minima recorded in Ring A in 1987-88.

On fairly infrequent occasions, Ring A was described as having a distinct outer and inner half in terms of intensity. In 1987-88, the outer half of Ring A was pale dusky white and was +0.3 mean intensity points lighter than the dusky white inner half. In 1986-87, it was the inner half that was the lighter portion. Compared with the 1986-87 Apparition, the outer half of Ring a showed a moderate elevation in brightness (+0.7 mean intensity points, but based on only 4 estimates), while the inner half remained stable in intensity.

Taken as a whole, Ring A, when compared with IL, was considerably darker in red light (W25; -1.6 mean intensity points), and was somewhat darker in yellow (W12; -0.8 points), yellowish-green (W11; -0.7 points), and light-blue light (-0.5; W80A).

Ring B.—The outer third of Ring B is the adopted standard of reference for the A.L.P.O. Saturn Intensity Scale, with an assigned value of 8.0. Throughout 1987-88, this portion of Ring B appeared white, stable in intensity, and the brightest feature on either Saturn's Globe or its Rings.

The inner two-thirds of Ring B, chiefly yellow-white in hue, was only +0.3 mean intensity points brighter in 1987-88 than in the immediately preceding apparition. It was also mostly uniform in intensity throughout 1987-88, except for just two unusual sightings of an intensity minimum at B1 (i.e., located at about 0.1 of the distance from the inner to the outer edge of Ring B). The dark greyish B1 was seen at the ansae only. Such features are not permanent, as was shown by the Voyager Missions.

Cassini's Division (A0 or B10).—This feature was frequently and easily visible at the ansae, and it was often seen all the way around the Rings in optimum seeing. Observers with even the smallest telescopes had no trouble in seeing this feature in 1987-88. It had a dark grayish-black appearance in 1987-88, equal in intensity to its 1986-87 appearance. [As with the Sh G on R, the deviation from a true black appearance is due to scattered light. Ed.]

Ring C.—In 1987-88, individuals reported Ring C as fairly easy to see at the ansae, very dark grayish-black in color, and darker in appearance when compared with 1986-87 (by -0.3 mean intensity points). Here, it should be noted that faint or narrow Ring features are usually easier to perceive, and look darker, when the Rings are open to the extent that they were in 1987-88. Note also that Ring C at the ansae was brighter in red light (W25) by +0.8 mean intensity points; and brighter in yellow (W12), green (W58), and light-blue light (W80A) by +0.7 mean intensity points.

The Crape Band, or Ring C as projected onto the Globe, was +0.6 mean intensity points brighter in 1987-88 than in the immediately preceding apparition. In the more recent apparition, observers described this feature as uniform in intensity and dark grey in color. [With the saturnicentric latitudes of the Sun and the Earth that existed in 1987-88, most of the Crape Band often coincided with the shadow of Ring C on the Globe. Undoubtedly this phenomenon affected the appearance of the Crape Band. Ed.]

Ring Components Other Than A, B, or C.—Neither Ring D (inside Ring C) or Ring E (outside Ring A) was reported in 1987-88. Of course, these Ring components are exceedingly difficult to observe except under the best conditions and using large apertures.

Terby White Spot (TWS).—The TWS is an occasionally-reported brightening of the Rings adjacent to the Sh G on R. Several observers during 1987-88 recorded a pale yellowish-white, somewhat bright TWS. How-

Table 5. Observations by Haas of the Bicolored Aspect of Saturn's Rings in 1987-88.

U.T. Date and Time		Aperture	Magnification	Seeing	Transparency
JUN 14	05:16-05:31	31.8 cm	366X	3.5	+3.0
JUL 11	04:29-04:38	20.3	231	4.0	4.0
AUG 31	02:58-03:02	31.8	366	4.0	3.0
OCT 16	01:36-01:41	20.3	231	2.5	3.5

Notes: In all cases, the east and west ansae were noted as equal in brightness in IL and red light (W25), but the west was brighter than the east in blue light (W47). Both telescopes were Newtonians, and seeing and transparency are given in the standard A.L.P.O. scales described on p. 51.

ever, as in 1986-87, this feature did not show the dazzling appearance characteristic of much earlier apparitions. Nonetheless, it was the brightest object in Saturn's Rings except for the outer third of Ring B. The TWS is probably a contrast phenomenon and is not usually considered to be an important, or intrinsic, Saturnian feature. Even so, it would be interesting to investigate any correlation that may exist between the brilliance of the TWS and varying Ring tilt, as well as its prominence or appearance in colored filters.

Bicolored Aspect of the Rings.—This phrase refers to reported differences in color between the two ansae of the Rings. Several persons attempted to observe this phenomenon in 1987-88, but only Haas was able to detect any variation between the east and west ansae (Haas uses east and west in the celestial sense, rather than the Saturnian). In this, he made comparisons among IL, red (W25), and blue (W47) light. On all the four evenings described in *Table 5* above, Haas found the two ansae equal in brightness in integrated and red light, but the west ansae slightly brighter than the east in blue light. On other dates, the observing conditions were mediocre when slight or inconsistent differences were suspected, and in most views no differences were found.

The writer cannot stress strongly enough the critical need for observers to participate in a simultaneous observing program which emphasizes, among other projects when observing Saturn, a meaningful study of the bicolored aspect of the Rings. Systematic filter techniques, both visual and photographic, should shed light on this intriguing and yet-to-be-understood phenomenon.

SATURN'S SATELLITES

A small fraction of the contributors to our observing programs in 1987-88 submitted visual studies of Saturn's satellites. No truly systematic program of visual magnitude estimates was undertaken, nor any other investigations of the satellites. We encourage observers to pursue satellite studies as outlined in the *Saturn Handbook*. [2]

SIMULTANEOUS OBSERVATIONS

There were several *bona fide* simultaneous observations in the 1987-88 Saturn Apparition; where persons independently observed at the same date and time. If more individuals carried out all of the routine programs discussed in this report, there would be more chance for observers, for example, to make drawings, intensity estimates, or central-meridian transits at the same time.

Simultaneous observations during 1987-88 provided limited confirmation of the appearance of Saturn. This is encouraging, and we invite readers who are interested in helping bring about more confirming reports to write to the A.L.P.O. Saturn Section for guidance and instructions.

CONCLUSIONS

Participants in the A.L.P.O. Saturn Section programs followed the planet reasonably well during 1987-88, and an increase in observer interest over recent years is encouraging. Our goals are to augment observational coverage during any given apparition, to increase participation in Saturn programs, and to continue to expand our international observer base.

Once again, this Recorder expresses his gratitude to those persons mentioned in this report for their lasting dedication to and participation in our programs. New observers of Saturn, as well as those who may have drifted away, are most welcome and are urged to contact the A.L.P.O. Saturn Section to find out how their teamwork can bring meaningful scientific results and increase our knowledge about the planet Saturn.

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

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

3. ________. "The 1986-87 Apparition of Saturn: Visual and Photographic Observations." *J.A.L.P.O., 33*, Nos. 7-9 (July, 1989), pp. 103-111.

4. United States. Naval Observatory. *The Astronomical Almanac.* Washington: U.S. Government Printing Office. (Annual publication; the 1987 and 1988 editions were used for this report, which were published in 1986 and 1987, respectively.)

Note: For the drawings and photographs in *Figures 7-15*, unless otherwise stated, seeing is on the 0-10 A.L.P.O. Scale and transparency is in terms of the limiting naked-eye visual magnitude in the vicinity of Saturn. South is at the top of these simply-inverted views. CM(I) is the longitude of the central meridian in rotational System I; CM(II), in rotational System II.

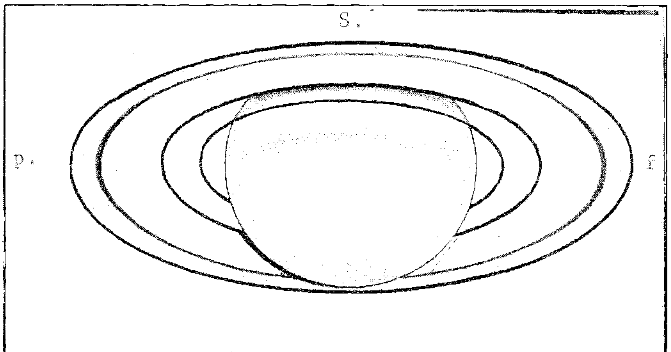


Figure 7. Drawing by Donald H. DeKarske. 1988 MAY 13, 07h50m-08h05m U.T. 10.2-cm. (4.0-in.) refractor, 150X. No filter. Seeing III-II on the Antoniadi Scale (moderate-good); transparency +5.0. CM(I) = 277-286°; CM(II) = 277-286°. B = +26°.2; B' = +26°.7.

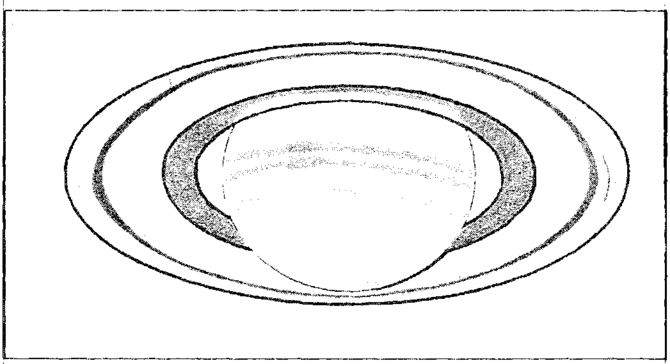


Figure 8. Drawing by Michael G. Sweetman. 1988 MAY 16, 07h55m-08h44m U.T. 26-cm. (10.3-in.) Cassegrain, 397X. W12 (yellow) Filter. Seeing 7; transparency +5.5. CM(I) = 294-322°; CM(II) = 197-224°. B = +26°.2; B' = +26°.6.

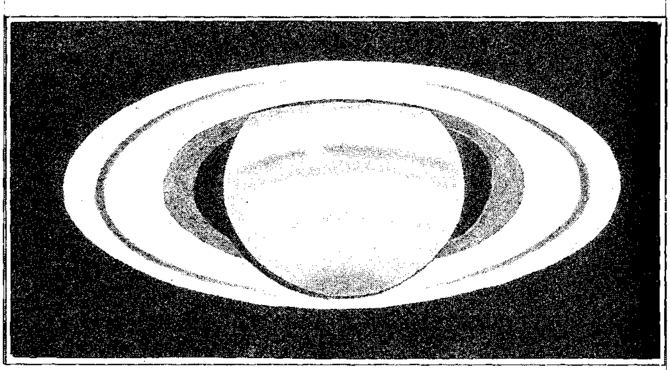


Figure 9. Drawing by David L. Graham. 1988 MAY 21, 00h45m-01h15m U.T. 15.2-cm. (6.0-in.) refractor, 222X. No filter. Seeing II on the Antoniadi Scale (good). CM(I) = 303-321°; CM(II) = 055-071°. B = +26°.3; B' = +26°.6.

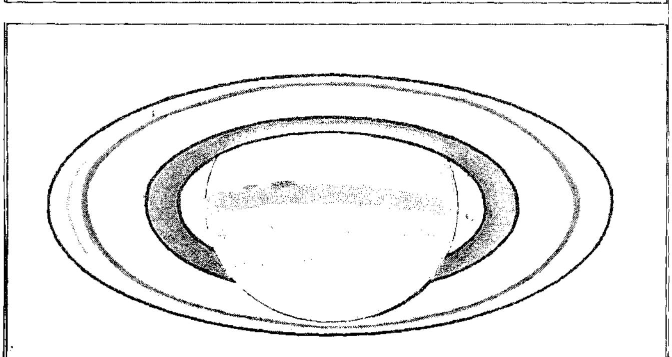


Figure 10. Drawing by Michael E. Sweetman. 1988 MAY 22, 08h55m-09h34m U.T. 26-cm. (10.3-in.) Cassegrain, 397X. No filter. Seeing 7; transparency +5.75. CM(I) = 355-018°; CM(II) = 063-085°. B = +26°.3; B' = +26°.6.

Note: For the drawings and photographs in *Figures 7-15*, unless otherwise stated, seeing is on the 0-10 A.L.P.O. Scale and transparency is in terms of the limiting naked-eye visual magnitude in the vicinity of Saturn. South is at the top of these simply-inverted views. CM(I) is the longitude of the central meridian in rotational System I; CM(II), in rotational System II.

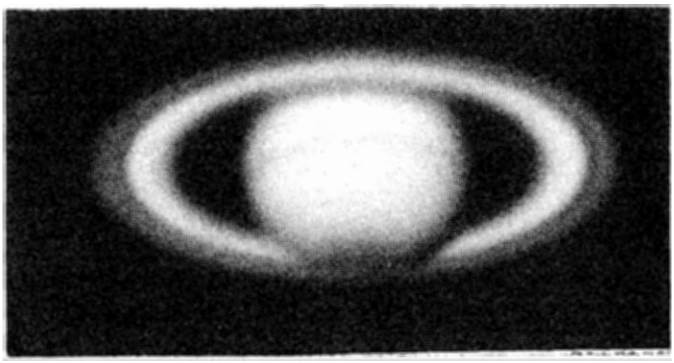


Figure 11.Photograph by Jean Bourgeois. 1988 JUL 30, 20h33m U.T. 105-cm. (41.3-in.) Cassegrain. 8 seconds expsoure on Kodak TP2415 Film. Orange filter. CM(I) = 346°; CM(II) = 329°. B = +26°.8; B' = +26°.5.

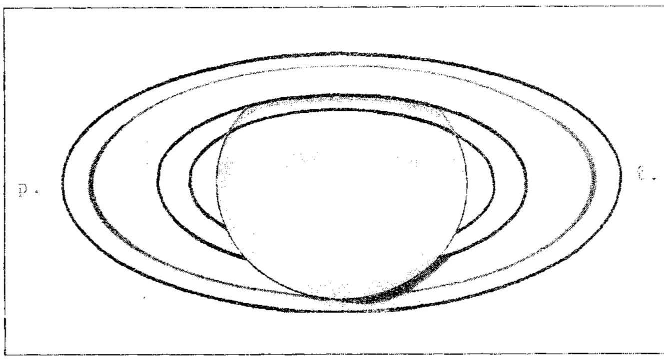


Figure 12. Drawing by Donald H. DeKarske. 1988 AUG 14, 04h15m-04h25m U.T. 10.2-cm. (4.0-in.)refractor, 150X. No filter. Seeing IV-III on the Antoniadi Scale (poor-moderate); transparency +5.0. CM(I) = 196-202°; CM(II) = 077-083°. B = +26°.8; B' = +26°.5.

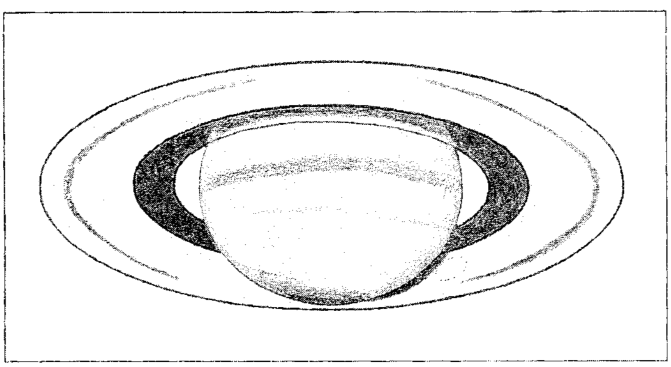


Figure 13. Drawing by Richard W. Schmude, Jr.. 1988 AUG 15, 03h03m-03h30m U.T. 15.2-cm. (6.0-in.) reflector, 203X. No filter. Seeing 8.5; transparency +5. CM(I) = 278-294°; CM(II) = 129-144°. B = +26°.8; B' = +26°.5.

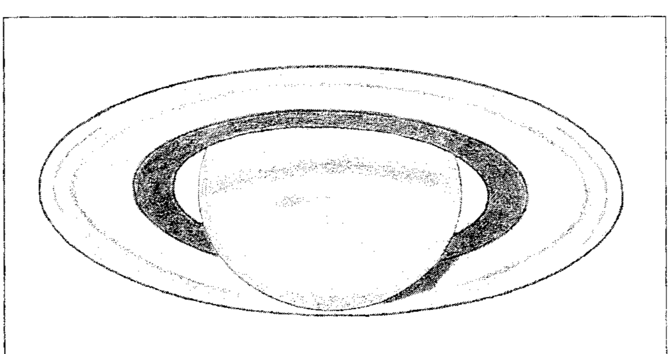
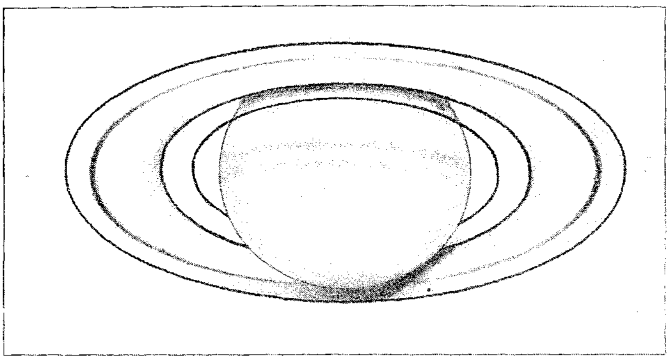


Figure 14. Drawing by Richard W. Schmude, Jr. 1988 AUG 20, 03h44m-04h04m U.T. 25.4-cm. (10.0-in.) reflector, 254X. No filter. Seeing 8; transparency +5. CM(I) = 204-216°; CM(II) = 252-263°. B = +26°.9; B' = +26°.5.



SELECTED DRAWING, 1986-87 APPARITION OF SATURN—*CONTINUED.*

Figure 15. Drawing by Donald H. DeKarske. 1988 OCT 03, 01h55m-02h15m U.T. 10.2-cm. (4.0-in.) refractor, 150X. No filter. Seeing 3-7; transparency +4.5. CM(I) = 205-217°; CM(II) = 274-285°. B = +26°.9;B' = +26°.4.

Note: The preceding report summarizes the observations submitted to the A.L.P.O. Saturn Section for that planet's 1987-88 Apparition. As was the case for several previous apparitions, Gianluigi Adamoli has also sent us a Saturn apparition report, based on observations collected by the Unione Astrofili Italiani (U.A.I.). It is very useful to have two independent and simultaneous reports for the same planet, and hence we are publishing them together here. The U.A.I. report follows and should be compared with the above A.L.P.O. report. Note that the B.A.A. (British Astronomical Association) visual intensity scale used by the U.A.I. is the reverse of that used by the A.L.P.O.; because the U.A.I. rates black as 10.0 and white as 0.0. Except for this, the terms and nomenclature are the same in the two Saturn reports.

VISUAL OBSERVATIONS OF SATURN IN 1988

By: Gianluigi Adamoli, Sezione Planeti, Unione Astrofili Italiani

ABSTRACT

Fifty-one observations by eleven amateurs yield a general picture of Saturn not very different from that recorded in recent years. Poor seeing often prevented quality observations, so that the data collected are comparatively scanty.

INTRODUCTION

During 1988, 51 visual observations of Saturn were submitted by the following 11 contributors: G. Adamoli, S. Baroni, G. Basti, M. Corbisiero, F. Canepari, M. Dal Santo, G. De Simone, M. Giuntoli, A.W. Heath (Great Britain), R. J. McKim (Great Britain), and P. Russo. Their instruments ranged in aperture from 10 to 60 cm, which were mostly reflectors. Observations were made during the period 1988 APR 25 - AUG 31, with eleven observations not being used for this report due to their lower quality,

Saturn was in opposition on 1988 JUN 20, with most observations being made after that date. Due to the northerly tilt of the axis of the planet [see p. 49], most of the Southern Hemisphere of the Globe was occulted by the Rings. Also, the southerly declination of the planet (-22°) placed it low in the sky from Europe, causing poor seeing that hampered observations in both quality and quantity. *Table 1* (p. 60) gives a statistical summary of the observations, based on 340 intensity estimates using the B.A.A. scale [see note above], 120 color estimates, and 110 Saturnicentric latitude measures made from drawings. The intensities and latitudes in the table are the weighted means of the measures made by each observer, with the observer's weight taken as the square root of the number of single estimates from which his measure was computed.

THE RINGS

According to the intensity estimates, the Rings at their ansae appeared somewhat darker than in recent years, although the Rings projected onto the Globe looked unchanged. **[1, 2]** As in the past, it was difficult to assess the color of Ring A; which was seen as grey, white, yellow, or even green. It appeared homogeneous, except that two observers noted a brighter inner rim. One of these was R.J. McKim, who noted the phenomenon on JUL 18 and 19 with the 60-cm Cassegrain reflector at Meudon Observatory in France. Also, on AUG 14 Dal Santo, using a 15-cm reflector, recorded a doubtful Encke's Division on the preceding ansa, two-fifths of the distance from the outer to the inner edge of Ring A.

Three observers, including McKim, recorded Ring B as darker in its inner portion as compared with its outer. Four observers saw Ring C at the ansae, although they were very discordant about its width; their reports ranging from 0.2 to 0.5 of the distance between the inner edge of Ring B and the Globe.

Table 1. Intensities, Colors, and Latitudes of Saturnian Features in 1988.

Note: In parentheses are given the number of observers for intensities, colors, and latitudes.

Feature	Intensity	Color	Saturnicentric Latitude
Rings—			
Ring A	3.3 (7)	Yellow-Green? (8)	---
Cassini's Division	9.0 (7)	---	---
Ring B (outer)	1.0 (7)	White-Yellow (8)	---
Ring B (inner)	2.3? (2)	---	---
Ring C	8.3? (3)	---	---
Rings A and B crossing Globe	1.5? (2)	---	---
Ring C crossing Globe	7.1 (6)	Grey? (3)	---
Shadow Globe on Ring	9.0 (5)	---	---
Globe—			
EZ	1.5 (7)	White-Yellow (7)	---
NEB	4.4 (7)	Brown-Grey (8)	+10° to +24° (7)
NTrZ	2.7 (6)	Yellow-Grey (5)	---
NTB	3.7 (6)	Brown-Grey (4)	+43° (6)
NTZ	2.5 (6)	---	---
NPR	4.3 (7)	Grey (7)	S. edge +71° (7)

Note: For the identification of features, see the previous article (p. 51). As expected, there is a strong *negative* relationship between the U.A.I. and the A.L.P.O. intensity estimates (R = -0.973), where: (A.L.P.O. Intensity) = (8.4 ± 0.3) - (0.88 ± 0.06)×(U.A.I. Intensity)with a standard error of ±0.62 A.L.P.O. intensity units. Note also that the two latitudes quoted for the NEB refer to the southern and northern edge, in that order, of that feature. For comparison with the previous article, the A.L.P.O. intensity values and colors are given on p. 54 and the A.L.P.O. latitudes are given on p. 55.

THE GLOBE

Compared with the Rings, the Globe's hue was "warmer," and showed faint brown hues on the belts, and yellow ones on the zones, while the NPR appeared neutral.

As in recent years, the EZ appeared quite dull. [1, 2] Most observers saw it as darker than Ring B. Through the Meudon instrument, McKim could detect a faint and narrow EB within the EZ on JUL 18 and 19. The NEB appeared almost always as a single belt; after having critically analyzed the observations at hand, we feel that this was not due to the usually poor seeing conditions. Instead, we can say that sometimes there was apparently a gradual intensity change on the NEB-NTrZ border, whose visibility varied with instrument, seeing, and the observer's experience. Moreover, irregular markings were occasionally recorded in both the NEB and EZ, but none were confirmed.

The latitudes and intensity values of all the Globe's belts and zones did not vary as compared with their values for 1987 when we consider their uncertainties. The apparent latitude displacement of the NTB of 5° to the north is doubtful because of the limited number of measures of it.

REFERENCES

1. Adamoli, G. "Osservazioni visuali di Saturno nel 1986." *Astronomia UAI*, No. 1 (1987), 13-15.

2. Adamoli, G. "Osservazioni visuali di Saturno nel 1987." *Astronomia UAI*, No. 6 (1988), 43-45.

OBSERVATIONS AND COMMENTS

Observers of the Sun may use narrow-band Hydrogen-Alpha filters to view and photograph prominences on the Sun's limb as well as features on its disk. The veteran French astrophotographer Jean Dragesco has been successful in both capacities. Below, in *Figures 16-18*, are three Hydrogen-Alpha photographs by him, taken at approximate 1-hour intervals, that show short-term prominence evolution that was associated with the large solar activity region SESC 5354, which was described in our previous issue on pages 28-29. The photographs below were taken a full 3 days before the Sun's rotation moved SESC 5354 onto the visible hemisphere of the Sun. All three photographs were taken by Jean Dragesco with a 35.5-cm Schmidt-Cassegrain telescope with a 0.6-Å Hydrogen-Alpha filter.

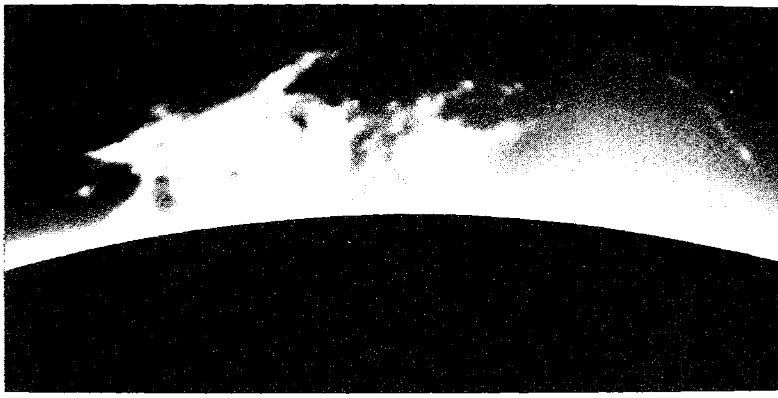


Figure 16. Solar prominences in Hydrogen-Alpha light with a 35.5-cm Schmidt-Cassegrain telescope. By Jean Dragesco 1989 FEB 01, 09h 41m U.T.

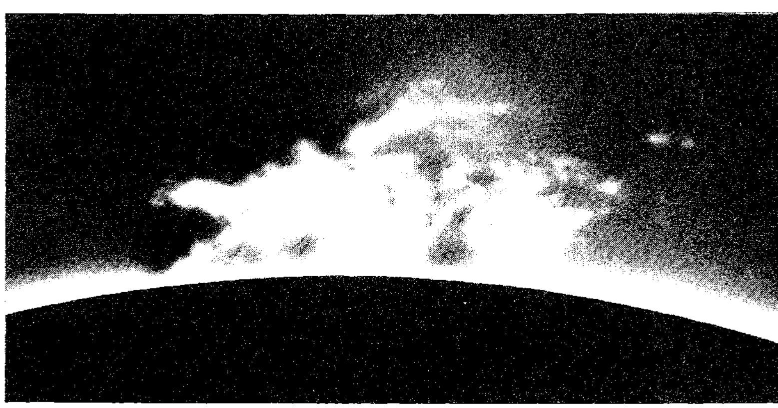


Figure 17. Solar prominences in Hydrogen-Alpha light with a 35.5-cm Schmidt-Cassegrain telescope. By Jean Dragesco 1989 FEB 01, 10h 43m U.T.

Figure 18. Solar prominences in Hydrogen-Alpha light with a 35.5-cm Schmidt-Cassegrain telescope. By Jean Dragesco 1989 FEB 01, 11h 40m U.T.

THE 1983-85 APHELIC APPARITION OF MARS—REPORT II

By: Donald C. Parker, M.D.; Jeffrey D. Beish; and Carlos E. Hernandez, M.D.; A.L.P.O. Mars Recorders

ABSTRACT

The meteorology of Mars from 1983 through 1985 is presented along with an update of a long-term statistical analysis of Martian atmospheric phenomena. Five transient or localized dust storms, as well as a major dust storm, were observed during this apparition. Possible relationships between these storms and the variations of Mars' polar caps are discussed. Several light and dark surface features underwent changes during the apparition, possibly as a result of the dust-storm activity.

INTRODUCTION

During the last several apparitions of Mars there has been an increase in both the quantity and the quality of the observations submitted to the Mars Section. A greater interest in the Red Planet , and improved observing skills, are evident in the visual observations and photographs recorded each day during an apparition. More A.L.P.O. Mars Section contributors are making systematic color-filter observations and are performing quantitative studies such as micrometry and photography. The writers feel that this is, in large part, the result of the systematic observing program initiated by our late Mars Recorder, C.F. ("Chick") Capen. We also wish to thank the many contributors during the 1983-85 Apparition for their patience throughout the long delay in publishing the results of their work.

Report I covered observations of the Martian Arctic. [Beish and Parker, 1988] This report describes meteorology and surface-feature changes, illustrated by the drawings and photographs in *Figures 21-25* (pp.70-79).

METEOROLOGY

The Martian atmosphere is very dynamic, exhibiting several types of clouds and hazes that are easily detected with the aid of color filters and modest-sized telescopes. White water clouds, local yellow dust clouds, global dust storms, bluish limb hazes, and bright surface ice-fogs and frosts have been studied with increased interest during the past two decades. During the 1960's and 1970's, C.F. Capen classified Martian atmospheric and near-surface clouds and hazes as: *Polar Hood*, *Polar Haze*, *Planetary System Cloud Banding*, *Limb Brightening* (non-rotating haze), *Recurrent Cloud* (diurnal orographic), *Seasonal Cloud* (stable topographic), and *White Area* (frost or fog). These classifications are still in use by the Mars Section. [Michaux and Newburn, 1972] Observations of these meteorological features suggest that their behavior and times of occurrence are most often coupled with the seasonal sublimation and condensation of polar-cap material. [Beish and Parker, 1988]

Meteorological activity during the Northern-Hemisphere Spring, Summer, and Autumn was well recorded during this aphelic apparition. The results are summarized below.

Visibility of Martian Atmospheric Phenomena, 1983-85.

Limb Phenomena.—Martian *Limb Clouds* are best seen with violet (Wratten 47 or "W47") or blue (W38A, W47B) filters. *Limb Hazes*, or "Limb Arcs," are also seen through these same filters; and often also through green (W57) and yellow (W8, W12, and W15) filters. The visibility of atmospheric features through different color filters defines the relative heights of atmospheric aerosols and condensates. Violet and blue filters are best for showing high-altitude clouds; while light-blue (W38A), green (W57, W58), yellow-green (W56), and yellow (W12) filters show low-lying hazes and surface ice-fogs.

Bright limb clouds and limb hazes were observed throughout the 1983-85 Apparition. Several astronomers noted that the white-cloud frequency was below "normal" for the early portion of the apparition. This view was later confirmed by statistical analysis.

Orographic Clouds.—These discrete white clouds begin to condense above mountainous regions and volcanoes as local noon approaches, due to the uplifting of water vapor in the Martian atmosphere after the rapid thawing of the North Polar Cap (NPC) begins. By early local afternoon, they appear as bright round or oval-shaped individual clouds, producing a "domino effect" on the Martian disk [i.e., appearing similar to the white dots on a domino]. They can be seen without filters, but tend to be brighter in blue light. These clouds continue to expand and brighten as the planet rotates them toward the sunset limb, when they can best be seen in violet light, which indicates that they also expand upwards by convection. Some of these clouds coalesce with other clouds to form large, bright limb clouds such as the well-known "W-Clouds" observed in the Tharsis-Amazonis region. [For a map of Martian features, see *Figure 19* on p. 68.]

Discrete white and blue-white orographic clouds were observed in the Elysium and Tharsis regions during Northern-Hemisphere Spring, Summer, and Autumn in 1983 and 1984. However, a "below-average" frequency of occurrence was noted for these features in Northern Spring and Autumn. Statistical analysis reveals that their frequency of occurrence fell far below the averages for those same seasons during the 1977-79, 1979-81, and 1981-

83 Apparitions. Orographic clouds became more abundant during the Northern Summer, after the rapid retreat of the NPC had begun.

Topographic Clouds.—Dense bluish-white clouds of limited extent populate many areas of Mars during local Spring and Summer and persist for days in the same general areas. They are classified as *topographic* because they appear in or near large, deep craters and over great plains and valleys. Three areas, Aram, Edom, and Ophir, are particularly productive sites for white-cloud formation. Another region that has been observed to be cloudy during each apparition is the Isidis-Libya-Crocea region near Syrtis Major. Yellow clouds, blue-white clouds, and low hazes appear to gravitate into this large depression which lies north of the Tyrrhenum-Hesperia block and just east of the up-slopes of the Syrtis Major Planum. Shortly after the Northern Summer Solstice, an increase in discrete-cloud activity was reported by J. Beish, J. Dragesco, M. Nakajima, R. Fabré, D. Parker, M. Legrand, and others. These topographic clouds had become quite numerous by late Summer (areocentric solar longitude, Ls, 160°), and were prominent in Libya, Aeria, Moab, Edom, and Candor.

Topographic clouds grow and move within a region, especially when near the sunset limb. These clouds, often called "localized" or "regional" discrete clouds, appear to be white, but will brighten when observed through a blue or blue-green filter, indicating that they are possibly blue or blue-white clouds. Their color can vary; they can become prominent in green or can brighten in yellow light. This fact has led the late C.F. Capen and the present writers to think that they are a combination of water vapor and dust.

These discrete clouds followed the same frequency distribution and relative frequency of occurrence as did the orographic clouds. This pattern was characterized by low activity during local Spring, then increasing during Summer, and finally decreasing during Autumn. White clouds were seen more often from March, 1984 (Ls = 111°) onward, as reported by A.Wilson, M. Will, D. Moore, M. Legrand, G. Rosenbaum, F. Van Loo, G. Nowak, C. Capen, and R Fabré.

White Areas.—Ice-fogs and frosts, often called *bright patches*, can be distinguished from elevated clouds by means of comparing their relative brightness and definition of boundary as seen with the aid of blue (W38A), blue-green (W64), green (W58), yellow (W8, W12, or W15), and orange (W21 or W22) filters. The behavior and location of a bright patch also helps to distinguish it from a cloud or limb haze. If the suspect bright feature appears brighter in blue light than it does in green or yellow light, it is an atmospheric cloud. If it is brighter and more clearly defined in blue-green light than in blue or yellow light, it is probably ice-fog on or near the surface. If the patch appears brighter and with a sharp boundary in green and yellow light, and is not well seen in blue light, it can be identified as surface frost. 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, basins, and on upper slopes.

Certain light areas exhibit temporary bright light patches which usually form when a polar cap is thawing rapidly; prior to the Summer Solstice in the appropriate hemisphere. These bright areas were mysteries to Mars observers until Viking Orbiter space missions identified them as surface frosts and dense fogs lying near the surface. They are analogous to terrestrial polar ice-fogs, known as "white-outs." The bright patches are thought by some to be topographically controlled. If this belief proves to be correct, careful observations of their occurrences and locations will be useful for improving local elevation maps of Mars. One example of such a region is the "Tractus Albus," a Y-shaped bright streak which runs southward from Tempe into Tharsis, bifurcating just north of Solis Lacus. This feature is seen well in green and yellow light and is most likely caused by the formation of patches of low fog in the system of valleys between the Acidalium Plate and the Tharsis Bulge. The Tractus Albus was not prominent during the 1983-85 Apparition, although D. Moore observed its partial formation during Northern Summer.

Blue Syrtis Cloud.—This feature was named the "Syrtis Major Blue Cloud" by C.F. Capen in 1978, who traced its seasonal occurrence as far back as 1858, when it was described by the astute Vatican Observatory astronomer Angelo Secchi, S.J. Employing an excellent 9.6-inch refractor, Father Secchi described a large blue triangular feature which he named the "Blue Scorpion." This cloud was next seen by J.N. Lockyer in 1862. Members of the British Astronomical Association reported it in 1911, and Lowell Observatory astronomers in 1920 saw this cloud appear to divide Syrtis Major into three sections. During the early Martian Summer of the 1950 Apparition, C.W. Tombaugh, C.H. Nicholson, and C.F. Capen made a number of observations of this feature. Capen later named it the "Blue Syrtis Cloud" because, when viewed through a yellow filter, Syrtis Major turned a vivid green; blue plus yellow makes green. [At times Syrtis Major itself has been reported as blue. Ed.] Although prominent in the 1960's and in 1982, this feature was not observed during the 1983-85 Apparition. Observers are encouraged to look for it during the aphelic apparitions of the 1990's because it is one of the most beautiful and mysterious features on Mars.

Equatorial Cloud Bands (ECB's).—These are rare, faint cloud streaks that tend to girdle the planet's equatorial zone. ECB's are only seen in violet light, suggesting high altitudes. The writers observed and photographed ECB's twice in 1984 during mid- and late northern Summer (Ls = 123° and 166°).

Zeta Clouds.—On 1984 APR 21, D.C. Parker photographed a very interesting and unusual white cloud formation that extended northward from Ophir (065°W/10°S) to Tempe (075°W/40°N), passing just east of the Nilus (082°W/25°S). Subsequently, for the period APR 16-20, visual and photographic reports of these same clouds were received from J. Dragesco, F.R. Van Loo, A. van de Jeugt, and Leo Aerts. The writers call these formations the "Zeta Clouds," because on violet photographs they resemble the Greek letter zeta (ζ). [Parker *et al.*, 1986] Individual white clouds are often observed in Ophir, Nilus, and Tempe during Northern Summers, as they were in 1984, but no extended formations of bright white clouds like these have been reported there.

Dust Storms

Although immense global dust storms are firmly entrenched in Martian lore, they may be rare. Lowell Observatory's Leonard Martin states that there have been only five well-documented *global* or *planet-encircling* Martian storms. These were reported in 1956, 1971, 1973, and 1977; in the last year, there were two storms discovered by the Viking space mission. [Martin, 1984] Records of observations of Mars indicate that most dust storms occur near the time of Southern Summer Solstice (Northern Winter Solstice; Ls = 270°), soon after perihelion passage (Ls = 250°).

While numerous yellow clouds have been seen on Mars in the Northern Spring and Summer, extensive and long-lasting dust storms are extremely rare in those seasons. Small transient aphelic dust storms were reported in 1914, 1915, 1929, 1959, 1961, 1967, 1969, and 1981-83, but they were observed to last only a few days and did not show expansion or significant motion.

From late October, 1983 (Ls = 053°), through mid-February, 1984 (Ls = 105°), an unusual number of dust storms was reported by Leo Aerts, J. Beish, C. Capen, F. Van Loo, J. Dragesco, D. Troiani, J. Olivarez, D. Parker, and others. Although these sightings have been discussed previously [Beish *et al.*, 1984], careful analysis of the A.L.P.O. observations by the present writers and by Lowell Observatory's Leonard J. Martin has resulted in a reassessment of the data. There was so much dust-cloud activity during this period that it was often difficult to determine when one storm began and another ended. Furthermore, the planet's small apparent diameter (approximately 6 arc-seconds) and inclement winter weather in much of Earth's Northern Hemisphere resulted in some gaps in the observational coverage. Nevertheless, there was enough international coverage of Mars during this period to permit an accurate picture of this early storm activity. To minimize ambiguity, only those clouds that were bright in red light, moved or expanded, and obscured surface features, are included in the following list, which is arranged chronologically in increasing order of areocentric solar longitude (Ls).

1. Ls = 053°-057°. Yellow clouds were suspected very early during the 1983-85 Martian Apparition when D. Parker noted on 1983 AUG 13 (Ls = 022°) that Chryse appeared very bright in orange light. On the following day, he saw a possible dust cloud in Chryse. Parker also reported a general "washed-out" appearance of Mars between 1983 OCT 20 and OCT 30 (Ls = 053-057°), when a bright yellow streak appeared over the Chryse-Oxia region. J. Beish, C. Hernandez, and D. Parker detected dust clouds in the area after OCT 30. On NOV 04 (Ls = 060°), D. Troiani reported that Mars appeared "dusty," with Sabaeus Sinus barely visible. According to observations by L. Aerts, J. Beish, D. Parker, D. Troiani, and A. Wilson, surface features remained dusty in appearance and difficult to observe through the last week in November.

2. Ls = 069°-077°. On 1983 NOV 27 (Ls = 069°), a dust cloud was sighted over Phaethontis, southwest of Solis Lacus. This cloud rapidly expanded to the northeast into Thaumasia, Daedalia, and Candor; covering Solis Lacus by NOV 28! On DEC 01, F.R. Van Loo, observing from Belgium, reported bright dust clouds in Aeria and Chryse, with obscuration of the previously conspicuous Meridiani Sinus. Within a few days, American observers confirmed these clouds which, by DEC 04 (Ls = 073°), had spread westward across Chryse, covering Lunae Lacus (Palus) and Ganges and appearing to merge with the dust clouds in Candor. Several observers noted that Meridiani Sinus and part of Sabaeus Sinus could not be seen until DEC 07. No further observations were obtained until DEC 11 when Parker noted bright clouds extending from Hellas-Noachis northward across Deltoton Sinus, merging with the cloud in Aeria. By DEC 13 (Ls = 077°), Beish reported that this complex of dust clouds was intensely bright, and even perceived anomalous dark features in violet light in the Moab-Aeria region. Unfortunately, no data were received from abroad until the end of December, so that observations during this critical period were limited to the region of Mars spanning approximately 130° to 320° west longitude.

From December 18, 1983, to mid-January, 1984, other types of Martian meteorology began to predominate, such as limb hazes and localized or orographic clouds. Sporadic dust activity was observed, however, with Beish reporting two long yellow streaks extending from Hellas northeastward into Libya on 1983 DEC 23 (Ls = 081°). Parker observed possible bright dust clouds in the regions of Electris, Atlantis, and Mesogaea on DEC 26 (Ls = 083°). This latter observation is of interest because Parker also perceived a conspicuous anomalous dark streak in Electris in violet light, adding to the suspicion of the presence of a dust cloud.

The period of time that spans Ls = 069°-077° is interesting in that at least two dust-storm systems appeared to be present simultaneously. Despite Mars' apparent diameter of only about 5 arc-seconds, these events are documented well worldwide by a number of independent observers.

3. Ls = 089°-092°. On 1984 JAN 11 (Ls = 089°), the writers independently observed dust clouds extending from Moab across Chryse, partially obscuring Meridiani Sinus and Margaritifer Sinus. In orange light, they also detected a brilliant morning-limb projection over Thaumasia. At the same time, J. Dragesco, observing the portion of the planet farther to the east, reported a brilliant cloud over Deltoton Sinus, obscuring most of Sabaeus Sinus. Over the next several days, the dust clouds extended from the Hellas-Yaonis region into Aeria, covering the eastern half of Sabaeus Sinus, and also westward across Moab and Chryse. Again, anomalous dark streaks were noted in these regions in violet light. This storm may well have extended into Candor, as Ganges became obscured; but there were no observations of longitudes west of Candor at the time of this storm. By JAN 18 (Ls = 092°), the dust began to subside, and Mars returned to a more normal appearance.

4. Ls = 097°-105°; A Major Dust Storm. A major dust storm began on 1984 JAN 29 (Ls = 097°) and lasted until at least FEB 15 (Ls = 105°). It covered much of the Martian Southern Hemisphere from Argyre to Ausonia and even extended into the Northern Hemisphere from Elysium to Nilokeras. Drawings made on JAN 29 by Dragesco and Robotham reveal some obscurations of the southern Maria Sirenum and Cimmerium. Beish noted bright dust clouds farther to the west over the Libya-Isidis region. On the following day, Parker reported dust clouds obscuring the Tyrrhenum Mare. They also reduced the intensity of Trivium Charontis, which has remained relatively inconspicuous throughout the next two apparitions. During the next several days, the storm expanded eastward, obscuring the northern borders of Cimmerium and Sirenum Maria, and also northward to cover Elysium and most of Tharsis.

By FEB 05 (Ls = 101°), Beish observed most of the planet's disk, centered at longitude 138°, as covered with dust *except* for a dark spot at the position of Olympus Mons! As the storm was followed eastward, it merged with dust clouds in Chryse-Xanthe, which clouds had been sighted from Europe by Dragesco and Van Loo, and completely obscured Solis Lacus, eastern Sirenum Mare, Ganges, and Lunae Lacus. Interestingly, as the storm moved east, dust clouds were seen to mingle with white orographic clouds over eastern Tharsis. Several observers reported anomalous dark features in violet light over areas where the dust clouds were brightest. Between Martian longitudes 070°-200°, Troiani, Beish, and Parker found that the entire southern half of the disk appeared dark in violet light.

By 15 FEB (Ls = 105°), the dust began to subside rapidly; and Mars appeared to be fairly normal for the season except for a fading of eastern Sabaeus Sinus, Trivium Charontis, and the northern border of Sirenum Mare. Reports from European astronomers revealed that the storm spared the regions from 290° westward to 010° longitude. Thus, this was not a *planet-encircling* storm, but nevertheless was a major event which long will be remembered by those who observed it. For further information on this storm, see Beish *et al*., 1984, and *Figure 22* (pp. 72-73).

5. Ls = 113°-121°. Between 1984 MAR 03 and MAR 22, several observers reported dust clouds in Memnonia and Zephyria. The character of these clouds was confirmed by color-filter study of slides submitted to the Mars Section. By MAR 10 (Ls = 116°), most of Sirenum Sinus again appeared obscured and Solis Lacus became subdued. Sirenum Mare was invisible by MAR 18 (Ls = 120°), as reported by Aerts, Van Loo, Beish, and Parker; but Solis Lacus had returned to prominence. However, several elongated dust clouds were reported extending from Chryse into Candor and eastern Tharsis, covering Ganges. These clouds extended little farther and dust-cloud activity had subsided by MAR 22 (Ls = 121°).

6. Ls = 169°; A Solitary Dust Cloud. On JUN 24 (Ls = 169°), J. Dragesco observed and photographed a bright yellow cloud in eastern Thaumasia, obscuring eastern Solis Lacus, Nectar, and Agathodaemon. On JUL 02 (Ls = 173°), Parker photographed approximately the same longitudes, revealing that the region had returned to normal. From JUN 26 through 29, yellow clouds in Chryse were reported by L. Aerts, J. Beish, R. Fabré, R. McKim, and K. Rhea; and in Aeolis by D. Parker. The last of these yellow clouds appeared in Chryse and along the Ganges between JUL 03 and 06 (Ls = 174-176°), and was photographed in color by Beish and Parker.

Dragesco's drawing and photograph of JUN 24 and Parker's photograph of JUL 02 are shown in *Figure 25* (pp. 78-79). They illustrate nicely the value of timely photography and international communication in following the course of a Martian dust cloud. More importantly, the value of familiarizing oneself with the "normal" appearance of Mars cannot be overrated. Martian dust storms are at once among that planet's most scientifically important phenomena and the most difficult to observe, at least in their early stages. Data are sadly lacking on these early, formative stages of Martian dust storms, so that it is important that the observer be able to recognize the phenomenon. While the terms "washed-out" and "yellow-appearing clouds" are helpful, they are usually quite subjective, even when interpreting photographs. The *sine qua non* of Martian dust storms is movement with the *obscuration* of previously well-defined albedo features, producing an abnormal appearance for the Martian surface. The observer, then, must be able to appreciate what "normal" is. Probably the best way to accomplish this goal is by systematically drawing the planet, starting several months before opposition. Thus, when an obscuration occurs, the astronomer will be immediately alerted to it, almost by reflex, and will be able to take appropriate action. For example, if Dragesco had not *seen* the JUN 24 dust cloud, he might well not have bothered to photograph it and certainly would not have alerted other observers to follow up when this region of Mars was no longer visible from his terrestrial longitude. This rapid international communication and cooperation has been the goal of the A.L.P.O. Mars Section International Mars Patrol (IMP).

Meteorological Interactions

Report I for this apparition disclosed that the rapid-regression phase of the North Polar Cap (NPC) in 1984 was delayed by approximately one Martian "month," or by 30° Ls. In reviewing the records of that apparition, it was found that the periods of anomalous behavior of the NPC coincided with the occurrences of four significant dust storms which appeared during late Northern Spring and early Summer (Ls = 069°-105°). Such yellow-cloud activity could have created enough atmospheric dust to upset the delicate energy balance of Mars' Arctic. Viking spacecraft data confirmed that such atmospheric aerosols absorb heat and retard NPC retreat. [James, 1979]

SURFACE FEATURES

In addition to its atmospheric phenomena, Mars exhibits varied and often-mysterious surface changes. The dark blue-green "maria," an example of "albedo features," appear to darken during local early Spring in such a manner that a "wave of darkening" appears to sweep from the thawing polar cap towards the equator. [Note: Photometry indicates that the blue-green color is a contrast effect and that the maria are neutral in hue. Ed.] This event, which occurs during each hemisphere's Spring, lent credence to the theory that the maria contain vegetation, which is replenished when water flows from the melting polar cap towards the equator. Now, we know that this concept is false. In fact, the late C.F. Capen showed that the wave of darkening is in actuality a "wave of brightening." These albedo features only appear to darken because the adjacent ochre desert areas have brightened during local early Spring. This explanation has been confirmed by Viking Lander images, which revealed a fresh, bright layer of dust that appeared on the ground during local early Spring.

Light and dark surface features tend to change in albedo and color diurnally and more slowly with the seasons. *Seasonal* variations are usually predictable, but *secular* (long-term) changes are unpredictable. Several regions that display seasonal changes are: Syrtis Major (293°W/10°N), Pandorae Fretum (345° W/25°S), Nilokeras-Lunae Lacus (or Palus) (060°W/25°N), Candor-Tharsis (090°W /10°N), Elysium-Trivium Charontis (215°W/ 23°N), Mare Australe (340°W/65°S), and Aonius Sinus (115°W/47°S). Another region of Mars that is subject to radical change is the Thaumasia-Solis Lacus ("Eye of Mars") area (085°W/28°S). For example, during the 1983-85 Apparition, J. Olivarez reported that Solis Lacus was not visible at Ls = 139°.

The Hellas Basin (292°W/50°S) is one of the most active areas on Mars, not only for its dynamic meteorology but also for its never-ceasing albedo changes. Its surface structure becomes apparent when its darker center (Zea Lacus) extends its arms or "canals" (Alpheus) to the north. This extension connects Hadriacum Mare (270°W/40°S) and Yaonis Fretum (312°W/ 35°S) eastward to the western edge of Peneus. As the Martian Southern Summer Solstice approaches, the Hellas Basin often becomes flooded with dust if and when a violent storm begins. Indeed, Hellas was involved in the 1983 DEC 11 and 1984 JAN 05 dust storms. Otherwise, it displayed no unusual changes. As the 1983-85 Apparition progressed and Southern-Hemisphere Winter got underway, Hellas and the high basin of Argyre (030° W/50°S) appeared as brilliant white on the southern limb. These great basins are the water-ice reservoirs for the Southern Hemisphere and are often covered with frost or with low clouds. Owing to the foreshortening caused by the planet's axial tilt, these features were often confused with the South Polar Cap (SPC) or its winter Hood.

Other seasonal changes of the Martian surface appear to be the result of the distribution of fine layers of surface dust by seasonal winds. The seasonal change in shape of Syrtis Major is an example of this. This dark, wedge-shaped feature, always a favorite subject for observers, classically broadens during Northern-Hemisphere Summer, reaching its maximum breadth near 145° Ls. [Dollfus, 1961] The eastern edge of Syrtis Major expands eastward to about 275° W longitude. Near the time of the Northern Autumnal Equinox (Ls = 180°), this boundary begins to retreat westward, reaching 283°W longitude during Northern Winter (Ls = 290°). P.A. Silveira of Caracas, Venezuela, along with C.L. Evans and J. Corder, showed Syrtis Major as very dark and possibly blunted at its north end during this apparition. However, the dramatic widening of Syrtis Major was not seen in the 1983-85 Apparition.

In addition, Syrtis Major has undergone some rather dramatic long-term or "secular" changes over the years. During recent apparitions, this feature appears to have become narrower and blunted compared with its appearance in the 1950's; and the once-conspicuous region to the east, called Nepenthes-Thoth, has all but disappeared. Osiridis Promontorium [not shown in *Figure 19*; position *ca.* 285°W/15°N] became very dark in 1984, appearing as a dark bar jutting out into Libya from the northeastern border of Syrtis Major.

This feature had been conspicuous in 1879, 1909, and during the 1940's and 1950's. The broad "canal," Nilosyrtis, which curves northeast from the northern tip of Syrtis Major, was inconspicuous in 1984.

Areas that have been observed to undergo secular changes during the past two decades are: Laocoontis Nodus-Amenthes (246°W/ 23°N), Nepenthes-Thoth (265°W/15°N), Thoana Palus (256°W/35°N), Moeris Lacus (270°W/08°N), the Antigones Fons-Astaboras complex (298°W/22°N), Margaritifer Sinus-Hydaspes Sinus (030°W/02°S; the Hydaspes Sinus is not shown in *Figure 19*), Solis Lacus (085°W/28°S), Nilokeras-Lunae Lacus (Lunae Palus) (060°W/25°N), and Acidalius Fons (not shown in *Figure 19*; 063°W/ 56°N).

Recent investigations revealed a possible secular change that occurred in the Trivium Charontis region (198°W/20°N) during the 1981-83 Mars Apparition. This area appears to have been covered over with dust during February and March, 1982. A somewhat "washed-out" appearance of this feature was observed during the remainder of that apparition, and it has been reported as low in contrast ever since. Dust storms during 1983 and 1984 appeared further to lower the contrast of the Elysium and Trivium Charontis region. On 1984 MAY 14, J. Olivarez reported that the Trivium Charontis-Cerberus was very difficult to see, or even missing from the face of Mars. This appearance was later confirmed by T. Dobbins.

The Nepenthes-Thoth (265°W/15°N) features, lying to the west of the Elysium Shield, which was so prominent in the 1940's and 1950's, decreased in size in 1960 and began fading in 1971. It was virtually undetectable in 1984. Laocoöntis Nodus (246°W/23°N), first described by S. Kibe in 1935, had faded during the 1970's and was not seen during the 1983-85 Apparition. Lying to the east of this region, toward Elysium, is Hyblaeus-Aetheria, an area that has undergone dramatic changes in recent years. In 1978, A.L.P.O. astronomers reported that the normally insignificant "canal," Hyblaeus (230°W/30°N), had darkened and expanded westward into Aetheria. Termed the "Hyblaeus Extension" by Capen, this change has persisted into the 1980's. On 1984 JUN 10 (Ls = 162°), J. Dragesco observed and photographed a further darkening in this region, located in Morpheos Lacus (not shown in *Figure 19*; 228°W/37°N). Later in June, J. Beish, R. Robotham, and D. Parker observed a bright streak running east-west from 160° to 260°W between 50° and 60°N. At 220°W longitude, another streak extended at right angles from the first streak southward into Elysium. These streaks were bright with all filters used, and their nature is not known. This entire region needs careful scrutiny and will be well-placed for observation during the aphelic apparitions of the 1990's.

Another area which has undergone change is the Daedalia-Claritas region (111°W/28°S) and Sirenum Mare (140°W/40°S). In 1973, the normally light region located between Sirenum Mare and Solis Lacus, consisting of Daedalia and Claritas, underwent a dramatic darkening which persisted through 1980. In 1984, this region had returned to normal. However, during March and April, 1984, D. Parker, J. Beish, R. Fabré, K. Schneller, T. Dobbins, and L. Aerts reported that northeastern Sirenum Mare had faded considerably. This appearance may have been the result of dust deposition from the storms sighted earlier in that region.

CONCLUSION

The 1983-85 Mars Apparition provided some interesting surprises for A.L.P.O. Mars Section astronomers. An unusual NPC regression, active Arctic meteorology, and moderate white-cloud activity were observed. The hallmark of this apparition, however, was the record number of significant dust storms that occurred when Mars was just past *aphelion*. The present writers feel that observational evidence already points to this unseasonable yellow-cloud activity as the cause of the retardation in the regression of the NPC, which in turn produced a diminution in white (water-ice) cloud activity. If this presumption is correct, the data furnished by the A.L.P.O. International Mars Patrol observers provides us with the first direct evidence of the relationships between Martian meteorology and the North Polar Cap.

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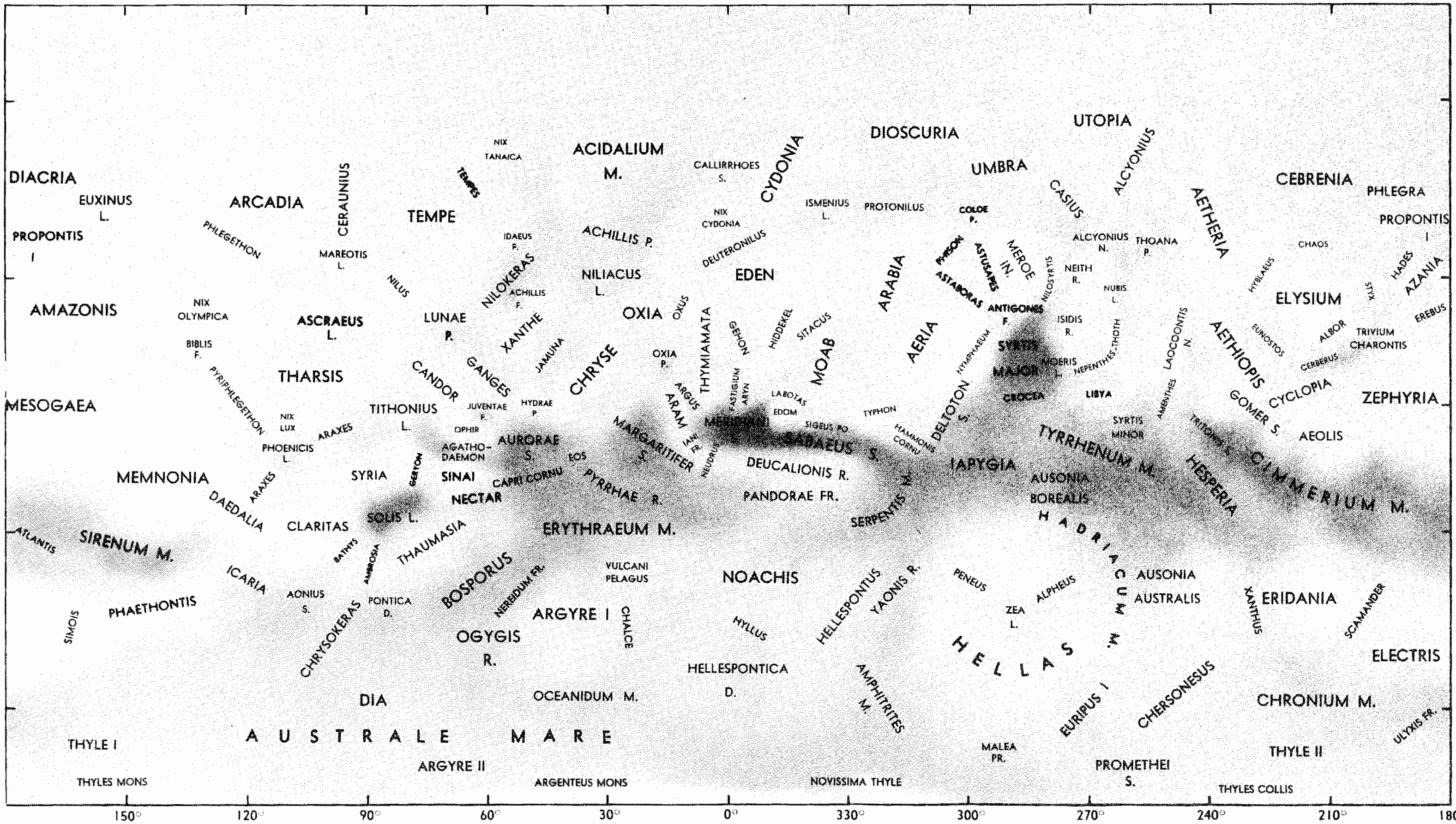

DIACRIA
EUXINUS L.
PROPONTIS I
AMAZONIS
MESOGAEA
ARCADIA
PHLEGETHON
NIX OLYMPICA
BIBLIS F.
CERAUNIUS
MAREOTIS L.
TEMPE
ASCRAEUS L.
THARSIS
PYRIPHLEGETHON
NIX LUX
PHOENICIS L.
ARAXES
MEMNONIA
DAEDALIA
CLARITAS
SIRENUM M.
ATLANTIS
ICARIA
AONIUS S.
PHAETHONTIS
SIMOIS
CHRYSOKERAS
PONTICA D.
TITHONIUS L.
SYRIA
SOLIS L.
THAUMASIA
BATHYS
AMBROSIA
GERYON
NILUS
LUNAE P.
CANDOR
JUVENTAE F.
OPHIR
AGATHO-DAEMON
SINAI
NECTAR
BOSPORUS
NEREIDUM FR.
OGYGIS R.
DIA
NIX TANAICA
TEMPES
IDAEUS F.
NILOKERAS
ACHILLIS F.
XANTHE
GANGES
HYDRAE P.
AURORAE S.
CAPRI CORNU
EOS
JAMUNA
CHRYSE
ACIDALIUM M.
ACHILLIS P.
NILIACUS L.
OXIA
OXUS
OXIA P.
ARGUS
ARAM
MARGARITIFER S.
PYRRHAE R.
ERYTHRAEUM M.
VULCANI PELAGUS
ARGYRE I
CHALCE
OCEANIDUM M.
CALLIRRHOES S.
NIX CYDONIA
CYDONIA
DEUTERONILUS
EDEN
THYMIAMATA
GEHON
HIDDEKEL
SITACUS
MOAB
FASTIGIUM ARYN
MERIDIANI
LABOTAS
EDOM
SIGEUS PO.
SABAEUS S.
DEUCALIONIS R.
PANDORAE FR.
NOACHIS
HYLLUS
HELLESPONTICA D.
ISMENIUS L.
PROTONILUS
DIOSCURIA
ARABIA
AERIA
TYPHON
HAMMONIS CORNU
DELTOTON S.
SERPENTIS M.
HELLESPONTUS
YAONIS R.
AMPHITRITES M.
UMBRA
COLOE P.
PHISON
ASTUSAPES
ASTABORAS
MEROE IN.
ANTIGONES F.
NYMPHAEUM
SYRTIS MAJOR
CROCEA
IAPYGIA
PENEUS
ZEA L.
ALPHEUS
HELLAS
MALEA PR.
UTOPIA
CASIUS
ALCYONIUS
ALCYONIUS N.
THOANA P.
NILOSYRTIS
NEITH R.
NUBIS L.
ISIDIS R.
MOERIS L.
NEPENTHES-THOTH
LIBYA
SYRTIS MINOR
TYRRHENUM M.
AUSONIA BOREALIS
HADRIACUM M.
AUSONIA AUSTRALIS
EURIPUS I
CHERSONESUS
PROMETHEI S.
LAOCOONTIS N.
AMENTHES
AETHERIA
AETHIOPIS
TRITONIS S.
HESPERIA
XANTHUS
ERIDANIA
CEBRENIA
HYBLAEUS
EUNOSTOS
ELYSIUM
CHAOS
CERBERUS
ALBOR
STYX
GOMER S.
CYCLOPIA
AEOLIS
CIMMERIUM M.
TRIVIUM CHARONTIS
PHLEGRA
PROPONTIS I
HADES
AZANIA
EREBUS
ZEPHYRIA
SCAMANDER
ELECTRIS
CHRONIUM M.
THYLE II
ULTXIS FR.
THYLES COLLIS
THYLE I
THYLES MONS
AUSTRALE MARE
ARGYRE II
ARGENTEUS MONS
NOVISSIMA THYLE
150°
120°
90°
60°
30°
0°
330°
300°
270°
240°
210°
180°

Figure 19 (on facing page). Chart of Mars for surface-feature identification. Prepared at Lowell Observatory in 1971. Note that, in order to fit the page, this chart has been rotated 90° so that Martian north is to the left, south to the right, east at top, and west at bottom. The tick marks along the minor dimension are for every 30° of latitude from 60°N to 60°S. The abbreviations used on this chart are as follows: **D.**, *Depressio*; **F.**, *Fons*; **Fr.**, *Fretum*; **In.**, *Insula*; **L.**, *Lacus*; **M.**, *Mare*; **N.**, *Nodus*; **P.**, *Palus* or *Pons*; **Po.**, *Portus*; **Pr.**, *Promontorium*; **R.**, *Regio*; and **S.**, *Sinus*.

Continued from p. 67—

Martin, L.J. (1984). "Clearing the Martian Air: The Troubled History of Dust Storms." *Icarus*, *57*, 313-321.

Michaux, C.M.; and Newburn, R.L. (1972). *Mars Scientific Model*. JPL Document No. 606-1, Section 4.1, p. 7.

Parker, D.C.; Beish, J.D.; and Capen, C.F. (1986). "A Simple Technique for Obtaining Violet Light Photographs of Mars." *J.A.L.P.O.*, *31*, Nos. 9-10 (July), 181-183.

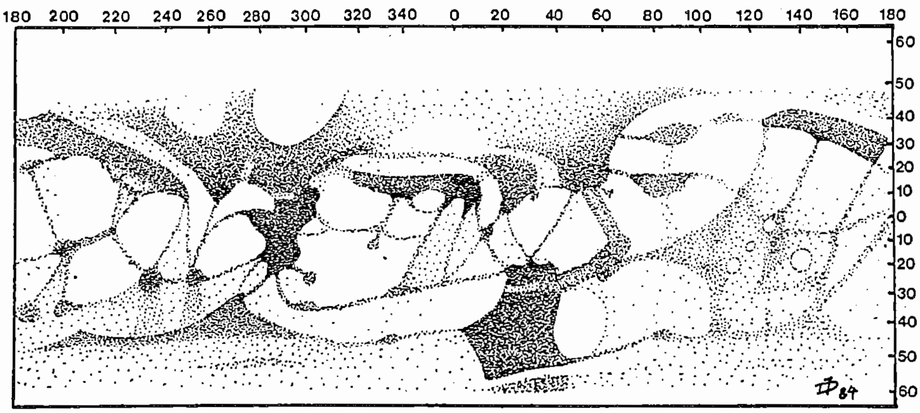


Figure 20. Map of Martian albedo features as they appeared in 1983-85. Drawn by J. Dragesco and based on his observations with a 36-cm catadioptric telescope during that apparition. This figure is oriented so that Martian south is at the top and west to the right.

Explanation for Figures 21-25.

The captions for the individual drawings and photographs in *Figures 21-25* are on the page facing each figure. The captions are arranged in rows and columns so as to match the illustrations. All Martian disks are oriented with south at the top and celestial east to the right.

In each caption, information is arranged as follows: Universal Date and Time; Ls, the areocentric longitude of the Sun; CM, the longitude of the central meridian; De, the areocentric declination of the Earth; k, the phase coefficient (proportion of disk illuminated); Dia., the apparent diameter of the disk in arc-seconds. These data are followed by the aperture of the telescope in centimeters followed by the focal ratio, if known; then by the type of telescope, where C indicates Cassegrain; N, Newtonian; R, refractor; and SC, Schmidt-Cassegrain. If "photograph" is not stated, the illustration is a drawing. Under "Filter," the Wratten numbers indicate the following colors: 8, yellow; 11, yellowish-green; 12, deep yellow; 15, deep yellow; 21, orange; 22, deep orange; 23A, light red; 25, red tricolor; 30, light magenta; 35, purple; 38, light blue; 38A, blue; 47, blue tricolor ("violet"); 47B, deep blue tricolor; 58, green tricolor; 64, light blue-green; and IL, integrated light (no filter). This information is followed by the observer's name, which in turn is followed by comments.

Figure 21 (facing).

1983 OCT 30, 11:15. Ls 058°. CM 016°. De +25°. k 0.95. Dia. 4".3. 32-cm. f/6.5 N. Filters: 30, 15. D.C. Parker. Brilliant streak on SW limb over Oxia-Chryse. Brightest in orange and yellow.

1983 OCT 30, 10:30. Ls 058°. CM 005°. De +25°. k 0.95. Dia. 4".3. 32-cm. f/16.5 C. Filters: 15. J.D. Beish. Bright cloud in Chryse. Dark streak (Arnon) extending S. from North Polar Collar.

1983 OCT 31, 10:30. Ls 058°. CM 356°. De +25°. k 0.95. Dia. 4".4. 32-cm. f/16.5 C. Filters: 23A. J.D. Beish. Bright yellow cloud in Chryse extending to Ophir.

1983 NOV 03, 11:25. Ls 059°. CM 340°. De +25°. k 0.95. Dia. 4".4. 32-cm. f/6.5 N. Filters: 23A, 15. D.C. Parker. Yellow clouds in Chryse and Aeria.

1983 NOV 24, 10:40. Ls 068°. CM 124°. De +24°. k 0.93. Dia. 4".8. 32-cm. f/6.5 N. Filters: 47. D.C. Parker. Conspicuous E. limb cloud over Candor. Note dark band N. of equator, seen only in violet light. Possible yellow cloud.

1983 NOV 27, 10:30. Ls 070°. CM 092°. De +24°. k 0.93. Dia. 4".8. 32-cm. f/30 C. Filters: 25, 23A, 58. J.D. Beish. Yellow-cloud activity over Daedalia-Phaethontis Note dark streak along S. limb; Poss. shadow. Yellow cloud also in Candor.

1983 NOV 28, 11:00. Ls 070°. CM 090°. De +24°. k 0.93. Dia. 4".9. 32-cm. f/30 C. Filters: 22, 23A, 64. J.D. Beish. Dust storm obscuring Solis Lacus.

1983 NOV 28, 11:20. Ls 070°. CM 095°. De +24°. k 0.93. Dia. 4".9. 32-cm. f/6.5 N. Filters: 15, 22. D.C. Parker. Dust over Chryse and Candor, obscuring Ganges. N. Polar Collar broad and bluish.

1983 NOV 29, 10:35. Ls 071°. CM 074°. De +24°. k 0.93. Dia. 4".9. 32-cm. f/30 C. Filters: 22, 8. J.D. Beish. Mixture of yellow and white clouds over Solis Lacus; white area in Boreum Mare. Strong violet clearing despite dust.

1983 NOV 30, 10:40. Ls 071°. CM 066°. De +24°. k 0.93. Dia. 4".9. 32-cm.f/30 C. Filters: 8. J.D. Beish. Yellow clouds persist over Solis Lacus region. Bright yellow clouds in Chryse-Xanthe.

1983 DEC 01, 05:20. Ls 071°. CM 338°. De +24°. k 0.93. Dia. 4".9. 25-cm. N. Filters: orange. F.R. Van Loo. Bright yellow clouds in Aeria and Chryse. Sabaeus Sinus and Meridiani Sinus not seen.

1983 DEC 04, 10:40. Ls 073°. CM 027°. De +24°. k 0.93. Dia. 5".0. 32-cm. f/30 C. Filters: 25, 23A, 30, 12, 58. J.D. Beish. Yellow haze on Eve. limb, with bright yellow streak extending from limb (Eden) into Chryse. NOTE: Meridiani Sinus completely obscured; very dark albedo feature along S. limb may be cloud shadow.

1983 DEC 06, 10:00. Ls 074°. CM 358°. De +23°. k 0.92. Dia. 5".0. 32-cm. f/30 C. Filters: 25, 12, 58, 30. J.D. Beish. Yellow clouds and hazes obscuring Meridiani Sinus and Margaritifer Sinus. No albedo features seen in Eden or Arabia.

1983 DEC 11, 10:40. Ls 076°. CM 319°. De +23°. k 0.92. Dia. 5".2. 32-cm. f/6.5 N. Filters: 12, 25, IL. D.C. Parker. Bright yellow cloud extending from Hellas-Noachis across Deltoton Sinus into Aeria. A second yellow streak on morning limb in Eden. Meridiani Sinus now visible.

1983 DEC 13, 10:15. Ls 077°. CM 294°. De +23°. k 0.92. Dia. 5".2. 32-cm. f/30 C. Filters: 12. J.D. Beish. Large yellow cloud extending from Hellas across Deltoton Sinus and E. Sabaeus Sinus into Aeria along W. border of Syrtis Major, thence westward across Moab and Eden. See next observation.

1983 DEC 13, 10:15. Ls 077°. CM 294°. De +23°. k 0.92. Dia. 5".2. 32-cm. f/30 C. Filters: 47, 47B, 38A. J.D. Beish. NOTE: Anomalous dark streak in Moab; probably the yellow cloud appearing dark in violet light! Also numerous white discrete evening and morning clouds.

1983 DEC 26, 10:00. Ls 082°. CM 164°. De +21°. k 0.91. Dia. 5".6. 32-cm. f/6.5 N. Filters: 15, 23A, 30. D.C. Parker. Bright yellow streak across Atlantis extending NE. into Zephyria-Amazonis. Bright E. limb clouds in green and blue-green light—possible orographic clouds.

1984 JAN 12, 11:30. Ls 090°. CM 022°. De +19°. k 0.91. Dia. 6".2. 32-cm. f/6.5 N. Filters: 12, 15. D.C. Parker. Brilliant morning limb cloud over Xanthe-Candor; also bright in violet. Yellow haze across Eden and Chryse. Margaritifer and Meridiani Sinus poorly defined.

1984 JAN 17, 10:05. Ls 092°. CM 314°. De +19°. k 0.90. Dia. 6".4. 32-cm. f/30 C. Filters: 25, 15, 58, 30. J.D. Beish. Yellow clouds/haze obscuring eastern Sabaeus Sinus and covering Aeria, Moab, and Eden. In violet light (see next observation) dark streaks in Moab still persist.

1984 JAN 17, 10:05. Ls 092°. CM 314°. De +19°. k 0.90. Dia. 6".4. 32-cm. f/30 C. Filters: 47, 47B. J.D. Beish. Six discrete clouds in Aeria-Moab-Eden. Anomalous dark streaks; probably yellow clouds.

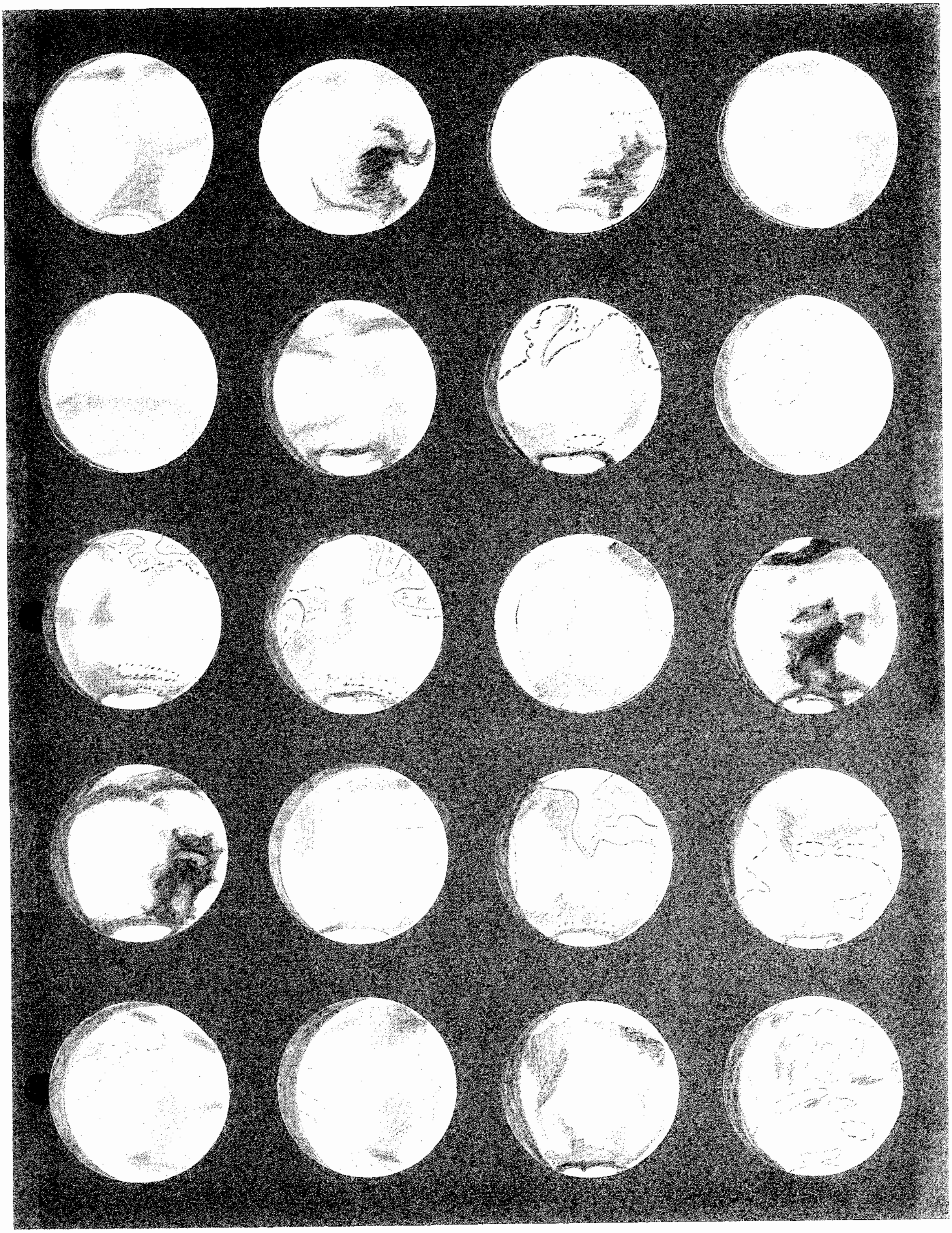


Figure 22 (facing).

1984 JAN 26, 04:55.
Ls 096°. CM 152°.
De +17°. k 0.90.
Dia. 6".9.
35.5-cm. SC.
J. Dragesco.
Bright orographic clouds on evening limb.

1984 JAN 29, 05:00.
Ls 097°. CM 124°.
De +16°. k 0.90.
Dia. 7".0.
35.5-cm. SC.
J. Dragesco.
Bright morning cloud obscuring Sirenum Mare—dust?

1984 JAN 31, 10:00.
Ls 098°. CM 178°. De +16°. k 0.90. Dia. 7".1.
32-cm. f/30 C. Filters: 15, 58, 30. J.D. Beish.
Bright yellow clouds in Zephyria and yellow haze covering southern half of disk. Cimmerium and Sirenum Maria washed out. Numerous discrete, orographic, and limb clouds seen in violet light.

1984 FEB 04, 05:05.
Ls 100°. CM 068°.
De +16°. k 0.90.
Dia. 7".4.
35.5-cm. SC.
J. Dragesco.
Bright clouds over Chryse-Xanthe and on morning limb, obscuring Solis Lacus.

1984 FEB 05, 10:30.
Ls 101°. CM 138°.
De +16°. k 0.90.
Dia. 7".5.
32-cm. f/30 C.
Filters: 25, 15, 58, 30.
J.D. Beish.
Dust storm obscuring major albedo features except Olympus Mons. See next observation.

1984 FEB 05, 10:50.
Ls 101°. CM 143°.
De +15. k 0.90.
Dia. 7".5.
32-cm. f/30 C.
Filters: 47, 47B, 38A.
J.D. Beish.
Anomalous dark feature positioned where yellow cloud was brightest!

1984 FEB 06, 09:25.
Ls 101°. CM 113°.
De +15°. k 0.90.
Dia. 7".5.
32-cm. f/6.5 N.
Filters: 12.
D.C. Parker.
Major obscuration of surface details by yellow cloud. Aonius Sinus seen on S. limb. Sirenum Mare obscured.

1984 FEB 06, 10:15.
Ls 101°. CM 125°.
De +15°. k 0.90.
Dia. 7".5.
32-cm. f/30 C.
Filters: 25, 15, 58, 30.
J.D. Beish.
Major surface features completely obscured by dust.

1984 FEB 06, 10:15.
Ls 101°. CM 125°.
De +15°. k 0.90.
Dia. 7".5.
32-cm. f/30 C.
Filters: 47, 47B, 38A.
J.D. Beish.
White cloud on evening limb near Lunae Lacus, apparently projecting onto terminator. See next observation.

1984 FEB 08, 11:10.
Ls 102°. CM 119°.
De +15°. k 0.90.
Dia. 7".6.
25-cm. N.
Filters: 47.
D. Troiani.
Evening limb cloud apparently projecting onto terminator. Surface features largely obscured in red light.

1984 FEB 13, 06:30.
Ls 104°. CM 004°.
De +14°. k 0.90.
Dia. 8".0.
25-cm. N.
Filters: Orange.
F.R. Van Loo.
Bright yellow clouds on SW. limb. N. Hemisphere features faint, such as Acidalium Mare.

1984 FEB 24, 05:15.
Ls 109°. CM 241°.
De +13°. k 0.91.
Dia. 8".8.
35.5-cm. SC.
J. Dragesco.
No yellow-cloud activity. Morning clouds in Libya, Isidis, and Aeria. Elysium not brilliant.

1984 FEB 24, 11:20.
Ls 109°. CM 330°.
De +13°. k 0.91.
Dia. 8".8.
32-cm. f/30 C.
Filters: 25, 15, 58, 30.
J.D. Beish.
No Evidence of dust.

1984 FEB 24, 11:40.
Ls 109°. CM 335°.
De +13°. k 0.91.
Dia. 8".8. 32-cm. f/30 C. Filters: 47, 47B, 38A.
J.D. Beish. Violet clearing relatively prominent. Evening cloud apparently projecting on terminator. Morning clouds and hazes. Edom cloudy.

1984 MAR 03, 05:10.
Ls 113°. CM 165°.
De +12°. k 0.91.
Dia. 9".5.
35.5-cm. SC.
J. Dragesco.
Bright orographic clouds on evening limb. Morning haze.

1984 MAR 07, 04:40.
Ls 115°. CM 120°.
De +11°. k 0.91.
Dia. 9".9.
35.5-cm. SC.
J. Dragesco.
"Domino" (white-dot appearing) orographic clouds.

1984 MAR 07, 07:30.
Ls 115°. CM 161°.
De +11°. k 0.91.
Dia. 9".9.
25-cm. N.
Filters: 47.
D. Troiani.
Elysium cloud on morning limb; orographic clouds near Olympus Mons.

1984 MAR 25, 08:36.
Ls 123°. CM 010°.
De +10°. k 0.93.
Dia. 11".9. 32-cm. f/6.5 N. Filters: 47.
D.C. Parker.
Violet-light photograph. Faint Equatorial Cloud Band; brilliant morning cloud over Xanthe, Candor, and Tempe.

1984 APR 01, 04:15.
Ls 126°. CM 242°.
De +10°. k 0.95.
Dia. 12".8.
35.5-cm. SC.
J. Dragesco.
Hellas brilliant. Discrete clouds over Elysium, Libya, and Aeria.

1984 APR 03, 18:20.
Ls 128°. CM 070°.
De +10°. k 0.95.
Dia. 13".1
20-cm. N.
M. Nakajima.
Solis Lacus small and weak. Claritas dusky. Bright cloud in Oxia-Chryse.

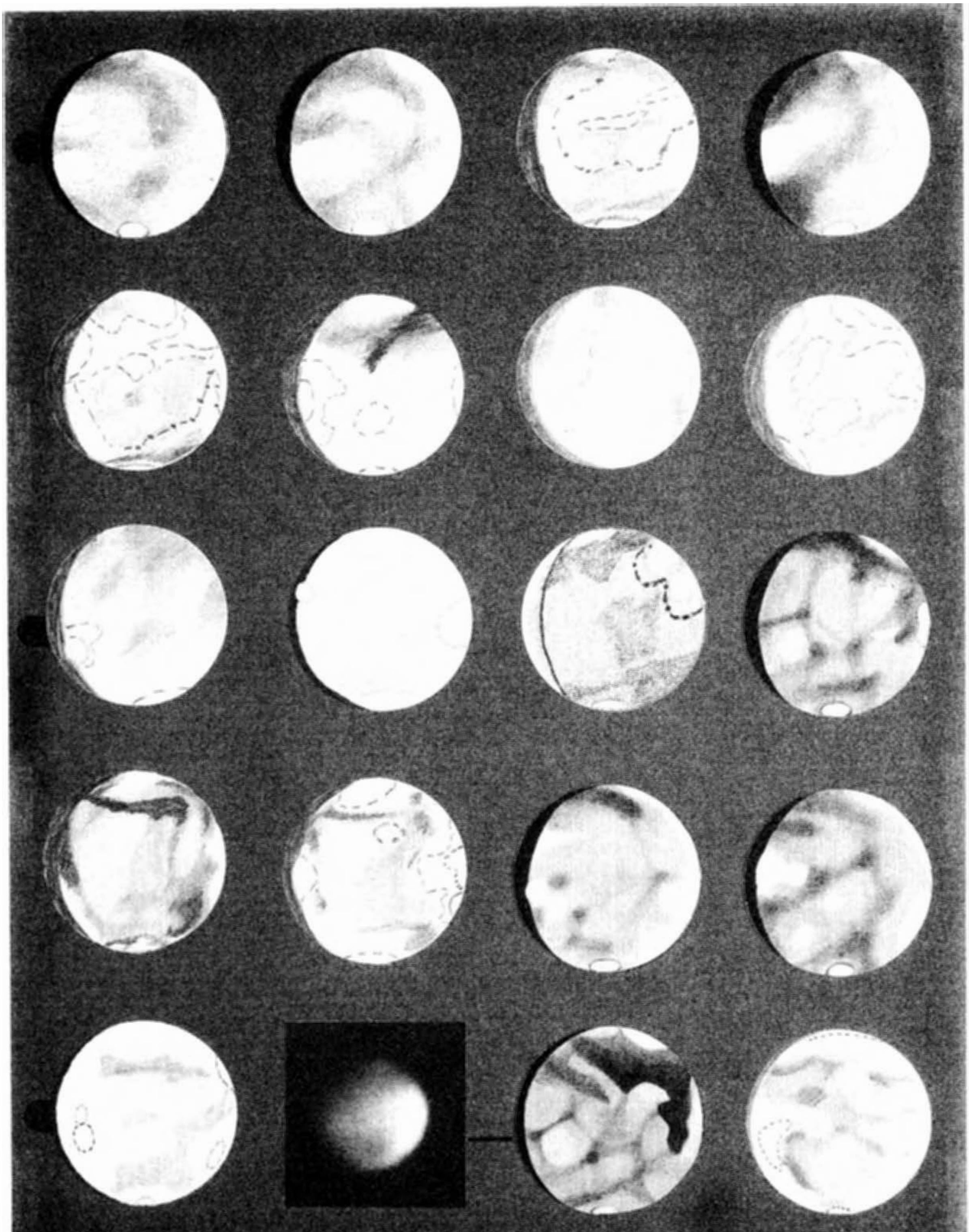


Figure 23 (facing).

1984 APR 06, 03:45.
Ls 129°. CM 189°.
De +10°. k 0.95.
Dia. 13".4.
35.5-cm. SC.
J. Dragesco.
Brilliant orographic cloud near Olympus Mons. Elysium dull.

1984 APR 06, 07:50.
Ls 129°. CM 249°.
De +10°. k 0.95.
Dia. 13".5.
25-cm. N.
Filters: IL, 58, 38.
J. Olivarez.
Elysium has now brightened during Martian afternoon, especially in green light. Hellas brilliant. North Polar Region dull.

1984 APR 09, 11:00.
Ls 130°. CM 268°.
De +10°. k 0.96.
Dia. 13".9.
28-cm. SC.
Filters: 47.
G. Rosenbaum.
Bright cloud over Elysium on evening limb. Morning cloud over Aeria. Hellas brilliant.

1984 APR 11, 05:30.
Ls 131°. CM 170°.
De +10°. k 0.96.
Dia. 14".1.
32-cm. f/6.5 N.
Filters: 15, 25.
D.C. Parker.
Atlantis appears widened due to S. limb haze. Trivium Charontis, Ceberus, and Propontis complex very faint.

1984 APR 12, 07:00.
Ls 132°. CM 182°.
De +10°. k 0.97.
Dia. 14".2.
25-cm. N.
Filters: Light blue.
R. Tatum.
Olympus Mons orographic cloud bright on evening limb. Elysium light; Cerberus-Trivium Charontis washed out.

1984 APR 15, 04:20.
Ls 133°. CM 116°.
De +10°. k 0.97.
Dia. 14".7.
35.5-cm. SC.
J. Dragesco.
"Domino" clouds. Discrete clouds over Olympus Mons, Arsia Mons, Alba Patera, and on evening limb over Tempe and Ophir.

1984 APR 19, 07:17.
Ls 135°. CM 124°.
De +11°. k 0.98.
Dia. 15".2.
32-cm. f/6.5 N.
D.C. Parker.
Violet-light photograph showing "Domino Clouds." Compare with previous observation.

1984 APR 18, 04:00.
Ls 134°. CM 085°.
De +10°. k 0.98.
Dia. 15".1.
35.5-cm. SC.
J. Dragesco.
Possible yellow clouds obscuring Tithonius, Candor, Xanthe, and Ophir. Brilliant white cloud in Tempe.

1984 APR 19, 06:30.
Ls 135°. CM 112°.
De +11°. k 0.98.
Dia. 15".2.
32-cm. f/6.5 N.
Filters: 25, 23A, 35.
D.C. Parker.
Tempe brilliant in red through violet. Ophir-Candor very bright. Cloud over Daedalia. N. border of Sirenum Mare very faint.

1984 APR 21, 06:03.
Ls 136°. CM 088°.
De +11°. k 0.98.
Dia. 15".5.
32-cm. f/6.5 N.
D.C. Parker.
Violet-light photograph showing "Zeta Cloud."
(See text on p. 64.)

1984 APR 21, 06:40.
Ls 136°. CM 097°.
De +11°. k 0.98.
Dia. 15".5.
32-cm. f/6.5 N.
Filters: 23A.
D.C. Parker.
Tithonius now visible. Candor returned to normal. NE. border of Sirenum Mare very faint.

1984 APR 21, 07:15.
Ls 136°. CM 105°.
De +11°. k 0.98.
Dia. 15".5.
32-cm. f/6.5 N.
Filters: 47.
D.C. Parker.
Orographic clouds over Ascraeus and Olympus Montes and Alba Patera. "Tractus Albus" partially formed. (See text on p. 63.)

1984 APR 29, 06:30.
Ls 140°. CM 023°.
De +12°. k 0.99.
Dia. 16".4.
32-cm. f/6.5 N.
D.C. Parker.
Violet-light photograph showing brilliant cloud in Argyre, morning-limb arc, and bright cloud in Tempe.

1984 APR 29, 07:00.
Ls 140°. CM 031°.
De +12°. k 0.99.
Dia. 16".4.
16.5-cm. R.
Filters: 21.
T. Dobbins and K. Schneller.
Noachis and Argyre bright. Small bluish cloud noted in Tempe.

1984 APR 30, 00:29.
Ls 140°. CM 286°.
De +12°. k 0.99.
Dia. 16".5.
35.5-cm. SC.
J. Dragesco.
Integrated-light photograph. E. Sabaeus Sinus weak.

1984 MAY 09, 05:50.
Ls 145°. CM 285°.
De +14°. k 1.00.
Dia. 17".3.
32-cm. f/6.5 N.
Filters: IL.
D.C. Parker.
Crocea bright. Nepenthes-Thoth, Laocoöntis, and most of Casius not seen.

1984 MAY 09, 06:30.
Ls 145°. CM 295°.
De +14°. k 1.00.
Dia. 17".3.
32-cm. f/6.5 N.
Filters: 47
D.C. Parker.
Strong violet clearing. Elysium not especially bright on evening limb..

1984 MAY 05, 05:51.
Ls 143°. CM 321°.
De +13°. k 1.00.
Dia. 17".0.
32-cm. f/6.5 N.
D.C. Parker.
Violet-light photograph showing Arctic clouds, haze in Libya, and cloud in Hellas.

1984 MAY 11, 10:00.
Ls 146°. CM 329°.
De +14°. k 1.00.
Dia. 17".4.
44-cm. N.
Filters: 11.
R. Fabré.
Arctic cloud. E. Sabaeus Sinus and Iapygia Mare weak.

1984 MAY 13, 05:00.
Ls 147°. CM 238°.
De +14°. k 1.00.
Dia. 17".5.
32-cm. f/6.5 N.
D.C. Parker.
IL photograph. Trivium Charontis -Cerberus weak. "Hyblaeus Extension" broad & dusky. Morpheos L. darkened. (See text on p. 67.)

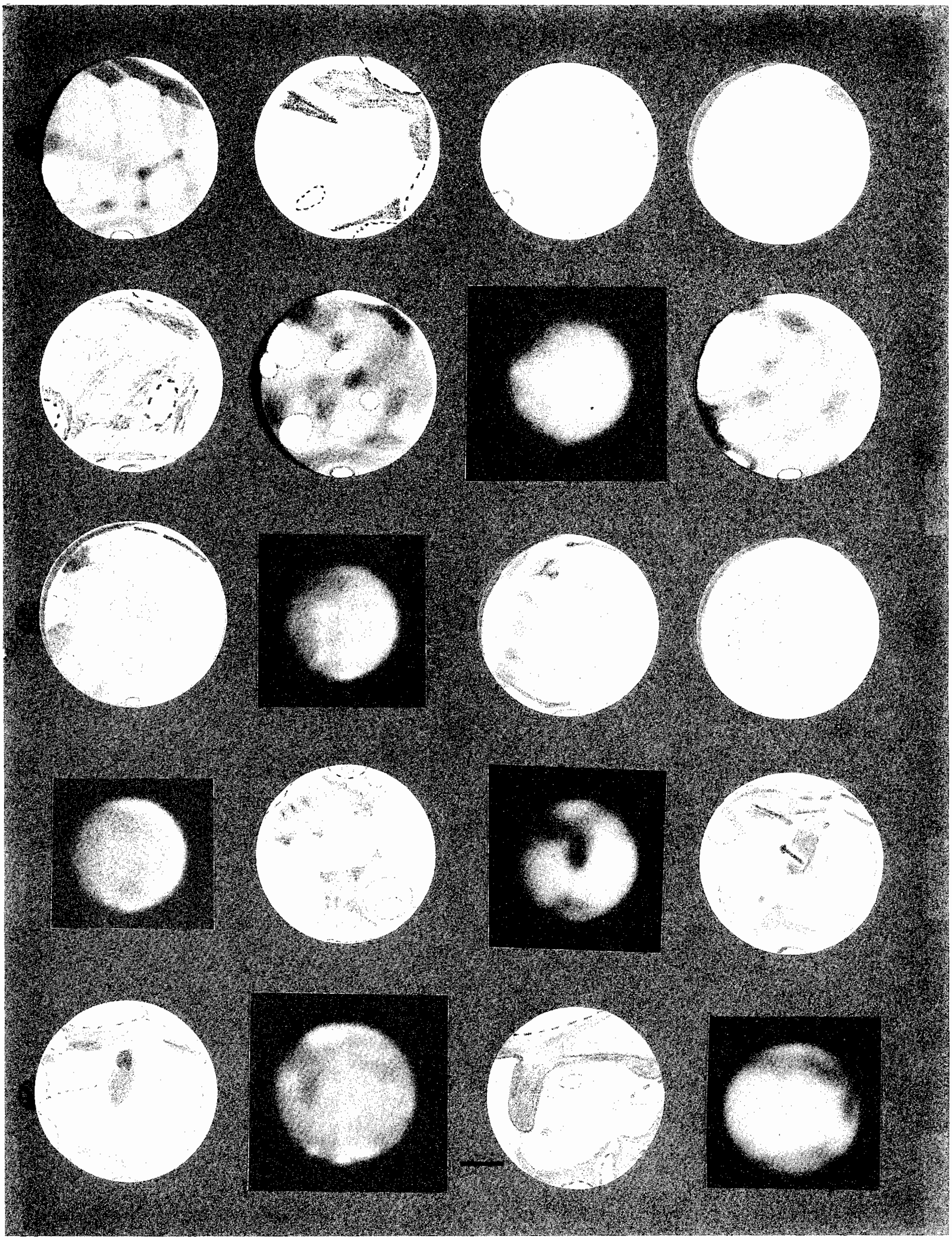


Figure 24 (facing).

1984 MAY 13, 06:50.
Ls 147°. CM 265°.
De +14°. k 1.00.
Dia. 17".5.
16.5-cm. R.
Filters: 21.
T. Dobbins and
K. Schneller.
Morpheos Lacus unusually dark. Evening cloud over Elysium.

1984 MAY 20, 21:05.
Ls 151°. CM 052°.
De +16°. k 0.99.
Dia. 17".6.
20-cm. C.
R. de Terwangne.
Limb clouds. Note streak in Chryse (Jamuna).

1984 JUN 04, 03:04.
Ls 158°. CM 016°.
De +18°. k 0.97.
Dia. 16"9.
32-cm. f/6.5 N.
D.C. Parker.
Red-light (W23A) photograph. Ismenius Lacus, Deuteronilus, and Oxia Palus conspicuous. Tempe dull in red; brilliant in yellow and blue light.

1984 JUN 10, 01:40.
Ls 161°. CM 301°.
De +18°. k 0.96.
Dia. 16".4.
32-cm. f/30 C.
Filters: 25.
J.D. Beish.
See next observation for meteorological notes.

1984 JUN 11, 01:50.
Ls 162°. CM 295°.
De +19°. k 0.95.
Dia. 16".3.
32-cm. f/30 C.
Filters: 47, 47B, 38A.
J.D. Beish.
Very large number of discrete and limb clouds seen in violet light..

1984 MAY 19, 22:15.
Ls 150°. CM 077°.
De +16°. k 1.00.
Dia. 17".6.
35.5-cm. SC.
J. Dragesco.
White cloud in Argyre, crossing Bosporus (South Polar Hood?).

1984 MAY 24, 01:40.
Ls 152°. CM 093°.
De +16°. k 0.99.
Dia. 17".5. 32-cm. f/6.5 N. Filters: 15, 25, 22, 30. D.C. Parker.
Bright streak running from Tempe to Arcadia; brighter in yellow than in red or violet. Evening cloud/haze over Xanthe-Chryse. Small yellow clouds in Candor. Phasis noted.

1984 JUN 09, 03:15.
Ls 161°. CM 333°.
De +18°. k 0.96.
Dia. 16".5.
25-cm. N.
Filters: Orange.
K. Rhea.
E. border of Syrtis Major obscured.

1984 JUN 10, 02:00.
Ls 161°. CM 306°.
De +18°. k 0.96.
Dia. 16".4. 32-cm. f/30 C. Filters: 47, 47B, 38A. J.D. Beish.
Evening limb clouds extend into Libya-Crocea. Evening limb haze; N. and S. Polar hazes. Intricate morning limb clouds. Discrete clouds in Deucalionis and Aeria.

1984 JUN 12, 02:50.
Ls 162°. CM 300°.
De +19°. k 0.95.
Dia. 16"2.
32-cm. f/6.5 N.
Filters: 47.
D.C. Parker.
Numerous discrete clouds in Libya and Aeria; polar and limb clouds.

1984 MAY 19, 22:29.
Ls 150°. CM 081°.
De +16°. k 1.00.
Dia. 17".6.
35.5-cm. SC.
J. Dragesco.
Integrated-light photograph. Ganges prominent.

1984 MAY 30, 03:45.
Ls 156°. CM 070°.
De +17°. k 0.98.
Dia. 17".3.
25-cm. N.
Filters: Orange, Yellow.
J. Olivarez.
Tempe streak bright in yellow light.

1984 JUN 08, 22:12.
Ls 161°. CM 259°.
De +18°. k 0.96.
Dia. 16".5.
20-cm. N.
Filters: Orange, Blue.
M. Legrand.
Bright streaks in Libya-Crocea and crossing Elysium. Trivium Charontis-Cerberus very weak.

1984 JUN 10, 20:25.
Ls 162°. CM 215°.
De +18°. k 0.96.
Dia. 16".4.
35.5-cm. SC.
J. Dragesco.
NOTE: New dark feature in Aetheria (Morpheos Lacus) and angular appearance of Elysium. See next observation.

1984 JUN 13, 05:50.
Ls 163°. CM 335°.
De +19°. k 0.95.
Dia. 16".1.
15-cm. N.
Filters: Yellow.
M. Wills.
Morning and evening limb clouds. Note bright streak over Crocea.

1984 MAY 20, 03:33.
Ls 150°. CM 155°.
De +16°. k 1.00.
Dia. 17".6.
32-cm. f/6.5 N.
D.C. Parker.
Violet-light photograph showing orographic clouds over Arsia Mons and cloud activity in Arcadia and on morning limb.

1984 JUN 03, 04:00.
Ls 158°. CM 038°.
De +18°. k 0.97.
Dia. 17".0
32-cm. f/30 C.
Filters: 47, 47B, 38A.
J.D. Beish.
Numerous morning and evening limb clouds. Clouds in Tempe.

1984 JUN 09, 04:00.
Ls 161°. CM 344°.
De +18°. k 0.96.
Dia. 16".5.
20-cm. N.
Filters: 25.
G. Rosenbaum.
N. Polar Cap brilliant. S. Polar Hood larger, bright in violet light. Bright limb clouds in Isidis Regio and Tempe.

1984 JUN 10, 20:33.
Ls 162°. CM 217°.
De +18°. k 0.96.
Dia. 16".4.
35.5-cm. SC.
J. Dragesco.
Photograph. Arrow indicates darkening and expansion of Hyblaeus into Aetheria.

1984 JUN 15, 20:25.
Ls 164°. CM 170°.
De +19°. k 0.94.
Dia. 15".9.
35.5-cm. SC.
J. Dragesco.
IL Photograph. Propontis I and Euxinus Lacus very dark; Amazonis dusky.

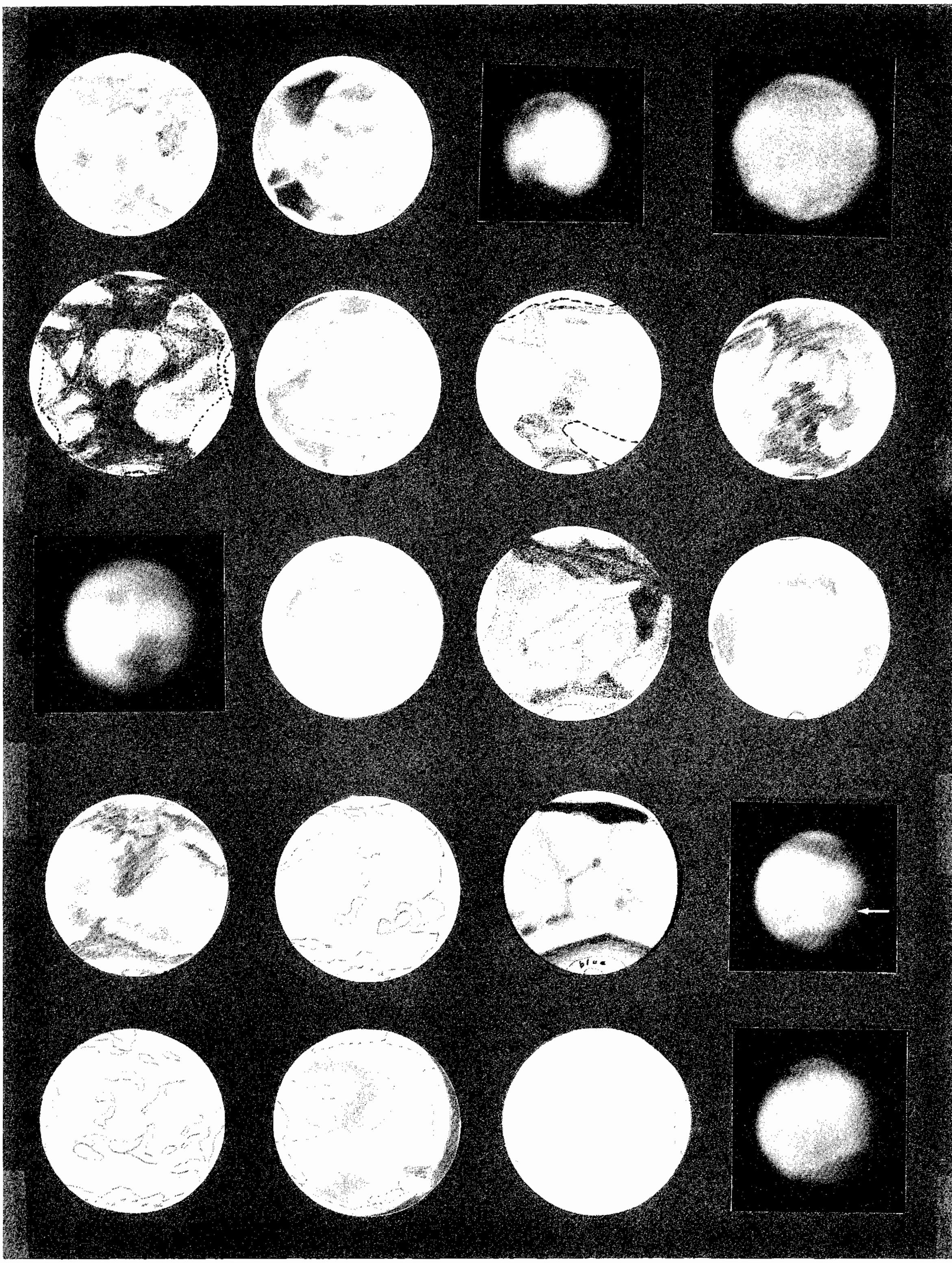

blue

Figure 25 (facing).

1984 JUN 16, 11:30.
Ls 165°. CM 031°.
De +19°. k 0.94.
Dia. 15".8.
20-cm. N.
M. Nakajima.
Evening limb haze over Meridiani Sinus. N. Polar Cap remnant bright.

1984 JUN 17, 02:30.
Ls 165°. CM 250°.
De +19°. k 0.94.
Dia. 15".7.
20-cm. N.
Filters: IL.
M. Daniels.
New darkening in Morpheos Lacus very pronounced. Hyblaeus darkening now extending across Aetheria. Cebrenia appears as a light streak.

1984 JUN 19, 02:50.
Ls 166°. CM 237°.
De +19°. k 0.94.
Dia. 15".5.
32-cm. f/30 C.
Filters: 25, 15.
J.D. Beish.
Hyblaeus-Aetheria dark. Alcyonius Nodus-Nubis Lacus - Nepenthes-Thoth more conspicuous than previously.

1984 JUN 19, 03:15.
Ls 166°. CM 243°.
De +19°. k 0.94.
Dia. 15".5.
32-cm. f/30 C.
Filters: 47, 47B, 38A.
J.D. Beish.
Equatorial cloud banding. Numerous discrete clouds. S. Polar Hood and Arctic hazes, indicating formation of N. Polar Hood.

1984 JUN 19, 03:24.
Ls 166°. CM 245°.
De +19°. k 0.94.
Dia. 15".5.
32-cm. N.
Filters: Rd4 (red).
A.K. Herring.
Trivium Charontis-Ceberus very washed out. Hephaestus Nodus now enlarged and dark. Aetheria dusky. Compare with Daniels view of JUN 17.

1984 JUN 20, 01:45.
Ls 167°. CM 212°.
De +19°. k 0.93.
Dia. 15".4.
32-cm. f/30 C.
Filters: 25, 58, 64.
J.D. Beish.
Ceberus weak but Trivium Charontis-Hades-Propontis I dark. Unusual appearance due to streak bright in green and blue-green light S. of Panchaia and S. into Elysium.

1984 JUN 20, 02:30.
Ls 167°. CM 223°.
De +19°. k 0.93.
Dia. 15".4.
15-cm. N.
Filters: IL.
R. Robotham.
Streaks in Cebrenia and into Elysium similar to JUN 19 Herring observation.

1984 JUN 20, 02:58.
Ls 167°. CM 230°.
De +19°. k 0.93.
Dia. 15"4.
32-cm. f/6.5 N.
D.C. Parker.
IL Photograph. Hyblaeus extension and Propontis I dark. Trivium Charontis-Hades moderate in tone. Elysium angular in shape.

1984 JUN 24, 19:25.
Ls 169°. CM 074°.
De +19°. k 0.92.
Dia. 14".9.
35.5-cm. SC.
J. Dragesco.
Yellow cloud in Thaumasia obscuring Nectar, E. Solis Lacus, and Agathodaemon. Bluish haze in N. Polar region—early N. Polar Hood.

1984 JUN 24, 19:36.
Ls 169°. CM 076°.
De +19°. k 0.92.
Dia. 14".9.
35.5-cm. SC.
Filters: IL.
J. Dragesco.
Photograph showing with arrow yellow cloud across E. Thaumasia.

1984 JUL 02, 01:19.
Ls 173°. CM 095°.
De +19°. k 0.91.
Dia. 14"1.
32-cm. f/6.5 N.
D.C. Parker.
IL Photograph. Yellow cloud resolved. Solis Lacus-Thaumasia region back to normal.

1984 JUL 02, 13:09.
Ls 174°. CM 268°.
De +19°. k 0.91.
Dia. 14"1.
(No telescope data).
M. Adachi.
Elysium dull; Aetheria dusky; Amenthes prominent.

1984 JUL 12, 21:00.
Ls 179°. CM 290°.
De +18°. k 0.89.
Dia. 13".0.
20-cm. C.
Filters: IL.
R. de Terwangne.
Nepenthes-Thoth now faintly visible. Tiny N. Polar Cap surrounded by polar haze (early N. Polar Hood?).

1984 JUL 14, 00:30.
Ls 180°. CM 331°.
De +18°. k 0.89.
Dia. 12".9.
32-cm. f/30 C.
Filters: 25, 15, 58, 30.
J.D. Beish.
Detailed surface features. See next observation for meteorological notes.

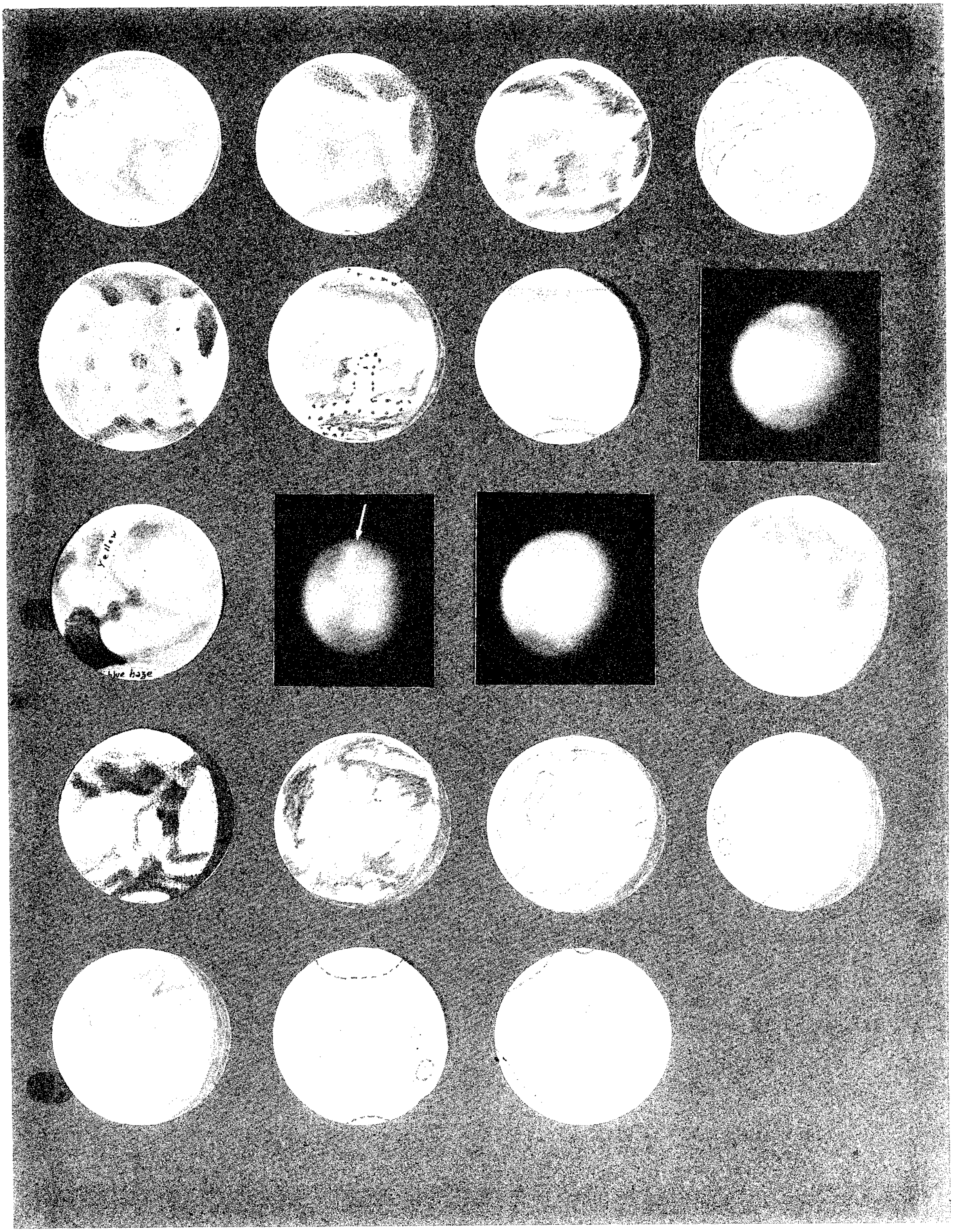
1984 JUL 14, 00:50.
Ls 180°. CM 336°.
De +18°. k 0.89.
Dia. 12".9.
32-cm. f/30 C.
Filters: 47, 47B, 38A.
J.D. Beish.
AUTUMNAL EQUINOX. N. Polar Hood growing bright. S. Polar Cap not visible. Numerous discrete clouds. Eve. limb haze.

1984 AUG 14, 11:00.
Ls 198°. CM 190°.
De +13°. k 0.85.
Dia. 10".4. 20-cm. N.
M. Nakajima.
S. Polar Cap brilliant; snow-white. First appearance of S. Polar Cap clear of hazes. N. Polar Hood bright. Olympus and Biblis Montes bright near evening limb.

1984 OCT 08, 23:35.
Ls 232°. CM 202°.
De -03°. k 0.86.
Dia. 7".7.
15-cm. R.
Filters:23A, 21, 8.
C.L. Evans.
S. Polar Cap brilliant.

1984 DEC 04, 00:50.
Ls 268°. CM 030°.
De -19°. k 0.89.
Dia. 6".0. 25-cm. N.
Filters: 25.
D. Troiani.
S. Polar Cap brilliant. Xanthe bright in red and yellow. N. Polar Hood large, bright in violet light.

1985 MAR 20, 01:05.
Ls 331°. CM 061°.
De -20°. k 0.96.
Dia. 4".2. 25-cm. N.
Filters 12, 23A.
D. M. Moore.
S. Polar Cap small, bright. Noachis bright on SE. limb.


Yellow
blue haze

A JUPITER PORTFOLIO

We recently have received several excellent photographic and electronic images of the planet Jupiter. They show with high resolution its current somewhat anomalous condition with the South Equatorial Belt (SEB) virtually absent. The views here, on the next page, and on the front cover, are all oriented with south at the top and Jovian west to the right. "CM" stands for the longitude of the central meridian in Rotational Systems I and II.

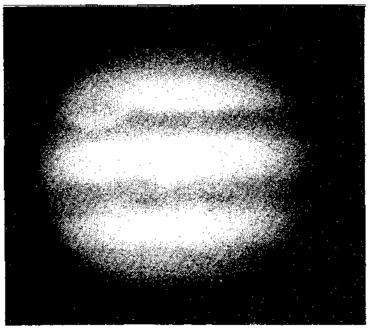


Figure 26. Integrated-light photograph by Donald C. Parker. 1989 MAR 06, 00h29m U.T. CM(I) = 160°, CM(II) = 061°. Seeing 7 on the A.L.P.O. Scale (0 = worst, 10 = best); Transparency 4 on the A.L.P.O. Scale (0 = worst, 5 = best). 32-cm Newtonian at f/123. 2.5 sec. on Kodak TP-2415 Film. Note the Great Red Spot in the upper left.

Figure 27. Integrated-light photograph by Donald C. Parker. 1989 OCT 16, 09h21m U.T. CM(I) = 175°, CM(II) = 164°. Seeing 8-9; Transparency 5. 41-cm Newtonian at f/93. 1 sec. on Kodak TP-2415 Film. Note the virtual absence of South Equatorial Belt, as well as an expanding North Equatorial Belt Eruption with a very bright center.

Figure 28. Detailed view of Great Red Spot area, with faded South Equatorial Belt at bottom; "South Temperate Zone Belt" at top containing two White Ovals (Number 6 on the left and Number 3 on the right). CCD (Charge-Coupled Device) image taken by P. Laques, Ch. Buil, A.L.P.O. member Jean Bourgeois, *et al.* on 1990 JAN 06, 02h27m40s U.T. Pic du Midi Observatory, France, 1-meter Cassegrain, f/50, red filter. CM(I) = 280°, CM(II) = 006°.

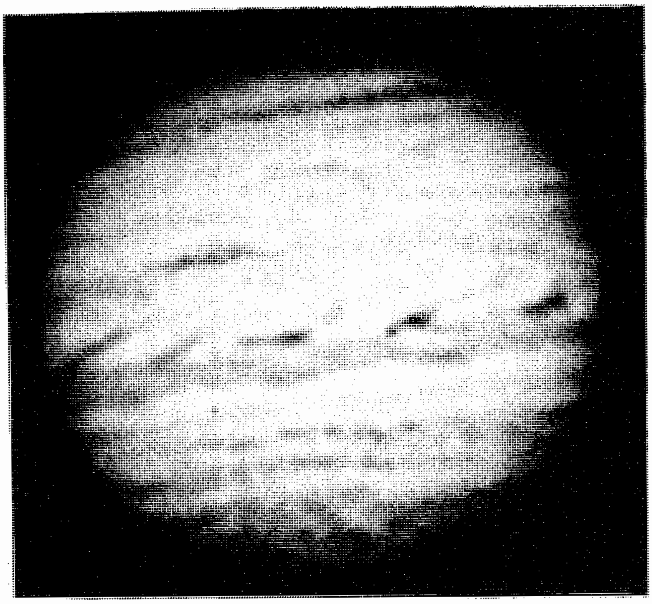


Figure 29. Whole-disk CCD view taken by P. Lacques, Ch. Buil, J. Bourgeois *et al.* on 1990 JAN 30, 22h44m20s U.T. Pic du Midi 1-meter Cassegrain at f/16, red filter. CM(I) = 133°, CM(II) = 029°. Note the Great Red Spot near the central meridian and intricate festoons in the Equatorial Zone (EZ).

Figure 30. CCD exposure of Jupiter by J. Melnick with the European Southern Observatory 3.5-meter NTT (New Technology Telescope) at Cerro La Silla, Chile. 1 sec. through a 50-Å width narrow-band 4540-Å (blue) filter, seeing 0.6 arc-seconds. 1990 JAN 06, 04h06m U.T. CM(I) = 340°, CM(II) = 065°. Note the greatly faded South Equatorial Belt, along with an intensely dark North Equatorial Belt, and a dark-grey Great Red Spot to upper left.

COMET CORNER

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

INTRODUCTION

Comet Austin (1989c1) continues to brighten, but less rapidly than by most predictions, as we approach Summer, 1990. We give ephemerides for this and other comets below, but first let's look at comet activity for the last few months of 1989.

COMET FINDS FOR THE SECOND HALF OF 1989

There were eight comet discoveries and recoveries during the first 17 days of 1989. Comet discovery and recovery activity then slowed down until mid-year, as shown below.

Category	1989: Jan-June	July-Dec.	Total
Discovered Visually by Amateurs (New Comets)....	2	4	6
Discovered by Professionals (New Comets)....................	6	5	11
Recovered by Professionals (Old Comets).....................	5	9	14
Discovered by Satellite (New Comets)..................	1	2	3
TOTAL..................................	14	20	34

So 1989 saw a record 34 labeled comets. This total included six finds by amateurs, five of them in the evening sky. Eleven new comets were found by professional astronomers; five by the team of Helin and Roman, plus three by the Shoemakers, all of them at Palomar Mountain. Fourteen returning comets were recovered; ten by Jim Gibson, of the JPL staff, at Palomar. Then, three bright sungrazing comets were found by the Solar Max Mission Satellite. Brief descriptions of the comets found in the last half of 1989 follow.

Periodic Comet Brorsen-Metcalf (1989o).—This comet made its third recorded return to the inner Solar System in 1989. However, despite extensive searches through June, 1989, large telescopes still had not recovered this comet. The suspense ended on JUL 04, when Eleanor Helin, using the 48-in. (122-cm) Schmidt telescope at Palomar Mountain, recovered this comet when it was 15° from its expected position and 15 days early. When recovered, it was at magnitude +11, bright enough to be seen in amateur telescopes.

There appear to be several reasons why this comet wasn't found sooner. Being so far off course, it was outside the narrow regions normally covered by the large professional instruments. It was also too faint for the amateur telescopes that covered larger sweep areas. In addition, it was diffuse, showed low surface brightness, and it may have brightened rapidly shortly before discovery.

The newly-calculated orbit meant that the Southern Hemisphere would lose the comet in mid-August. Northern observers saw it rise before morning astronomical twilight until late September. Apparently no one saw it in October. When it emerged from the solar glare, for both hemispheres, in early Novem-ber, it was difficult to see at magnitude +12. It had been widely observed by A.L.P.O. members, and many reported it as brighter than magnitude +6 in September. A full study of this comet will appear in a future issue of this Journal. The comet will not reappear for 70 years.

Periodic Comet Lovas 1 (1989p).—T. Seki of Japan recovered this comet on JUL 07 at magnitude +17. It has an orbital period of 9.1 years and was closest to the Sun, at 1.7 AU [Astronomical Units; 1 AU = 149.6 million km] in October. It was observed at magnitude +13 by amateurs late in 1989.

Comet SMM9 (1989q).—The Solar Maximum Mission satellite discovered its ninth comet on JUL 08. This one attained magnitude -2 and did not reappear from near the solar vicinity. It was likely a member of the Kreutz Sungrazer group.

Comet Okazaki-Levy-Rudenko (1989r).—This comet was discovered on AUG 24 by Kiyomi Okazaki of Japan with a 10-in. (25-cm) Schmidt telescope. David Levy of Arizona found it independently on the next night with a 16-in. (41-cm) reflector; since his last comet find he had searched for 350 hours over 17 months. Finally, Michael Rudenko of Massachusetts discovered it on AUG 26 with a 6-in. (15-cm) refractor; he had searched for 174 hours over two years. This comet was then at magnitude +10.5, near the Corona Borealis-Boötes border in the evening sky.

In terms of credit, Okazaki had previously independently discovered comet 1975 X in October, 1975; but, because he was the fourth person to find it, he did not get his name on it. Comet 1989r was Levy's fifth named comet and Rudenko's third.

Comet 1989r was closest to the Sun, at 0.64 AU, on NOV 11, but even then was 39° from the Sun as seen from the Earth. Our Northern Hemisphere had an uninterrupted view of it as it passed north of the Sun in late October from the evening to the morning sky. In the morning sky during November, it was visible to the unaided eye; and on November 24, there was a rare view of the crescent Moon and the comet less than one degree apart.

Comet Helin-Roman (1989s).—This comet was discovered on SEP 05 by Eleanor Helin and Brian Roman with the 18-in. (46-cm) Schmidt telescope on Palomar Mountain. This comet was then at magnitude +12.5. It was closest to the Sun in August, with a perihelion distance of 1.33 AU.

Periodic Comet Wild 2 (1989t).—Recovered on SEP 09 by K. Meech at Mauna Kea, Hawaii, and on SEP 10 by J. Gibson at Palomar, this comet was then more than a year prior to perihelion. When recovered, it was at magnitude +20, but will be visible in amateur telescopes by Autumn, 1990.

Periodic Comet Kearns-Kwee (1989u).—J. Gibson recovered this comet on SEP 10 at Palomar Mountain, more than one year before perihelion. Then at magnitude +20, it will be at magnitude +13 by Autumn, 1990.

Comet Helin-Roman-Alu (1989v).—This comet was discovered on OCT 01 by Eleanor Helin, Brian Roman, Jeff Alu, and R. Bambery with the 18-in. (46-cm) Schmidt Telescope on Palomar Mountain. Although at magnitude +14.5 at discovery, it brightened to magnitude +10 by December. Perihelion occurred on DEC 15 at 1.05 AU.

Periodic Comet Helin-Roman-Alu 1 (1989w).—The same team that found Comet 1989v found this comet on the following night, although pre-discovery images taken on September 7 were found later. The orbital period of Comet 1989w is 9.6 years, and it was closest to the Sun two years ago at 3.67 AU. Currently, it is near magnitude +18.

Comet SMM 10 (1989x).—This Sungrazing comet was discovered by the Solar Maximum Mission satellite. The comet was closest to the Sun on 1989 SEP 28.8 and then brighter than magnitude -4. It was not seen to reappear, possibly due to a momentary data loss by the satellite. The satellite itself reëntered the Earth's atmosphere on DEC 02, making this perhaps the last bright comet to be found by it.

Periodic Comet Helin-Roman-Alu 2 (1989y).—This comet, the third found by this team in one month, was magnitude +15 upon discovery. It has an orbital period of 9.1 years and was closest to the Sun on OCT 31.

Periodic Comet Sanguin (1989z).—B. Weller, R. Coker, and K. Meech recovered this comet on NOV 9, when it was at magnitude +22. Comet 1989z has an orbital period of 12.5 years and will pass perihelion at 1.8 AU on 1990 APR 02, when it will be opposite the Sun from the Earth, at magnitude +18.

Comet Aarseth-Brewington (1989a1).—Knut Aarseth of Volda, Norway and Howard Brewington of Newberry, South Carolina, discovered this comet on NOV 16 in the evening sky at magnitude +9.0. Brewington was using an 8-in. (20-cm) reflector at 27×, piggy-backed on a 16-in. (41-cm) reflector on an altazimuth mounting. He had searched for 230 hours over 14 months to find this, his first comet, which is also the first one discovered from South Carolina.

Comet 1989a1 moved rapidly toward perihelion, passing that point on DEC 27 at 0.30 AU. By then it had reached magnitude +3, displaying a fine short tail. After perihelion, it dimmed at a small elongation from the Sun, making further observation impossible.

Periodic Comet Tuttle-Giacobini-Kresak (1989b1).—Jim Gibson used the 1.5-meter reflector at Palomar to recover this comet at magnitude +19 on NOV 09. With a 5.46-year period, it was closest to the Sun on 1990 FEB 08 at 1.07 AU. This was a favorable apparition, and the comet hovered near magnitude +12 during early 1990. This comet occasionally has outbursts, becoming even brighter.

Comet Austin (1989c1).—Rodney Austin of New Zealand discovered this, his third comet, on the morning of DEC 06; when the comet was technically in the evening sky, circumpolar at declination -62°, and at magnitude +11. He was using a Meade 8-in. (20-cm) f/4 reflector at 41× with a 1°.7 field of view. Austin had searched for 49 hours over the last five years before finding this comet.

Early in 1990, this comet was visible at magnitude +9 and was steadily brightening. It will be closest to the Sun at 0.35 AU on 1990 APR 09. As seen from the Earth, it then passes 20° north of the Sun from the evening to the morning sky, then perhaps as bright as magnitude +1. Over the following weeks, from late April through late May, its solar elongation increases while its brightness is predicted to remain about constant. This effect is due to a decreasing Earth-comet distance, with the comet only 20 million miles (32 million km) distant in mid-May. In early June, Comet Austin reaches opposition and moves into our southern evening sky, where it will dim over the summer months. [For an update on Comet Austin, see the note on the next page. Ed.]

Periodic Comet Schwassmann-Wachmann 3 (1989d1).—This comet was recovered by J. Luu, D. Jewitt, and S. Ridgway at Mauna Kea, and by Jim Gibson at Palomar, in early December at magnitude +20. Comet "SW3" has a period of 5.35 years, passing perihelion at 0.94 AU on 1990 MAY 19. This is a very favorable apparition of this comet, forecast to be at magnitude +10 in mid-April, 1990.

Comet Skorichenko-George (1989e1).—Boris Skorichenko of the Soviet Union and Douglas George of Kanata, Canada (near Ottawa), discovered this comet on DEC 17. Skorichenko was using a 6-in (15-cm) reflector, while George used a 16-in (41-cm) reflector and had searched for 65 hours. When discovered, this comet was at magnitude +10.3 in the northern evening sky. It will be closest to the Sun on 1990 APR 12, at a distance of 1.57 AU. Through May, it will remain in the Northern-Hemisphere evening sky at magnitude +9 to +10. Its solar elongation will decrease as it reaches conjunction on the far side of the Sun in July, after which it will enter the morning dark sky in August at magnitude +10.

Comet McKenzie-Russell (1989f1).—Patricia McKenzie and Ken Russell of Siding Spring Observatory in Australia discovered this comet on plates taken on DEC 21. It was then at magnitude +14 and moving 1°.5 per day westward through Orion. This comet is now dimming as it pulls away from the Sun.

Periodic Comet P/Russell 4 (1989g1).–J. Gibson, when at Palomar, recovered this comet at magnitude +19 on 1989 DEC 11.

Periodic Comet Van Biesbroeck (1989h1).—Jim Gibson recovered this comet at Palomar at magnitude +20 on DEC 09. It may reach magnitude +15 at perihelion in April, 1991.

PRESENT COMET ACTIVITY

Several comets continue to be visible in small- to moderate-sized telescopes. The brightest will probably be Comet Austin. A brief description and ephemeris for each comet so visible follow.

Comet Austin (1989c1).—The latest orbit should be accurate to within 1° in mid-May, when this comet will be 24 million miles (39 million km) from the Earth. The brightness estimates in this ephemeris are conservative, but its tail should be interesting no matter how bright the comet becomes or fails to become.

Periodic Comet Schwassmann-Wachmann 1.—This comet will emerge from the solar glare, less than 1 year after perihelion in its 15-year orbit. Usually this comet is near magnitude +17, but occasionally it has outbursts and brightens to magnitude +14 or even +12. Sunch an event occurred several times in late 1989, and the comet should be monitored now as well. Please report all positive and negative observations to the writer, whose address is given on the inside back cover.

Periodic Comet Schwassmann-Wachmann 3.—Not to be confused with "SW1", this comet has an orbital period of 5.35 years and will be closest to the Sun on 1990 MAY 19 at 0.94 AU. It is intrinsically faint, with an absolute magnitude of +12 [its magnitude when 1 AU from both the Earth and the Sun], but good placement makes this a favorable return.

Periodic Comet Wild 4 (1990a).—An early orbit shows that this comet, discovered on 1990 JAN 21 by Paul Wild, has an elliptical 6.2-year orbit. It will reach perihelion on 1990 JUL 04 at 1.95 AU. The ephemeris given below relies on a preliminary orbit, and the comet may be up to one magnitude brighter.

Comet Skorichenko-George (1989e1).—This comet is in our northern evening sky through May; in the morning sky after July.

Periodic Comet Honda-Mrkos-Pajdusáková.—Not yet recovered as of mid-February, this comet, with an orbital period of 5.3 years. will brighten rapidly this summer as it passes near the Earth (28 million miles; 45 million km), reaching perihelion on 1990 SEP 12.

COMET EPHEMERIDES

Tables 1-6 below give ephemerides for the comets described above under "Current Comet Activity." Under "Elong.", "E" refers to the evening sky and "M" to the morning.

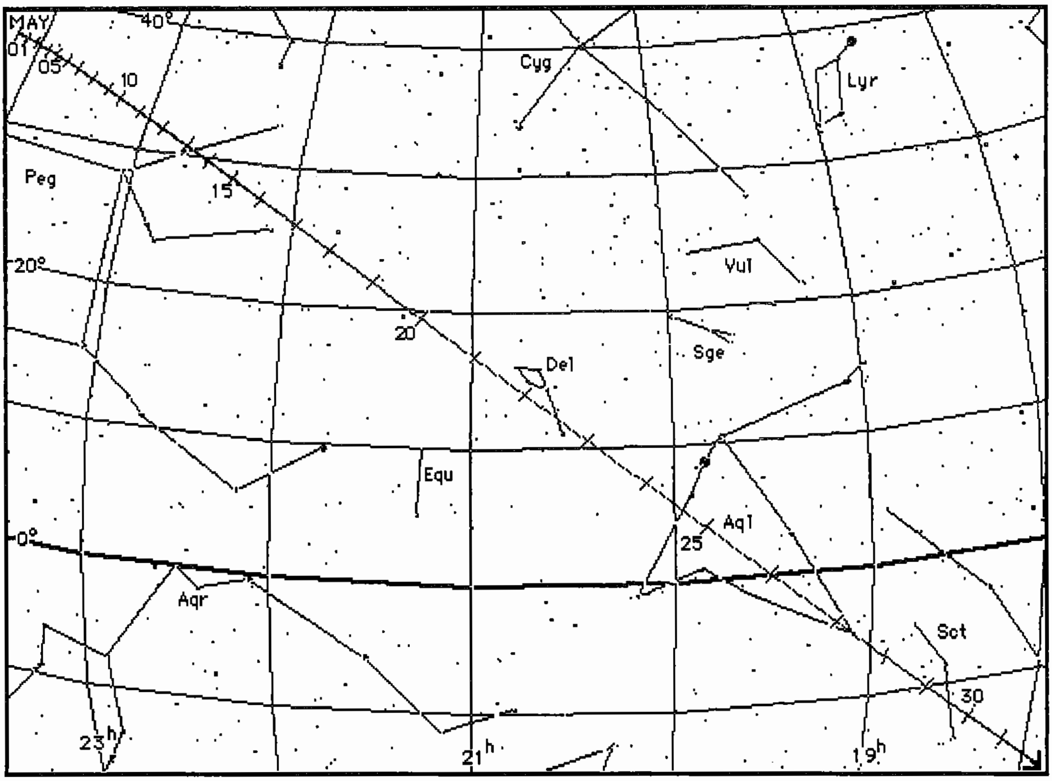
Table 1. Ephemeris of Comet Austin (1989c1).

1990 U.T. Date	2000.0 Coörd. R.A.	2000.0 Coörd. Decl.	Elong. from Sun	Total Mag.	1990 U.T. Date	2000.0 Coörd. R.A.	2000.0 Coörd. Decl.	Elong. from Sun	Total Mag.
	h m	° '	°			h m	° '	°	
APR 19	01 07.6	+34 19	025 M	+1.4	JUN 13	16 25.5	-31 14	165 E	+5.7
24	00 43.6	+35 52	030 M	+1.9	18	16 02.8	-33 09	156 E	+6.4
29	00 17.6	+36 02	036 M	+2.4	23	15 47.5	-34 15	148 E	+7.0
MAY 04	23 48.5	+35 01	044 M	+2.7	28	15 37.2	-34 57	142 E	+7.5
09	23 13.7	+32 39	054 M	+2.8	JUL 03	15 30.5	-35 24	136 E	+8.0
14	22 29.1	+28 08	067 M	+2.9	08	15 26.5	-35 44	131 E	+8.5
19	21 29.9	+19 49	086 M	+2.8	13	15 24.3	-36 00	126 E	+8.9
24	20 15.4	+06 14	112 M	+2.9	18	15 23.6	-36 12	121 E	+9.3
29	18 56.2	-09 31	141 M	+3.4	23	15 24.1	-36 24	117 E	+9.7
JUN 03	17 48.6	-21 11	165 M	+4.1	28	15 25.5	-36 35	112 E	+10.0
08	16 59.2	-27 45	175 E	+4.9	AUG 02	15 27.6	-36 46	108 E	+10.3

Editorial Note: On 1990 APR 19, Comet Austin was reported to be about 3 magnitudes fainter than the above predictions. However, this would still render it a naked-eye object for late April and much of May for observers with dark skies.

Figure 31 (facing page, top). Comet Austin's path in May, 1990, across the constellations Pegasus, Delphinus, Aquila, and Scutum. One-day interval between ticks. Limiting magnitude about +6. Plot made with Voyager program © Carina Software.

Figure 32 (facing page, bottom). Comet Austin's path in June and July, 1990, across Scorpius and Lupus. One-day interval until June 10; 2 days for June 10-30; 10 days in July. Limiting magnitude about +6. Plot made with Voyager program © Carina Software.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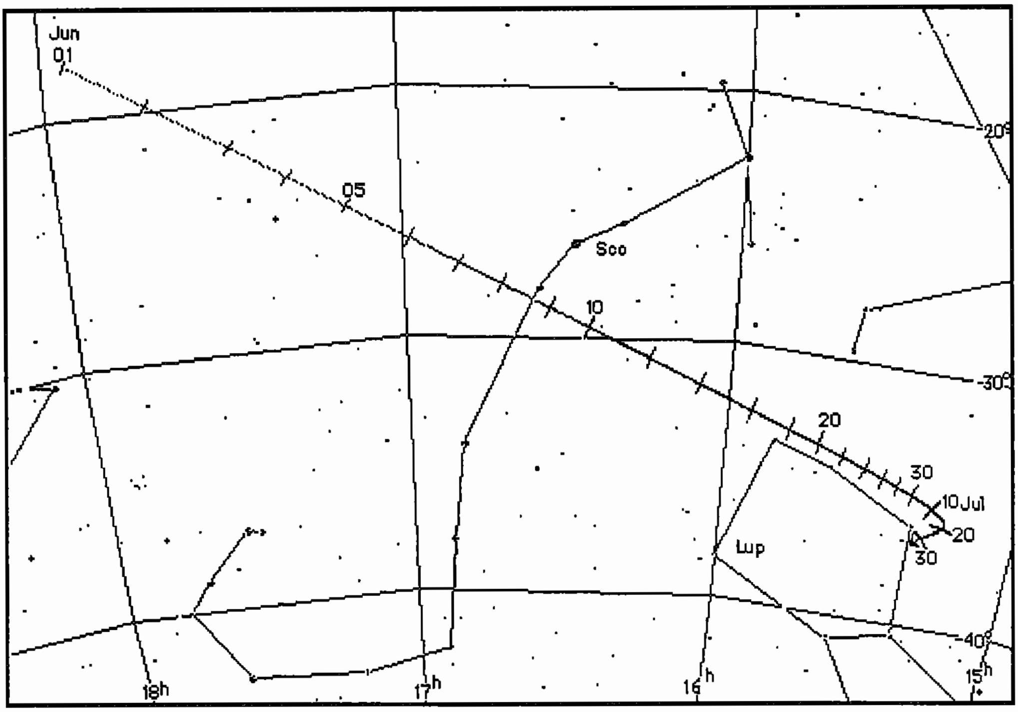
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15h

Table 2. Ephemeris of Periodic Comet Schwassmann-Wachmann 1.

1990 U.T. Date	2000.0 Coörd. R.A. h m	Decl. ° '	Elong. from Sun °	Total Mag.
MAY 09	01 06.8	+15 00	028 M	+17.7
14	01 10.4	+15 26	032 M	+17.7
19	01 13.9	+15 51	036 M	+17.7
24	01 17.3	+16 16	039 M	+17.7
29	01 20.6	+16 41	043 M	+17.7
JUN 03	01 23.8	+17 05	047 M	+17.7
08	01 26.9	+17 29	051 M	+17.6
13	01 29.8	+17 52	055 M	+17.6
18	01 32.6	+18 15	059 M	+17.6
JUN 23	01 35.3	+18 37	063 M	+17.6
28	01 37.8	+18 58	067 M	+17.6
JUL 03	01 40.1	+19 19	071 M	+17.5
08	01 42.2	+19 38	075 M	+17.5
13	01 44.1	+19 57	079 M	+17.5
18	01 45.7	+20 15	084 M	+17.4
23	01 47.2	+20 32	088 M	+17.4
28	01 48.4	+20 47	092 M	+17.4
AUG 02	01 49.3	+21 02	097 M	+17.4

Table 3. Ephemeris of Periodic Comet Schwassmann-Wachmann 3.

1990 U.T. Date	2000.0 Coörd. R.A. h m	Decl. ° '	Elong. from Sun °	Total Mag.
APR 19	20 15.6	-07 46	085 M	+10.0
24	20 57.4	-08 47	080 M	+10.0
29	21 36.7	-09 28	075 M	+9.8
MAY 04	22 12.7	-09 50	072 M	+9.8
09	22 44.8	-09 55	069 M	+9.9
14	23 13.3	-09 45	068 M	+10.0
19	23 38.6	-09 25	067 M	+10.1
24	00 01.0	-08 58	066 M	+10.3
29	00 21.0	-08 25	066 M	+10.5
JUN 03	00 39.0	-07 50	067 M	+10.7
JUN 08	00 55.4	-07 13	068 M	+11.0
13	01 10.2	-06 36	069 M	+11.2
18	01 23.6	-06 00	070 M	+11.5
23	01 35.9	-05 27	072 M	+11.8
28	01 47.0	-04 58	074 M	+12.1
JUL 03	01 57.1	-04 32	076 M	+12.4
08	02 06.1	-04 11	078 M	+12.7
13	02 14.1	-03 54	081 M	+12.9
18	02 21.1	-03 42	084 M	+13.2

Table 4. Ephemeris of Periodic Comet Wild 4 (1990a).

1990 U.T. Date	2000.0 Coörd. R.A. h m	Decl. ° '	Elong. from Sun °	Total Mag.
APR 19	09 12.0	+19 26	106 E	+12.0
24	09 16.8	+18 50	102 E	+12.1
29	09 22.3	+18 11	099 E	+12.1
MAY 04	09 28.4	+17 30	095 E	+12.1
09	09 34.9	+16 45	092 E	+12.2
14	09 42.0	+15 58	089 E	+12.2
19	09 49.4	+15 08	087 E	+12.2
24	09 57.2	+14 15	084 E	+12.3
29	10 05.4	+13 20	081 E	+12.3
JUN 03	10 13.8	+12 23	079 E	+12.3
08	10 22.5	+11 23	076 E	+12.4
JUN 13	10 31.4	+10 21	074 E	+12.4
18	10 40.6	+09 17	072 E	+12.4
23	10 49.9	+08 12	069 E	+12.5
28	10 59.4	+07 04	067 E	+12.5
JUL 03	11 09.0	+05 55	065 E	+12.6
08	11 18.8	+04 45	063 E	+12.6
13	11 28.6	+03 33	061 E	+12.6
18	11 38.6	+02 21	059 E	+12.7
23	11 48.7	+01 08	057 E	+12.7
28	11 58.9	-00 06	055 E	+12.8
AUG 02	12 09.2	-01 20	053 E	+12.8

Table 5. Ephemeris of Comet Skorichenko-George (1989e1).

1990 U.T. Date	2000.0 Coörd. R.A. h m	Decl. ° '	Elong. from Sun °	Total Mag.
APR 19	03 17.4	+40 00	035 E	+8.3
24	03 38.0	+38 57	033 E	+8.3
29	03 57.6	+37 46	031 E	+8.4
MAY 04	04 16.1	+36 29	029 E	+8.4
MAY 09	04 33.6	+35 07	027 E	+8.5
14	04 50.2	+33 42	025 E	+8.7
19	05 05.8	+32 13	022 E	+8.7

(Subsequently too close to the Sun to be observed)

Table 6. Ephemeris of Periodic Comet Honda-Mrkos-Pajdusáková.

1990 U.T. Date	2000.0 Coörd. R.A. h m	Decl. ° '	Elong. from Sun °	Total Mag.
JUL 03	23 15.3	-10 48	115 M	+11.9
08	23 37.8	-09 28	114 M	+11.3
13	00 06.3	-07 40	112 M	+10.8
18	00 43.4	-05 11	107 M	+10.2
JUL 23	01 32.0	-01 45	099 M	+9.6
28	02 33.9	+02 42	088 M	+9.1
AUG 02	03 45.4	+07 32	074 M	+8.7
07	04 56.3	+11 33	061 M	+8.5

METEORS SECTION NEWS

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

I would like to begin this column by thanking all the observers who participated in our 1989 Perseid Watch. A forthcoming article in the *Journal, A.L.P.O.* will discuss worldwide observations of the 1989 return of this shower. It would be shortsighted to discuss this display using data from the contiguous United States only. This is obvious when one realizes that our data cover only four time zones, or just 17 percent of the available observing window.

My special thanks go out to those dedicated contributors who have continued to observe and to supply data during the cold weather of late Fall and Winter. *Table 1* below gives a summary of our observations from October, 1989, to January, 1990. These observers form the true backbone of the Meteors Section. In order to aid them, we need more of our Perseid observers to expand their efforts into active observing throughout the year. Good opportunities lie ahead with favorable circumstances for the Delta Aquarids, Orionids, Leonids, and the Geminids during the balance of 1990.

The next A.L.P.O. meteor watch will be held between 1990 JUL 21 and AUG 05. No less than eight showers will be active during this period. As an added bonus, the Perseids will begin to streak from the morning northeast sky during this time. This period is also a good time for observers to try their hands at plotting meteor paths. This is an interesting and satisfying method for distinguishing different showers. For those interested in plotting, send a stamped self-addressed envelope to the Meteors Recorder (address on inside back cover) for charts and instructions. See the "Meteors" section of "Coming Astronomical Events" on page 90 of this issue for further details on activity in late July.

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

1989-90 U.T. Date	Observer and Location	U.T.	Number and Type of Meteors Seen*	Comments* (+*N* = Limiting Magnitude)
OCT 23	George Gliba, MD	07:55-08:55	6 OR; 4 SP	+4.6
	" " "	08:55-09:55	3 OR; 1 NT; 1 ST; 2 SP	+4.6
24	George Gliba, MD	08:05-09:05	5 OR; 1 ST; 1 NT; 2 SP	+5.4; OR ZHR = 19
	" " "	09:05-10:05	7 OR; 4 SP	+5.4; OR ZHR = 28
25	George Gliba, MD	07:45-08:45	7 OR; 1 ST; 3 NT; 9 SP	+5.6; OR ZHR = 19
	" " "	08:45-09:45	6 OR; 3 SP	+5.6; OR ZHR = 17
DEC 01	Robert Lunsford, CA	09:47-10:47	16 SP	+6.8
	" " "	10:47-11:47	21 SP; 3 DL	+6.9
	" " "	11:47-12:47	12 SP; 2 DL	+6.8
12	J. Kenneth Eakins, CA	06:30-07:30	3 GE	+4.3
13	J. Kenneth Eakins, CA	06:00-07:00	3 GE	+4.3
	" " " "	07:00-08:00	4 GE; 1 SP	+4.3
	" " " "	08:00-09:00	9 GE; 1 SP	+4.3
14	Roger Venable, GA	02:29-03:30	17 GE	+4.7; 16-day Moon
	" " "	03:58-05:09	41 GE	+4.5; 16-day Moon
	George Gliba, MD	08:08-09:08	23 GE; 3 SP	+4.6; 16-day Moon
	" " "	09:08-10:08	20 GE; 4 SP	+4.6; 16-day Moon
17	Barbara Hands, NC	04:00-05:00	3 SP	+4.4
	Dennis Hands, NC	04:00-05:00	1 SP	+4.3
	Mary Krieg, NC	04:00-05:00	2 SP	+4.4
	Barbara Hands, NC	05:02-06:02	(none seen)	+4.5
	Dennis Hands, NC	05:02-06:02	(none seen)	+4.4
	Mary Krieg, NC	05:02-06:02	(none seen)	+4.5
22	George Gliba, MD	10:05-11:05	6 UR; 1 SP	+5.5
	Robert Lunsford, CA	11:48-12:48	1 UR; 5 SP	+6.2
29	J. Kenneth Eakins, CA	08:05-09:05	2 SP	+5.1
	" " " "	09:05-10:05	2 SP	+5.1
30	J. Kenneth Eakins, CA	08:00-09:00	4 SP	+5.3
	" " " "	09:00-10:00	5 SP	+5.3
JAN 02	George Gliba, MD	09:40-10:40	1 QD; 9 SP	+5.4

-*Table 1 and notes continued on p. 88*-

Table 1—Continued.

1990 U.T. Date	Observer and Location	U.T.	Number and Type of Meteors Seen*	Comments (+*N* = Limiting Magnitude*)
JAN 03	Robert Lunsford, CA	09:47-10:47	19 QD; 7 SP	+6.7; QD ZHR = 30
	" " "	10:47-11:47	23 QD; 7 SP	+6.8; QD ZHR = 34
	" " "	11:47-12:47	42 QD; 2 CB; 8 SP	+6.8; QD ZHR = 50
	" " "	12:47-13:47	34 QD; 11 SP	+6.7; QD ZHR = 37
04	J. Kenneth Eakins, CA	07:00-08:00	(none seen)	+4.8
	" " " "	08:00-09:00	1 SP	+5.1
	" " " "	09:00-10:00	4 SP	+5.3

* *Abbreviations:* CB = Coma Berenicid; DL = December Leonid; GE = Geminid; NT = N. Taurid; OR = Orionid; QD = Quadrantid; SP = Sporadic; ST = S. Taurid; UR = Ursid; ZHR = zenithal hourly rate.

COMING SOLAR SYSTEM EVENTS: MAY - JULY, 1990

WHAT TO LOOK FOR

We use this column to alert our readers about events happening in the Solar System during the next three months; including the visibility conditions for major and minor planets, the Moon, comets, and meteors. You can find more detailed information in the 1990 edition of the *A.L.P.O. Solar System Ephemeris*. (See p. 100 to find out how to obtain this publication.) Celestial directions are abbreviated. All dates and times are in Universal Time (U.T.), which is found by adding 9 hours to H-ADT (Hawaii-Aleutian Daylight Time), 8 hours to ADT (Alaska Daylight Time), 7 hours to PDT, 6 hours to MDT, 5 hours to CDT, and 4 hours to EDT. Note that this addition may put you into the next U.T. day!

JUPITER APPROACHES SUN; MARS AND SATURN PULL AWAY

Jupiter, located in Gemini, continues as essentially the only evening planet until July. In May it is high in the W. as twilight ends; but it is approaching the Sun and ceases to be readily observable in mid-June, reaching conjunction with the Sun on JUL 15. While you still can, watch developments in the North Temperate Current Disturbance.

Mercury is both a morning and an evening object in this period. At greatest elongation W. of the Sun on MAY 31 (24°.7), it is observable (i.e., over 15° from the Sun) before dawn between MAY 15 and JUN 19. Its next apparition, an evening one, is between JUL 17 and AUG 31, with greatest E. elongation on AUG 11 (27°.4). Both Mercury apparitions favor Southern-Hemisphere observers.

During this three-month period, **Saturn**, in Sagittarius, moves from the morning to the evening sky; officially this happens on its opposition day, JUL 14. On that date, the Ringed Planet is at declination 22° S., visual magnitude +0.06; its Globe measures 18".4 by 16".7; with its Rings tilted 23° N. relative to our line of sight, subtending 41".7 E.-W. and 16".5 N.-S., thus largely covering the Globe's Southern Hemisphere.

The next two planets outward, **Uranus** and **Neptune**, also move from the morning to the evening sky, and are also located in Sagittarius. Uranus reaches opposition on JUN 29 at magnitude +5.61, and declination 23°.6 S. Only about 6° to the ENE. Neptune has its opposition on JUL 05, magnitude +7.89, declination 21°.9 S. Note that, on JUN 15, Uranus will be only 0°.4 N. of the globular cluster Messier 22; then, on JUL 09, it passes just 0°.1 S. of globular cluster NGC 6642..

If you have dark skies and a 20-cm or larger telescope, it will pay to look for **Pluto**, on the Libra-Serpens border, near its opposition date of MAY 07, when it will be closest to the Earth for the next 248 years. When at opposition, Pluto's visual magnitude will be +13.64 and its declination 1°.4 S.

The remaining two major planets are definitely morning objects. **Venus** continues low in the E. before dawn. Although its elongation from the Sun decreases from 44° W. on MAY 01 to 24°W. on AUG 01, it actually becomes more readily visible for Northern-Hemisphere observers because its angular inclination to the horizon increases. During the same period, Venus' disk diameter decreases from 18." to 11.", the proportion of its disk that is illuminated increases from 64 to 91 percent; its visual magnitude remains close to -4.

Mars is now becoming easier to observe above the SE. horizon in the morning sky as it moves from Aquarius to Pisces and then to Aries. On MAY 01, the Red Planet's disk is 6".1 in diameter, 89 percent illuminated, and at declination 10°S. These quantities change gradually so that on AUG 01, the diameter is 9".1, the phase 84 percent, and the declination 14°N. Mars' Southern Hemisphere will be turned toward the Earth during this period. Mars now appears large enough to see surface and meteorological detail with moderate-size telescopes; by late Summer, useful photography should be possible.

Four readily-visible **minor planets** reach opposition between MAY 11 and JUL 30; their 10-day ephemerides are published in the *A.L.P.O. Solar System Ephemeris: 1990*. The conditions at their oppositions are:

Minor Planet	Opposition Data 1990 Date	Magnitude	Declination
3 Juno	MAY 11	+10.1	02°S.
7 Iris	MAY 13	+9.5	22° S.
8 Flora	JUN 29	+9.0	21° S.
194 Prokne	JUL 30	+9.9	01°N

3 Juno reaches opposition only 4 days after Pluto does. It passes 0°.3 S. of Pluto at 07h U.T. on MAY 12; finding one body may help you to find the other! Note that, although not in opposition, the minor planets **Ceres**, **Pallas**, and **Vesta** will all be of magnitudes +8 to +9 in this period. **1627 Ivar** continues unusually close to the Earth, at magnitude +13.3 in June and early July. **1951 Lick** also comes close, reaching magnitude +12.9 at the beginning of August. Detailed ephemerides of these bodies appear in our *Solar System Ephemeris.*

THE MOON

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

New Moon	First Quarter	Full Moon	Last Quarter
APR 25.2	MAY 01.8	MAY 09.8	MAY17.8
MAY 24.5	MAY 31.3	JUN 08.5	JUN 16.2
JUN 22.8	JUN 29.9	JUL 08.1	JUL 15.5
JUL 22.1	JUL 29.6	AUG 06.6	AUG13.7

The four lunations above are Numbers 833-836 in Brown's series. The 1990 JUL 22 New Moon causes a total solar eclipse, which is described below on p. 91. Then, the AUG 06 Full Moon marks a partial lunar eclipse, described in more detail below.

During this season, the crescent phases will be well-placed, and the Full phase poorly placed, for observers in the Earth's Northern Hemisphere; the opposite is true for those south of the Equator. North American observers will have a challenge in spotting the very young Moon on MAY 24-25.

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

East	North	West	South
MAY 02	MAY 09	MAY 18	MAY 23
MAY 30	JUN 05	JUN 15	JUN 19
JUN 27	JUL 02	JUL 12	JUL 16
JUL 25	JUL 30	AUG 08	AUG 13

Lunar E. and W. above follow the usage of the International Astronomical Union, with Mare Crisium near the *east* limb. Lighting and libration conditions provide favorable views of the W. and SW. limbs on MAY 18-22, JUN 16-20, and JUL 16-17; and of the E. limb on MAY 27-30, JUN 25-28, and JUL 24-27. Due to the Sun's northerly selenocentric latitude, combined with a northerly libration, a very favorable opportunity for viewing the **north polar region** occurs on MAY 06-12, with another almost as good a period on JUN 02-08.

TOTAL SOLAR ECLIPSE: 1990 JUL 22

(See separate article on p. 91.)

PARTIAL LUNAR ECLIPSE: 1990 AUG 06

This event follows the schedule below:

First Penumbral Contact...........	$11^h 29.5^m$
First Umbral Contact.................	12 44.2
Middle of Eclipse........................	14 12.3
Last Umbral Contact.................	15 40.5
Last Penumbral Contact...........	16 55.1

At mid-eclipse, the umbral magnitude (fraction of Moon's diameter covered by the umbra) will be 0.682. From the times, it is evident that this will be an Eastern-Hemisphere event. Its entirety will be visible from E. Asia, Australia, New Zealand, and Indonesia. The beginning portions will be seen from Hawaii and W. North America, while the end will be visible from S., SW., and central Asia, along with E. Africa.

For this forecast, it is assumed that the Earth's umbral radius will be 2 percent larger than based on geometry alone. During the partial phase (12:44.2-15:40.5), the southern and central portion of the Moon will be covered by the dark umbral shadow, affording a large number of opportunities to time the umbral entrances and exits of craters, as well as of the Moon's limb itself. The *approximate* times, rounded to 5 minutes, for the umbral *immersion* and *emersion* of selected craters are:

Crater	Immersion	Emersion
Grimaldi	$12^h 55^m$	$14^h 35^m$
Gassendi	13 00	14 55
Tycho	13 05	15 20
Kepler	13 15	14 35
Birt	13 15	15 10
Nicolai A	13 20	15 30
Abulfeda E	13 25	15 15
Copernicus	13 30	14 40
Aristarchus	13 35	14 05
Stevinus A	13 35	15 35
Pytheas	13 45	14 20
Manilius	14 00	14 40
Menelaus	14 05	14 40
Taruntius	14 05	15 05
Plinius	14 10	14 40
Proclus	14 25	14 35

Proclus will be quite near the edge of the umbra, so its times above are quite approximate; very careful timing of that crater will help to fix accurately the extent of the umbra.

For more information on how to observe lunar eclipses, write to our Lunar Eclipse Recorder, Francis Graham (address on inside back cover) to obtain a copy of the *A.L.P.O. Lunar Eclipse Handbook*, which costs $4.00. Forward observational reports to him, with an extra copy of limb and crater umbral contact times to *Sky & Telescope*, P.O. Box 9111, Belmont, MA 02178-9111, U.S.A.

OCCULTATIONS

Below are selected occultations of stars by Solar-System objects. **8 Flora** occults three stars in 12 hours as it passes in front of the open star cluster M21! The data here are the date, occulting object, visual magnitudes of asteroid/star, and zone of visibility for each of these occultations. Note the rare occultation of a star by Neptune's major satellite Triton.

MAY 10.67. **93 Minerva**, 12.0/8.8. W. Australia
MAY 15.45. **554 Peraga**, 12.7/9.3. Indonesia
JUN 06.66. **8 Flora**, 9.6/9.1. Indonesia
JUL 02.37. **8 Flora**, 9.0/8.2. N. So. America
JUL 20.56. **211 Isolda**, 14.1/6.7. Korea, Japan
JUL 28.69. **8 Flora**, 9.6/8.8. W. & N. Australia
JUL 28.81. **8 Flora**, 9.6/7.1. Indonesia
JUL 29.20. **8 Flora**, 9.6/9.3. Central America
AUG 01.51. ***Triton***, 13.5/9.2. Pacific Oc. exclept E.

The only lunar occultation of a planet is not observable; that of Jupiter on JUL 21 when it is only 5° W. of the Sun. However, the Moon occults the bright star **Antares** (magnitude +1.2) three times, all visible in the Southern Hemisphere as shown in *Figure 33* below.

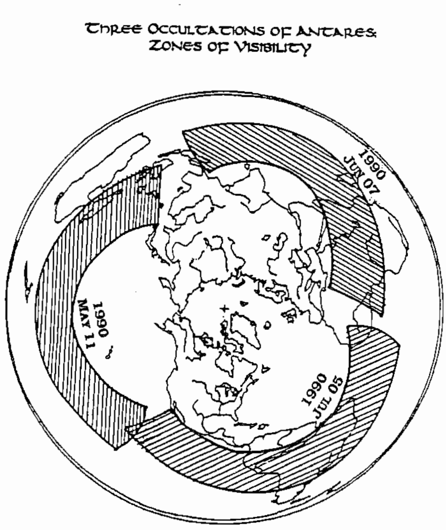

Figure 33. Areas of visibility for lunar occultations of Antares, 1990 MAY- JUL.

Other interesting lunar events include two passages of the Moon in front of the Pleiades star cluster. The first, on JUN 20, 15 h, can be seen before dawn from Hawaii, with a 7-percent sunlit Moon. The second is on JUL 18, 0 h, with a 22-percent Moon; seen before dawn from N. and E. Europe and the Middle East.

Then, from the Southern Hemisphere, the Moon will pass in front of the Beehive star cluster after sunset on: MAY 01, 14 h (47 percent Moon; SW. Australia); MAY 28, 22 h (25 percent Moon; Argentina); and JUN 25, 08 h (9-percent Moon; New Zealand).

COMETS

The "Comet Notes" article on pp. 82-86 gives ephemerides for no less than six comets currently in the skies. The *A.L.P.O. Solar System Ephemeris: 1990* also gives ephemerides for this period for Periodic Comet Encke (which should reach naked-eye brightness in OCT), Periodic Comet Kearns-Kwee (1989u), Comet Kopff (1988k), and Comet Okazaki-Levy-Rudenko (1989r). Naturally, there may be some new discoveries as well!

METEORS

(Contributed by Robert D. Lunsford, A.L.P.O. Meteors Recorder)

The **Eta Aquarids** provide a fine show during the first week of May, with little interference from a First-Quarter Moon. These meteors are among the swiftest of all showers. I have seen several of these meteors span from horizon to horizon in the blink of an eye. Most of the brighter members leave trains. Look for these blue darters to be most active between MAY 03 and 07; the last three hours before dawn are the most productive. This stream is the strongest shower visible in the Southern Hemisphere, where rates often exceed 50 per hour. Northern viewers can expect to see between 5 and 30 per hour, depending on latitude and the date of maximum.

The **Alpha Scorpiids** reach their maximum on MAY 03. This stream has low rates, but provides many fireballs during its period of activity. While facing eastward to spot the Eta Aquarids, expect to see an occasional bright Alpha Scorpiid shooting eastward over your right shoulder.

With Comet Schwassmann-Wachmann 3 at perihelion on 1990 MAY 19, the **Tau Herculids** may be interesting to watch this year. Their maximum is predicted for JUN 03. Near that date, you may watch for activity in the evening sky with a gibbous Moon toward the south; or, better yet, wait until moonset and face toward the west to see these very slow meteors. Enhanced rates are not likely; but only by observing will we know for sure. The normal rate is only 1 per hour.

Moonlight spoils the many minor showers of mid-June and mid-July. Not until late July are circumstances favorable for a good display. The **South Delta Aquarids** and the **Alpha Capricornids** reach their maxima on JUL 28 and JUL 29 respectively. These two showers can be easily distinguished from each other by their radiant locations and velocities. The S. Delta Aquarids are twice as fast, but fainter, then the average Alpha Capricornid. The S. Delta Aquarids are also more abundant, with a rate of 20 per hour at maximum; compared with 5 per hour for the Alpha Capricornids. While facing south to view these two showers, you may also notice activity from the **Pisces Australids** (radiant 22h30m, -28°), the **Northern Delta Aquarids** (22h00m, -02°), the **Upsilon Pegasids** (23h 10m, +15°), and the **Perseids**; the last-mentioned radiating from the northeastern sky.

TOTAL SOLAR ECLIPSE: 1990 JUL 22

On 1990 JUL 22, the Earth experiences its first total solar eclipse since 1988 MAR 18. This time, the path of totality begins at sunrise near Helsinki, Finland, runs eastward through the Soviet Arctic, then southeast through the Bering Sea into the eastern Pacific Ocean, terminating at sunset northeast of Hawaii. If the weather coöperates, particularly spectacular near-horizon views should be had in southern Finland.

Figure 34, below, shows the zone where this eclipse will be total, along with where it will be seen as a partial eclipse. This last zone includes the entire Soviet Union, and parts of the Middle East, China, Mongolia, Korea, Japan, Alaska, western Canada, Hawaii, and the northwestern contiguous United States. Attractive views of the partly-eclipsed Sun on the horizon will be had from Iran, the European and Kazakh Soviet Union, British Columbia, Alberta; and portions of Washington, Oregon, Idaho, Montana, California, and Nevada.

Totality begins at 01h 53.4 m (all times in this report are in U.T.), at 023°42' E., 59°47' N. and ends at 04h 11.2m at 138°52' W., 29°56' N. The maximum duration, 2m 36.0s, occurs at 03h 00m at 167°18' E., 65°57' N. in the northeasternmost Soviet Union. From the totality zone, or even near it, several planets should be visible during totality. Jupiter in particular will be evident, just 6° W. of the Sun. In east-to-west order, the other planets visible near the Sun will be Mercury, 19°E. of the Sun, at magnitude -0.4; and Venus, 26° W., and at magnitude -3.9.

Table 1, below, lists some information about the places that will experience totality, while *Table 2* gives similar information for localities in the partial-eclipse zone.

Table 1. Total Phase, Selected Stations, Solar Eclipse of 1990 JUL 22.

Locality	Solar Alt.	Total Phase U.T. Max. Ecl.	Duration
Helsinki, Finland	01°	01:53:11	1^m26^s
Mikkeli, Finland	03	01:53:50	1 27
Joensuu, Finland	04	01:53:49	1 33
Kem', U.S.S.R.	07	01:55:01	1 35
Markovo, U.S.S.R.	40	03:03:56	2 32
Atka, Aleutian Is.	35	03:35:06	1 31

Table 2. Partial Phase, Selected Stations, Solar Eclipse of 1990 JUL 22.

Locality	Maximum Partial Eclipse Sol.Alt.	U.T.	Mag.
Leningrad, U.S.S.R.	03°	01:50.7	0.975
Moscow, U.S.S.R.	02	01:43.2	0.854
Beijing, P.R.China	56	02:09.8	0.013
Tokyo, Japan	74	03:12.4	0.079
Anchorage, Alaska	23	03:24.0	0.763
Seattle, Washington	02	03:40.3	0.698
Honolulu, Hawaii	09	04:28.9	0.691

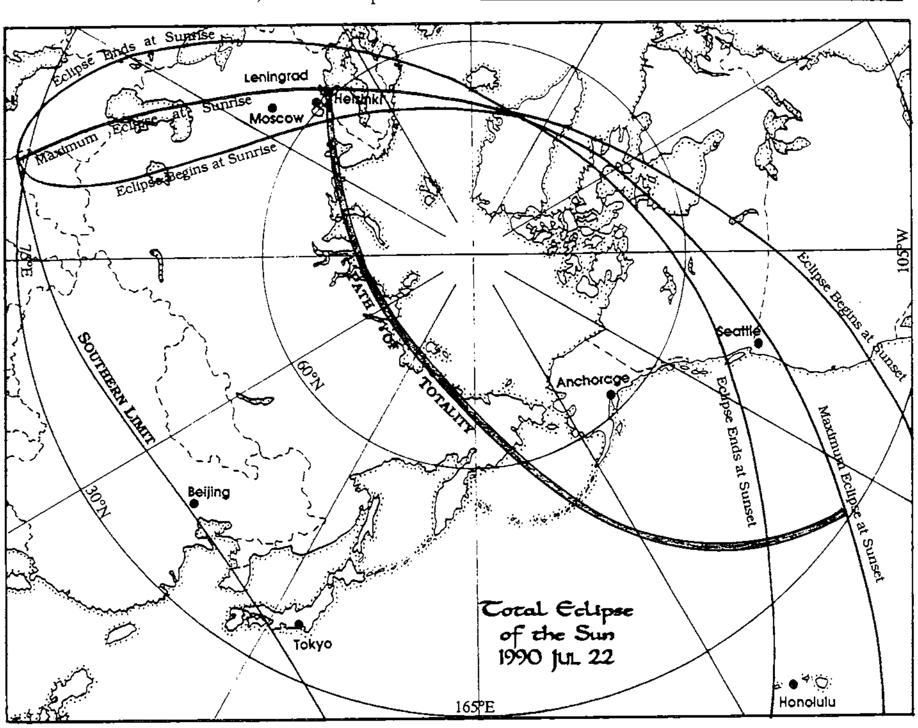

Figure 34. Zone of visibility for the total solar eclipse of 1990 JUL 22.

SOLAR SYSTEM EVENTS FOR THE 1990'S

It is rare that we look ahead more than a few months to forthcoming celestial events. The diagram below (*Figure 35*) attempts to show when selected Solar-System events will occur for the remainder of the Twentieth Century. This schematic diagram is not intended for detailed observational planning. Rather, its purpose is to give observers an idea of when they should start to plan for events and should then consult more detailed sources.

First, the periods when the major planets can be seen are shown by shaded areas. These are oscillating curves for the inner planets Mercury and Venus; and are horizontal bars for Mars, Jupiter, Saturn, and the Remote Planets. On the planet-lines, special events are shown: occultations by the Moon, close conjunctions between planets, oppositions of the superior planets, transits of Mercury, and equatorial-plane crossings for Jupiter and Saturn. Elongations from the Sun of the interior planets are graphed. For the superior planets, the declinations at opposition are given; for Mars the disk diameter is also indicated. The two bottom rows show when the various forms of lunar and solar eclipses will occur.

Your editor has jammed as much information as possible into this crowded diagram; even so, it shows only the highlights of the next decade.

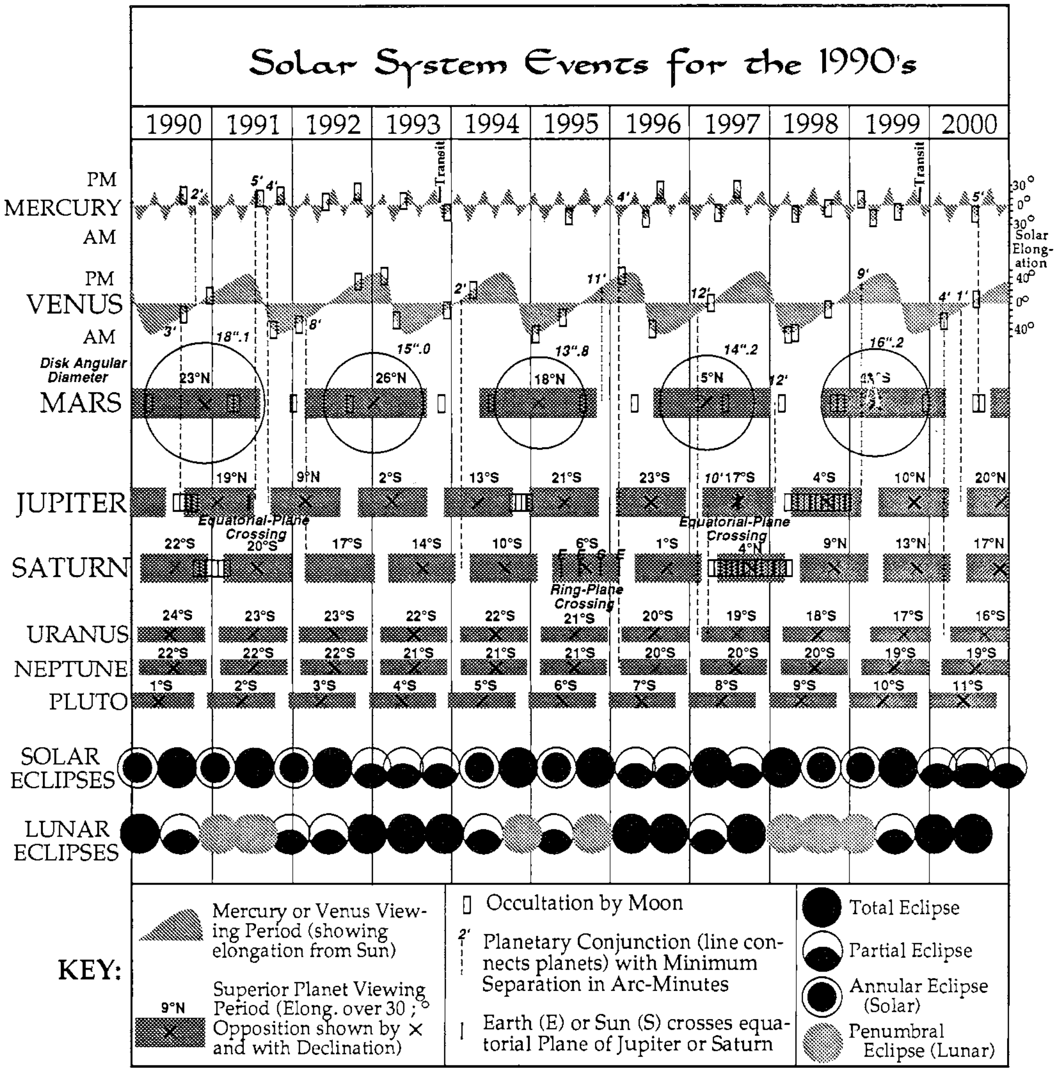

Figure 35. Diagram of Solar-System events, 1990-2001.

A.L.P.O. SOLAR SECTION OBSERVATIONS FOR ROTATIONS 1813-1817 (1989 MAR 04 TO JUL 19)

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

ABSTRACT

This report summarizes A.L.P.O. Solar Section observations for Rotations 1813-1817 (1989 MAR 04 TO Jul 19), particularly in terms of the morphology and development of sunspot groups. Twenty-two observers in four nations contributed visual drawings and integrated-light and Hydrogen-α photographs. Solar activity continued to increase in this period, peaking at a record high for the Solar Section during Rotation 1816 (1989 MAY-JUN).

INTRODUCTION

The period covered here saw a continuing increase in solar activity. Also, the participating observers numbered 22, a new record; they are listed in *Table 1* (to the right). Some data were not available for this report because they were on loan. Fortunately, due to the high output of our observers, even this causes no serious gap in this five-rotation report.

On most days of this period, and certainly for all the rotational means, the American Sunspot Number (**RA**) was higher than the International Sunspot Number (**RI**). Also, the lowest mean of either number was higher than the highs of only one year earlier! Due to this delightfully high level of activity, only one or two regions can be highlighted for each rotation. Sometimes even this choice was difficult.

The mean **RI** for this period was 145.7, rising to 181.7 in Rotation 1816, and peaking at 265 on JUN 16 during that rotation. The mean five-rotation **RA** was 158.3, reaching 201.8 in Rotation 1816 and 295 on JUN 15 during that rotation. Rotation 1814 had the lowest **RI**, 131.4; and the lowest daily count was 70, on MAR 31 during Rotation 1813. For the American count, the lowest count was in Rotation 1814 with the value 137.6; the lowest daily **RA** was 79 on MAR 30 in Rotation 1813. [**1-6**] *Figure 36* (p. 94) graphs both forms of Sunspot Number during this period.

As always, most of the terms and abbreviations used in this report are explained in our Section's *Handbook for the White Light Observation of Solar Phenomena*, which can be obtained from the writer for $US 6.00; or in the *A.L.P.O.S.S. Monochromatic Handbook*, available from Co-Recorder Randy Tatum (both addresses on inside back cover). Other references to sunspot classification are explained in the article, "A Three-Dimensional Sunspot Classification System" (*J.A.L.P.O.*, *33*, Nos. 1-3, Jan., 1989, pp. 10-13). The times used here are all Universal Time (UT); and directions are abbreviated (e.g., N, SW) and are heliographic as are angular dimensions. The term "group" refers to white-light collections of magnetically-associated sunspots, while "region" designates whole areas of activity in all wavelengths. Regions (and also groups in this report) are enumerated by the Space Environmental Services Center (SESC) of the National Oceanic and Atmospheric Administration (NOAA) in Boulder, Colorado.

Table 1. Observers Contributing to This Report.

Observer	Telescope cm.	Telescope f/	Telescope Type	Location
Clement, D.	8	15	Mak.	Louisiana, USA
Dragesco, J.	36	10	S.-C.	France
Flugan, S.	25	10	S.-C.	Ohio, USA
Garcia, G.	20	10	S.-C.	Illinois, USA
Garfinkle, R.	25	10	S.-C.	California, USA
Glaser, P.	20	10	S.-C.	California, USA
Glatz, A.A.	6	?	Refr.	Pa., USA
Hill, R.E.	6	13	Refr.	Arizona, USA
Johnson, G.E.	10	14	Refr.	Maryland, USA
Kavanagh, O.	20	10	S.-C.	New Jersey, USA
Lao, F.	6	5	Refr.	Illinois, USA
Luciuk, M.	20	10	S.-C.	New Jersey, USA
Maxson, P.	15	6	New.	Arizona, USA
Melillo, F.J.	20	10	S.-C.	New York, USA
Rousom, J.	13	10	New.	Ontario, Can.
Tao, Fan-Lin and Chang, Grace	13	?	Refr.	Rep. of China
Tatum, R.	18	15	Refr.	Virginia, USA
Timerson, B.	18	8	New.	New York, USA
VanHoose, D.	11	7.8	New.	Indiana, USA
Viens, J.F.	11.5	7.9	New.	Quebec, Can.
Winkler, W.	25	6	New.	Texas, USA

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

Rotation 1813 (1989 MAR 04.85 to APR 01.16)

Sunspot Number	Mean	Maximum (Dates)	Minimum (Dates)
RI	134.3	187 (MAR 16)	70 (MAR 31)
RA	143.0	201 (MAR 15)	79 (MAR 30)

Rainer Beck of West Germany and I were two of many who observed the MAR 07 partial solar eclipse early in this rotation and saw a large sunspot that itself was eclipsed from some locations. [See Paul Maxson, "Personal Observations of the Partial Solar Eclipse of 1989 MAR 07," *J.A.L.P.O.*, *33*, Nos. 7-9, July, 1989, pp. 122-123.] That Region, **SESC 5395**, dominated this rotation and solar astronomy for a few weeks. Otherwise, there was little to mark this rotation, as if the Sun had exhausted itself with this one Region!

On the second day of the rotation, MAR

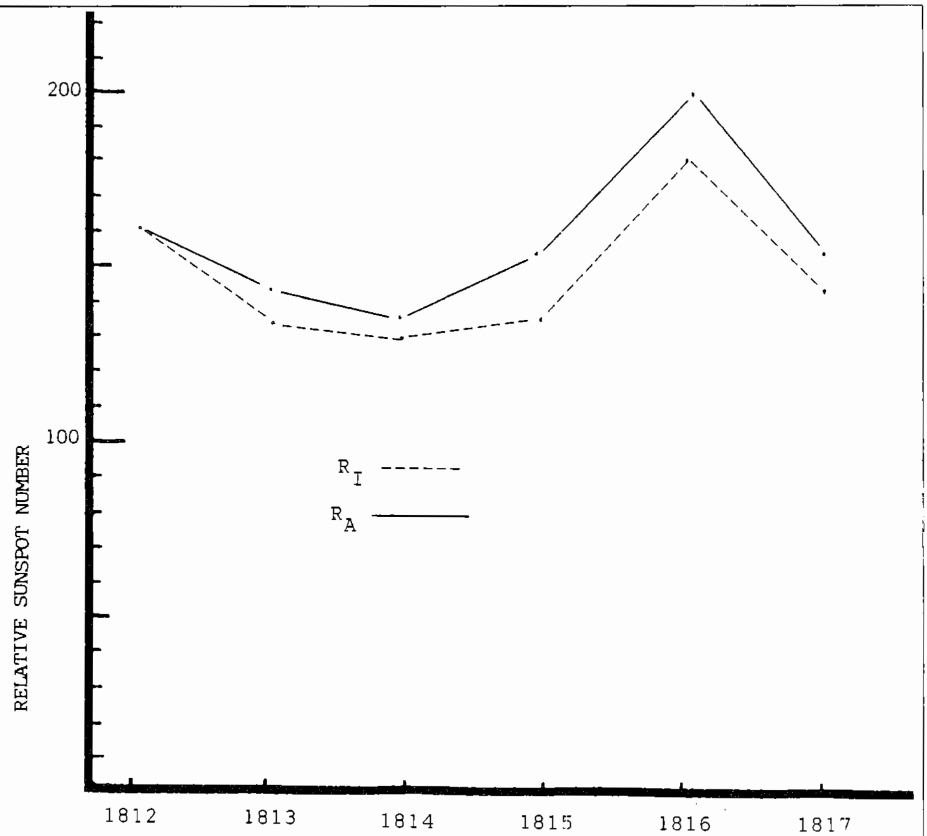

Figure 36. Graphs of means of **RI** (International Sunspot Number) and **RA** (American Sunspot Number) for Solar Rotations 1812-1817.

06, several observers noticed large complex prominences on the NE limb. [See "Observations and Comments" on p. 61 of this issue.] Viens observed a group on the limb at 14h 06m, catching a white flare in progress; the first of many bright flares that this region would produce. These events created electromagnetic havoc on Earth, including spectacular aurorae covering the Northern Hemisphere as far south as Arizona, Florida, and Puerto Rico! Classified as "3B" (or X15), the flare seen by Viens was the most powerful since Sunspot Cycle 19 in the late 1950's-early 1960's. It lasted over 6 hours in X-Ray and nearly 3 hours in H-α, beginning 13 continuous days of SESC Major Flare Alerts. [2]

On the day of the solar eclipse, MAR 07, Garfinkle, Glaser, Rousom, Garcia, and Hill reported many faculae in this region; Garcia submitted excellent color prints. During the eclipse, Garfinkle was the only reporting observer that saw the group occulted, and clouds interfered with his observations. The group was easily seen with the naked eye from now until it left the disk. A high-resolution photograph by Winkler on MAR 08 showed three main umbral concentrations in one penumbra with scattered bright spots next to several umbrae. All observers classed this group as *Ekc* or *Fkc* The group was slightly elongated E-W, with several small bits broken off to the N. A day later, another large piece separated to the NE, which broke into two pieces on MAR 10, each with rudimentary penumbrae on the outward side only. The three umbral concentrations in one penumbra were now more elongated and aligned E-W. The leader umbra was circular and large, and was followed by a middle spot of similar size but more irregular. The following or last concentration contained three spots aligned N-S with the largest on the N, the middle second in size, and the S the smallest. The penumbra was disorganized, possibly in a delta configuration, with a wedge-shaped peninsula on the N and a hole between the middle and following concentrations.

On MAR 11, the group's white-light appearance was as before, but the bright holes hugged the following side of the lead spot. A large bright hole had developed between the leader and middle concentrations, with a further break between the two N and S following spots. The N member of the following concentration began to lag behind. In H-α, there was almost continual flaring. Imagine the energy output! Each flare produces more energy than the human race has used in its entire history. Tatum (14h18m), Melillo (15h40m, 16h15m), and Garcia (16h13m) photographed violent ejections, illustrating this phenomenal activity.

MAR 12 saw SESC 5395's greatest development, when it covered 3500 millionths of the solar disk. The group was now quite elongated E-W. The bisected, detached piece was still N of the leader spot, but now there was a bright spot between the leader and middle concentrations of spot umbrae. The leader was about twice as large as it had been the day before and was twice as long as it was wide. The middle spot was also elongated E-W. The following concentration of three spots was now changing rapidly. The N spot continued to fall back. Meanwhile the S two spots were merging, with new small umbrae forming on either side of the break between them.

The entire group was over 10° long by MAR 13, and much of its former organization was gone, as shown in *Figure 37*, below. Many holes perforated the penumbra, with detached bits of penumbral material N and S. The leader consisted of one large umbra, followed by an E-W row of progressively diminishing umbrae. The middle spot now contained three or four umbrae in an E-W line. Between the leader and the middle was a new N-S line of 10 to 12 umbrae with a bright hole following. Two S spots in the following collection had almost merged, and the N spot had nearly detached with its own penumbra.

The elongation continued the next day, when the entire group was breaking up. The leader and the N-S string of spots following it were just one long line of umbrae, with penumbrae mostly to the S. The middle spot was detaching from the group, followed by the now-merged S umbrae from the following collection. The N following spot was connected by only a thin streamer of penumbral material.

Due to data requests, we had no data for MAR 15 and 16 when compiling this report. On MAR 17, SESC 5395, near the limb, was breaking down yet more. The group was then a collection of umbrae with penumbrae; all decreasing in area and becoming more circular.

Rotation 1814
(1989 APR 01.16 to APR 28.42)

Sunspot Number	Mean	Maximum (Date)	Minimum (Date)
RI	131.4	185 (APR 08)	92 (APR 13)
RA	137.6	175 (APR 08)	85 (APR 13)

In stark contrast to previous rotations, no single group stood out or was reported as naked-eye during this rotation, which had the least activity of this reporting period.

SESC 5450 entered the disk on APR 11, followed by **SESC 5451** on APR 12. All observers, including the writer, classified these two regions as a single one of class *Eki*, *Ekc*, or *Fkc*. Without magnetic information, it is difficult to decide on the exact classification.

On APR 11, none of the four observers noted any spots. On the next day, Melillo saw a 1F-classification flare in H-α. On APR 14, observers noted two concentrations led by the smaller of the two regions, SESC 5450, consisting of one umbral spot with a penumbra and some attendant umbral spots. This small region decayed during its entire disk passage, and separated from SESC 5451; thus it will not be commented upon further. Also on APR 14, the leader spot of SESC 5451 had two umbrae in a single penumbra, with a detached portion containing small umbrae on its following side. Following it was one large and three or four smaller umbrae in one penumbra that fanned out N and S, forming penumbral wings. On APR 15, the following portion of the leader and the wings of the follower detached and began to move into the space between leader and follower. More umbral spots were seen in this area. An H-α photograph by Garcia showed filaments connecting the leader and the follower. Photographs of one arc-second quality by Maxson on APR 16 showed the leader as two large umbral spots aligned N-S in a N-S-oriented penumbra with umbral spots following. The S wing led the follower, sepa-

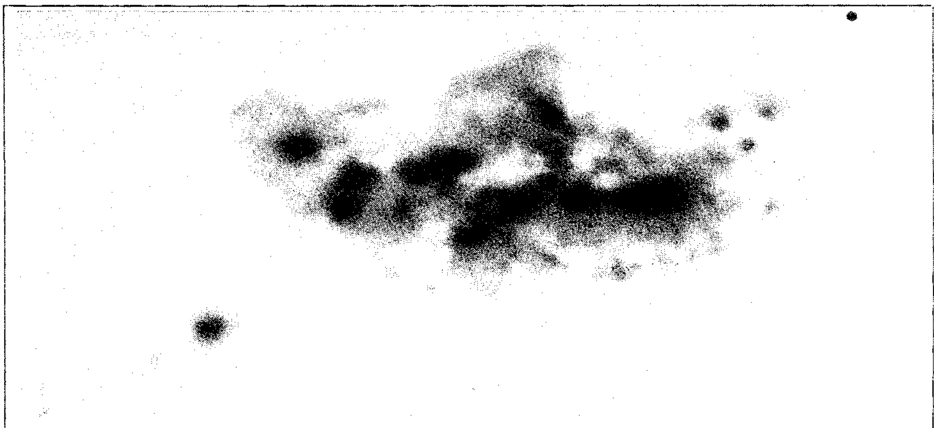

Figure 37. Sunspot Group SESC 5395, photographed on 1989 MAR 13, 18h15m U.T. by William Winkler using a 10-in. (25-cm) Newtonian telescope and eyepiece projection. 1/125-second at f/21 on Kodak TP2415 Film. Sky conditions fair-good, seeing 2 arc-seconds.

rated from the rest by a thin light bridge. The N wing was now only a decaying penumbra.

On APR 17, the leader was elongated E-W with umbral spots following. The follower was now in two pieces; with the leading portion larger, the light bridge wider, and the following portion more circular. Dissolution was well underway by APR 19, when the leader's following portion consisted of only small umbrae in a rudimentary penumbra, while the follower spot was two small umbrae in a penumbra with many small umbrae in a rudimentary penumbra between them. All this region's spots decreased in area, organization, and complexity from this time until it left the disk.

Rotation 1815
(1989 APR 28.42 to MAY 25.64)

Sunspot Number	Mean	Maximum (Dates)	Minimum (Dates)
RI	136.4	196 (MAY 24)	83 (MAY 05)
RA	152.6	222 (MAY 20)	98 (MAY 03)

The dip in the previous rotation was temporary; and activity increased in Rotation 1815, as borne out by the statistics above.

One group, **SESC 5464**, reached naked-eye visibility. This group came onto the disk on APR 25, during Rotation 1814, and was unimpressive at first. On APR 27, the group consisted of two leader spots and one large follower. The leader was composed of small umbrae with a rudimentary penumbra, followed by another spot that was somewhat larger but similar in composition. The follower spot held a large umbra in a symmetrical penumbra. Over the next several days, leader and middle spot decayed. When SESC 5464 crossed the disk's central meridian on MAY 01, it was a naked-eye group, having reached an area of 600 millionths of the disk. It then consisted of one large umbra in a symmetrical penumbra, surrounded by small umbral spots.

On MAY 02, Clement observed a flare S of the main umbra, curving beyond the penumbra E and then back S and W. He used a 4-cm aperture stop on a Maksutov telescope, proving that, given good-quality optics, useful observations depend more on the diligence of the observer than on the size of equipment! A day later, the main spot was surrounded by three small spots with rudimentary penumbrae in a rough equilateral triangle. Also, there was a curl of penumbral material S of the main spot, following the site of the previous day's flare. In H-α, Garcia observed a ribbon of bright material still marking the site of the flare. Another flare was caught in typically excellent photographs by Dragesco, showing mass ejection. In white light, only one triangular spot was left, on the SW. The N spot had been engulfed by the penumbra of the main spot. The group's largest area was on MAY 05, when the main spot was a very large umbra with three or four smaller umbrae to its N, all in one penumbra. Leading were several smaller umbrae in rudimentary penumbrae and many faculae as the region neared the limb. The entire complex covered some 900 millionths of the disk. Near the limb on the next day, the region was surrounded by large tracts of faculae. Finally, on MAY 07, Dragesco photographed the group on the limb, showing a flare in progress among the remaining spots.

Rotation 1816
(1989 MAY 25.64 to JUN 21.85)

Sunspot Number	Mean	Maximum (Dates)	Minimum (Date)
RI	181.7	265 (JUN 16)	111 (MAY 31)
RA	201.8	295 (JUN 15)	124 (MAY 31)

This rotation was the activity peak for this reporting period. Thus, many of our data are on loan, especially for the region SESC 5528.

Although we do not have all the data for **SESC 5528**, it remains the best region to describe. It was first seen on JUN 09 as a large teardrop-shaped leader with an irregular penumbra. To its S was another spot with a very irregular penumbra, chiefly on its leading side, and a smaller spot to the N that was mostly penumbra. Excellent photographs by Garcia on JUN 11 in both white light and H-α showed that the main leader spot was dominant, and was a circular umbra in an irregular penumbra with many small bits following to the N and S. A rubble of umbrae and penumbrae followed these. The following spot comprised two large umbrae in their own penumbrae, with more detached penumbral material. In H-α, both Tatum and Garcia observed SESC 5528 as poorly organized, with bright patches and filaments where faculae were located in white-light views. The group was already of class Fki or Fkc; potentially a good flare producer.

On JUN 12, there were no longer clear leaders or followers. Elongated N-S, the old leader spot was in the middle, and slightly W, of the line of spots. Both N and S was a jumble of umbrae, only some with penumbrae; with bits of penumbra extending over 15°. By JUN 13, the larger portions merged into one penumbra, with the rest following. This group was still developing and growing, but already had been an easy naked-eye object for several days. By now, one could even make out detail and structure in the group without a telescope! It was still of class Fkc, and was producing flares and aurorae. I could detect changes in the Earth's magnetic field by using a simple magnetometer like that described in the October, 1989, issue of *Sky & Telescope* (p. 426). The maximum development of the region occurred when it was on the central meridian on JUN 14, when its area reached 2500 millionths of the disk. Detached spots to the N had begun to fall behind the larger spot, which could now be called a leader. Many penumbral projections were S of the main spot.

A smaller sunspot group, **SESC 5536**, followed SESC 5528 and began to close with it. SESC 5528's largest spot was aligned nearly E-W on JUN 15, when some dissolution was apparent, especially on the N end. A small spot to the S was connected to the main body by a long, thin penumbral projection. The N spots now lagged more and more. On the next day, the N end of the main spot broke into about ten small spots with penumbrae. The main spot itself was notched by many light bridges, a sure sign that breakup was underway. The little spot to the S was still connected by the thin tendril of penumbra, now longer and thinner. One long light bridge cut into the main spot from the E, dividing the umbra. This was to be a site for future flares.

Dissolution continued on JUN 17, with the main spot becoming more circular, with fewer light bridges. The detached spot decreased in size and in the number of umbrae. The tendril of penumbra and the S spot were still there, but all the umbrae were gone. With another large group in the S Hemisphere, there were now two naked-eye spots on the disk. The little group to the E, SESC 5536, was decaying rapidly. In H-α, Garcia caught a flare in SESC 5528 at 17h17m. NOAA/SESC show no flares in SESC 5528 for that time, but do show one in SESC 5533 to the S. Garcia saw a flare in each region, but the one in SESC 5528 clearly was the brighter! Glaser, again in H-α, showed both regions as much dimmer one hour later.

SESC 5528 was near the limb on JUN 18, with the entire group breaking up into smaller spots, both with and without penumbrae. The umbrae of the main spot had also broken up into smaller pieces, losing the group's Eki or Fke classification. On the last day of observations, JUN 19, the group was still decaying, with the large light bridge dividing it from the E and many faculae around all its spots. Finally, Garcia caught yet another flare of sN [small, normal] importance to the region's W.

Rotation 1817
(1989 JUN 21.85 to JUL 19.05)

Sunspot Number	Mean	Maximum (Dates)	Minimum (Dates)
RI	144.9	227 (JUN 25)	91 (JUL 16)
RA	156.6	265 (JUN 26)	96 (JUL 15)

This rotation had many groups, but they were usually less evolved than in previous rotations, with few reaching class D and most being classes B or C. Most of the impressive activity was due to two parallel chains of regions; one in the N Hemisphere (**SESC's 5555**, **5559**, **5564**, and **5565**) and the other in the S (**SESC's 5552**, **5556**, **5561**, and **5563**). Mean sunspot counts were somewhat less than the highs of the previous rotations.

The N chain of groups began to enter the disk on JUN 20, and all had entered by JUN 23; the chain spanning some 35°. The S chain started entering the disk on JUN 19, and was completely on by JUN 23, making it 10° longer yet. Both chains were naked eye by JUN 24, making a strange sight because neither chain could be resolved, giving the appearance of broken lines. In the N chain, the largest and most evolved group was the leader, SESC 5555. On JUN 22, it was Dki class, while all other groups in the chain were C class.

In the S chain, SESC 5552 was the leader, and again the most evolved. Spots here tended to be single or to form N-S pairs. On JUN 23, the N chain was poorly defined because there were several groups to its S. The leader was still the dominant group and was by then barely naked-eye. Dragesco photographed this group in white light on JUN 23 and 24, showing rapid changes as part of the leader spot broke away and joined the followers, forming a circle of umbrae with some rudimentary penumbra. The S chain was quite distinct, however; with the addition of several other groups in the SW disk quadrant, it appeared to stretch from limb to limb. It had no clearly dominant group because all were C or D class. The most interesting group was still SESC 5552. Its leader spot was circular, with a small umbra in a rudimentary penumbra to the N and a scattering of umbral spots followed by a few umbrae in a large rudimentary penumbra. There were some scattered bits of penumbral material to the N of all this activity.

On JUN 24, there was little change in the N chain, but the following spot of SESC 5561 (the third group from the preceding end of the S chain) had a bizarre umbra. In an excellent white-light photograph by Garcia with one arc-second resolution, this was an unbroken line 10-12 arc-seconds long, bent in the shape of a flattened V. The umbral width was only about 2 arc-seconds, with no hint of fragmentation! In some 25 years of solar observing, I have never seen such an umbra. In the S chain, the leader of the last group (SESC 5563) had an unusual teardrop-shaped penumbra. Such groups should be monitored!

By JUN 25, both chains were well onto the disk and both leader groups were on the central meridian. In the N chain, the following spots of the lead group were dissolving while the leader was becoming more nearly circular. Other groups were decaying as well. The N chain was losing its organization. Meanwhile, the S chain's spots were becoming more circular or were dissolving. Even the unusual umbra of SESC 5561 was broken up. In H-α there was nothing unusual about these regions.

By JUN 26, SESC 5555 dropped below naked-eye visibility and the other groups in the N chain were still decaying. The S chain was 50° long; longer were SESC 5549 included to its W. All groups except SESC 5563 were decreasing in area and complexity. There is a data gap for the next day, JUN 27. By JUN 28, SESC 5555 had a circular leader, followed by a small spot with a rudimentary penumbra and some umbral spots. To the S, old spots were decaying or gone except for SESC 5563. This group had undergone a revival—remember the earlier remark about teardrop-shaped groups? Now it consisted of four collections of umbrae in separate penumbrae with the two large spots leading, the two smaller following, and a number of umbral spots surrounding them.

Decay continued in the N chain on JUN 29.

In the S the lead spots of SESC 5563 had merged, followed by many umbral spots in rudimentary penumbrae, aligned roughly N-S. Both chains began to leave the disk on JUN 30. Dissolution continued in the N; and in H-α a bright region was seen between the leader and the follower of SESC 5569, the last region in the N chain. This region produced several flares on JUN 30. There was little left of the old groups in the S chain and even SESC 5563 was showing signs of decay. All the leader spots had merged into one large spot that contained a few umbrae in one irregular penumbra, with an extension to the follower of two umbrae in a rudimentary penumbra, still aligned N-S. There was a bright light bridge between the two largest umbrae in the leader, and many faculae evident around the group. All the groups decayed from now until leaving the disk. SESC 5563 decreased in area and consolidated, leaving the disk on JUL 04.

CONCLUSION

Many observations were submitted for this period, even when one subtracts those on loan to researchers. Some minor data problems need to be corrected. First, all observers should include the correct orientation on their photographs and drawings. If you include celestial orientation, it should be noted by the cardinal-point notation (N, E, SW, etc.). If possible, observers should take the time and effort to also indicate the position angle of the Sun's axis, which would be quite helpful to the Recorders. Second, when making drawings, only outline the penumbrae of the spots; do not color or shade them in. Outlining is required for both reproduction of the drawings and for interpretations of activity; there are often very interesting internal motions among enclosed umbrae. Third, again applying to drawings, observers who do not trace a projected image must be very careful about the sizes of features with respect to the solar disk. There is an innate tendency to draw interesting features too large. This, along with incorrect orientation and colored-in penumbrae, can render otherwise-good observations useless.

We had many interesting, active groups in the latest rotations. As a result, we have had data requests which leave our files with gaps in coverage. If you see interesting features, *please* submit several copies of your data. We have tried sending requests for more data, but the return rate from observers was only about 10 percent; not enough to replenish our files. We also need more drawings of individual features. Draw-ings can be done by anyone with telescope and paper, and are economical and, with practice, relatively easy to do. Single-feature drawings take a bit more time than whole-disk drawings, but give much more information. As a matter of fact, for groups like SESC 5395 and SESC 5528, hourly drawings of each group would have been useful. With SESC 5555, hourly drawings would have shown us the movement of the piece of the leader into the followers. Such movements can happen rapidly and violently. In this case, the spot moved at over 100 miles per hour across the group!

In closing, I wish to apologize for my slow mail responses. With high levels of activity recently, I have received many requests for articles, and more than the usual mail, which have both slowed things considerably. Please be patient; the Section will be back to normal soon. But whatever you do, don't let this slow you down; keep observing that close-by star!

REFERENCES

1.) *Solar-Geophysical Data (prompt reports)*, Part I, No. 536, April, 1989.
2.) ________, No. 537, May, 1989.
3.) ________, No. 538, June, 1989.
4.) ________, No. 539, July, 1989.
5.) ________, No. 540, August, 1989.
6.) ________, No. 541, September, 1989.

A.L.P.O. CONVENTION REMINDER

Our 40th Convention will be with the Astronomical League at *ALCON '90*, on July 31-August 4, 1990, at Washington University in St. Louis. Air-conditioned lodging will be in Elloit Hall on campus at $14.00 per day single occupancy and $12.00 per person double. Meal tickets are $14.25 per day for breakfast, lunch, and dinner. Make meal and dorm reservations before July 1. Registration for all five days is $30.00 per person before July 1, and $35.00 after. The daily registration fee will be $7.50. Payment, for registration, lodging, and meals, should be to "ALCON'90" and should be sent to: Stephen Best, 6943 Amherst Avenue, St. Louis, MO 63130.

The A.L.P.O plans a paper session, a workshop, and exhibits of Section activities. A members' business meeting will be held, prior to a Board of Directors' meeting

All members are welcome to present papers. If so, please send an abstract to the Director (address on inside back cover) no later than June 15th, including in it the amount of time needed (20 minutes maximum) and any audio-visual needs. Plan to bring a camera-ready copy of the paper to the meeting.

Note that the A.L.P.O. will host a "Solar System Portraiture Display and Contest." Write the Director for more information on this event; all entries should be in his hands by July 1. (See previous issue, p. 46.)

We invite A.L.P.O. staff and members to supply exhibits; not only for the above event. Bring your items with you or, if you can not come, send them to our Exhibit Coordinator, Harry D. Jamieson, by July 1 (*for exhibits only*, his address is 907 Birdsong St., Heber Springs, AR 72543-2004).

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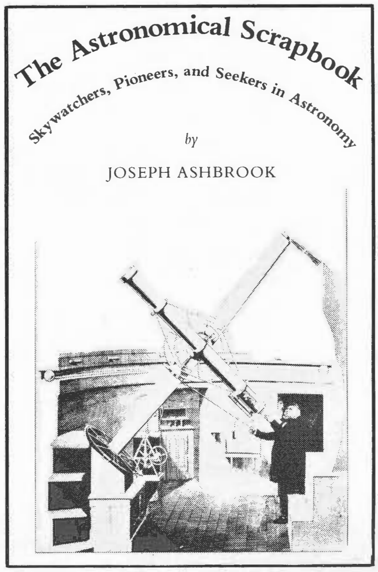

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