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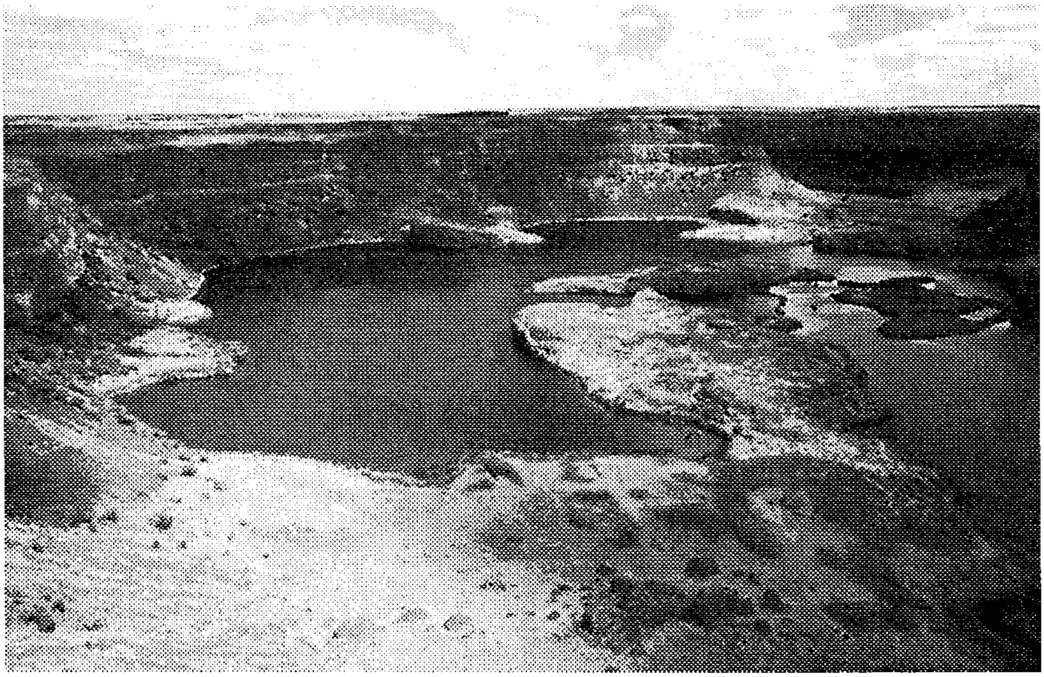

Dry Falls, the eroded remains of a catastrophic flood of about 12,000 years ago. This 125-m (400 ft) precipice is a terrestrial analog to the Martian channels. In the Channeled Scablands of Washington State, this feature is about 90 km (55 mi) west of Spokane and was a stopping place on the ASTROCON 99 field trip conducted by Dr. John P. Buchanan of the Department of Geology of Eastern Washington University (see page 134).

THE ASSOCIATION OF LUNAR AND PLANETARY OBSERVERS

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In This Issue

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A.L.P.O. SOLAR SECTION OBSERVATIONS FOR ROTATIONS 1887-1900 (1994 SEP 12.96 TO 1995 SEP 29.81)

By: Richard E. Hill, A.L.P.O. Solar Coordinator (rhill@lpl.arizona.edu)

Welcome to sunspot minimum, in complete contrast to the situation at present! Activity on the Sun was low to very low throughout the entire period covered in this report. Only 134 active regions were designated by SEC [the Space Environment Center of the National Oceanic and Atmospheric Administration] during this time. The most complex sunspot groups reported were classed Eai and managed to maintain that MacIntosh Class for only a day or so [the classification system for solar phenomena is given at the end of this report; on p. 107]. The mean R(I) was 19.4 and R(A) was 21.4. No spots at all were reported for over 40 days, while the highest daily counts were R(I) = 65 on 1995 MAR 04 and R(A)=74 on the same day. The most active rotation, however, was CR 1888 [CR = Carrington Rotation], with a mean R(I) for the rotation of 44.8 and mean R(A) of 43.9. Unfortunately, this rotation was also very poorly observed by members. *Figure 1*, below illustrates this activity.

The old Section Handbook, now being rewritten by Assistant Coordinator Jeffery Sandel, defines the majority of terms and abbreviations used in this report. Until this is finished, observers are advised to use the Astronomical League book *Observe and Understand the Sun*, available from Astronomical League Sales, P.O. Box 572, West Burlington, Iowa 52655 for $US 5.75, which also contains definitions and explanations. The McIntosh Sunspot Classification System is used herein. These sunspot classifications are explained in the aforementioned A.L. publication, and in "A Three-Dimensional Sunspot Classification System" (*J.A.L.P.O.*, *33*, Nos. 1-3, Jan., 1989, pp. 10-13), and on our webpage for the White Light Flare (WoLF) Patrol at:

http://www.lpl.arizona.edu/~rhill/solar.html

Universal Time (UT) is used throughout this report and celestial directions are abbreviated (e.g. , N, E, SW). All dimensions in degrees are heliographic and areas are expressed in the standard units of millionths of the visible disk. A "group" refers to a white-light collection of sunspots, while "region" refers an entire area of activity in all wavelengths. Rotations are enumerated by the Carrington Rotation number (CR) which began at 12h00m UT on January 1, 1854. Preceding and following spots in a group are abbreviated as p-

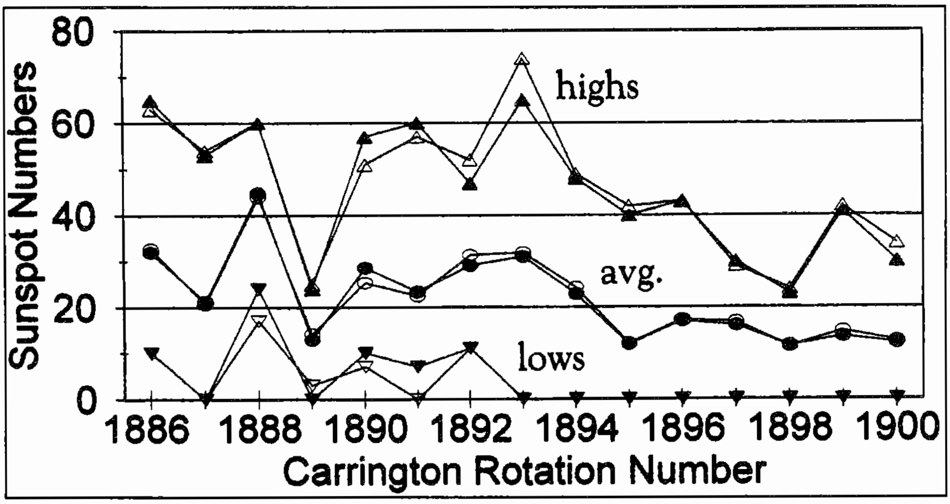

Figure 1. Relative sunspot numbers for CR 1886-1900. From top to bottom, the three groups of lines show rotational highs, means, and lows. Solid symbols are American Sunspot Numbers [R(A)]; open symbols are International Sunspot Numbers [R(I)].

Table 1. A.L.P.O. Solar Section observers, Rotations 1887-1900.

Name	Telescope Aperture (cm)	F.L. (cm)	Type*	Stop (cm.)	Location
Robert Birket	25	152	rfl	n/a	Mesa, AZ
David Boschat	10?	?	rfr	?	Halifax, N.S., Can.
Dave Branchett	20	200	s-c	n/a	Deltona, FL
Mathew Damien	60?	?	rfr	n/a	Dickinson, ND
Jean Dragesco	13	?	rfr	n/a	France
Gordon Garcia	13	102	rfr	n/a	Hoffman Estates, IL
Jan Janssens	6	70	rfr	n/a	Kapelle, Belgium
Karl Keller	8.3	100	rfr	--	Canastota, NY
David Lehman	25	125	rfl	--	Fresno, CA
Paul Maxson	25	152	rfl	15	Phoenix, AZ
Frank J. Melillo	20	200	s-c	6.4	Holtsville, NY
Jeffery Sandel	25	165	rfl	--	Cayce, SC
Larry Scott	20	122	rfl	10.2	Tyler, TX
Fan-Lin Tao	25	375	rfr	n/a	Taipei, R.O.C.
Ronald C. Tanguay	9	130	mak	4	Saugus, MA
Brad Timerson	11.4	127	rfl	n/a	Newark, NY
Vince Tramazzo	8.9	152	mak	6.4	DeRuyter, NY

*mak = Maksutov, rfl = Newtonian reflector, rfr = refractor, s-c = Schmidt-Cassegrain.

spot and f-spot. Active Regions are designated with the prefix AR and are enumerated by the Space Environment Center (SEC) of the National Oceanic and Atmospheric Administration (NOAA) in Boulder, Colorado.

Observers for this reporting period, in alphabetical order, are given in *Table 1*, above.

Solar Cycle 23. Rotation 1887. 1994 Sep 12.96-1994 Oct 10.24

Relative Sunspot Numbers

Type	Mean	Maximum Value	Maximum Date	Minimum Value	Minimum Dates
R(I)	21.2	53	Oct 06	0	Sep 20 & 21
R(A)	20.7	54	Oct 06	0	Sep 20 & 21

This report opens with moderate activity levels. Of the 14 designated ARs of the rotation (AR 7776-89 inclusive), **AR 7776** was the only region to attain an area greater than 300 millionths. Observations submitted covered only half of the days and unfortunately these were not consecutive. Of these observations only two covered AR 7776 in its latter stages of decay. Two other groups were observed but not well enough to discuss their activity.

One observation deserves special mention. On 1994 Sep 18 at 16h54m UT, Garcia took a remarkable photograph of **AR 7780** (then a Bxo group) on the limb the day it came into view, shown in *Figure 2* (p. 99). It shows a p-spot and f-spot each with a few umbrae aligned N-S, with rudimentary penumbrae in a filigree of faculae. The resolution of this image was about one arc second, showing a wealth of detail.

Solar Cycle 23. Rotation 1888. 1994 Oct 10.24-1994 Nov 06.53

Relative Sunspot Numbers

Type	Mean	Maximum Value	Maximum Dates	Minimum Value	Minimum Date
R(I)	44.8	60	Oct 15	24	Nov 06
R(A)	43.9	60	Oct 15 & 19	17	Oct 24

Although there was a slight overall increase in activity as compared with the previous rotation, it was still only moderate and decreased throughout the rotation. The largest group was **AR 7790**, the first of only 11 designated in this rotation. Only three whole-disk spot maps by Fan-Lin (for sunspot-counting purposes only) were submitted, again not enough for a good summary of activity.

Solar Cycle 23. Rotation 1889. 1994 Nov 06.53-1994 Dec 03.84

Relative Sunspot Numbers

Type	Mean	Maximum Value	Maximum Date	Minimum Value	Minimum Date
R(I)	12.9	24	Nov 10	0	Dec 03
R(A)	14.1	25	Nov 10	3	Dec 03

Activity continued to fall to low levels during this rotation, with 12 groups designated by SEC. None exceeded 200 millionths of the disk in area. This low activity was reflected in the low interest by observers as no observations are on file for this 27-day period.

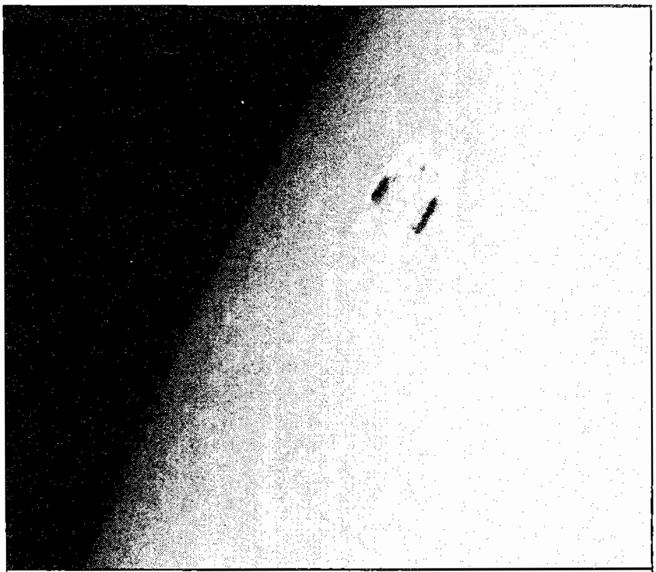

Figure 2. Photograph of AR 7780 by Gordon Garcia. 1994 SEP 18, 16h54m UT. 13-cm f/8 refractor, eyepiece projection at f/57. 1/1000 second exposure on Kodak Technical Pan 2415 Film using Herschel wedge and ND64X Filter. Seeing 2 arc seconds. North at top.

Solar Cycle 23. Rotation 1890. 1994 DEC 03.84-1994 DEC 31.17

Relative Sunspot Numbers

		Maximum		Minimum	
Type	Mean	Value	Date	Value	Dates
R(I)	28.6	57	DEC 11	10	DEC 04 & 30
R(A)	25.3	51	DEC 11	3	DEC 30

While activity (reflected by sunspot numbers) increased from the last rotation, the level remained low and only nine ARs were designated. Of these nine, **AR 7815** and **AR 7817** were the largest, attaining areas of 700 millionths and 250 millionths respectively (500 millionths is the threshold for naked-eye visibility for a sharp-eyed observer). Only the former was observed well enough to deserve comment.

AR 7815 was first observed on 1994 DEC 11, by Janssens (09h40m UT) and Maxson (20h38m UT), when it was seen as an Eac-class group of 360-370 millionths area. Janssens counted 25 umbrae within the group. A Maxson photograph showed the p-spot as a cluster of umbrae surrounded by a well-developed penumbra. A small fragment of penumbra followed, followed by two parallel lines of spots, roughly SW-NE aligned, some with rudimentary penumbrae. These parallel lines of spots probably indicated where the neutral line dividing magnetic polarity ran through this region. The f-spot was subdivided by a N-S running, broad light bridge that cut off the preceding 20 percent of the spot and penumbra.

The next observations were on DEC 14 when the group, now Eki class, had reached its maximum area. The p-spot was a little larger than before but was morphologically unchanged for the most part. The central scattering of spots were now in an "L" shape with the short leg of the "L" to the north. These were in one large rudimentary penumbra. A teardrop-shaped f-spot brought up the rear, surrounded by a well-developed penumbra.

Three more days passed before Section observers saw this group again on DEC 17. Both the p-spot and f-spot were then smaller. The spots between were then only pores as the group was in decay. As the region was near the limb much faculae, especially around the p-spot and in the middle, could be clearly seen. The final observation was the next day, when AR 7815 was on the limb with more faculae around all spots. The f-spot was then quite small in a rudimentary penumbra. The p-spot was unchanged as it left the disk.

Solar Cycle 23. Rotation 1891. 1994 DEC 31.17-1995 JAN 27.51

Relative Sunspot Numbers

		Maximum		Minimum	
Type	Mean	Value	Dates	Value	Dates
R(I)	23.3	60	JAN 24	7	JAN 7
R(A)	22.4	57	JAN 22	0	(3 days)

Although this rotation was low in activity, it was relatively well observed by the Section. The largest active region of the 11 designated during this rotation was **AR 7830**, which attained a maximum area of 300 millionths on 1995 JAN 24, still well short of naked-eye visibility.

AR 7830 was first observed on JAN 21, two days after coming onto the disk, by

Section members Janssens (09h20m UT) and Sandel (21h08m UT; see *Figure 3* below). It was then classified as Dso, with an area of only about 100 millionths. The p-spot consisted of several small umbrae with penumbrae. This was followed by a half-dozen umbral spots, themselves followed by 4-5 umbrae in a single penumbra. Janssens counted a total of 14 spots in the group, probably an underestimate. On the next day, JAN 22, Sandel observed the leader to be several large umbrae in penumbra with several other umbral spots around it, and with penumbrae followed by a chain of umbrae that trailed back to the f-spot which also consisted of 4-5 umbrae in a rudimentary penumbra. Some of the spots in the chain had their own rudimentary penumbrae, while a few were still just umbral spots.

Two days later, with AR 7830 at its maximum area, at class Dai, its leader was seen as several large umbrae in a more circular penumbra. The middle spots had lost all penumbrae and were just naked umbral spots. The f-spot was a collection of umbrae in penumbra arranged in a "v" shape open to the north. One day later, Sandel saw that the leader was much the same but slightly more elongated E-W (shown on *Figure 4*, p. 101). The f-spot had by then broken into three pieces, each with its own rudimentary penumbra. In the middle the spots were still just umbral spots, but fewer in number than before. On JAN 26 the group was classed as Cao and was decaying. The leader had rotated slightly clockwise but was otherwise unchanged. The middle spots, now numbering only four, were moving towards the leader and the f-spot consisted of two umbrae. The last observation was by Maxson on JAN 29. by then into CR 1892 (17h31m UT) and showed just the leader in a photograph of 4-5 arc second resolution.

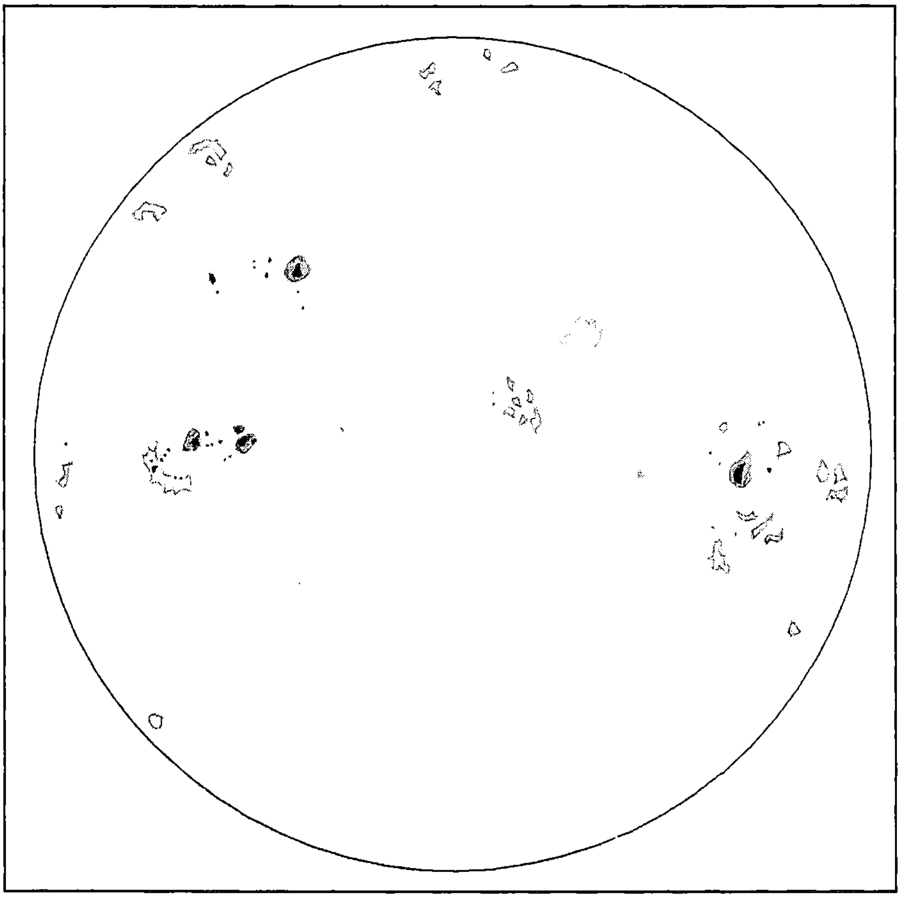

Figure 3. Whole-disk drawing by Jeffery Sandel, 1995 JAN 21, 21h08m UT. 25-cm f/6.5 Newtonian, projection with 16.3-mm eyepiece. Seeing 7-8 on A.L.P.O. 0-10 scale. North at top.

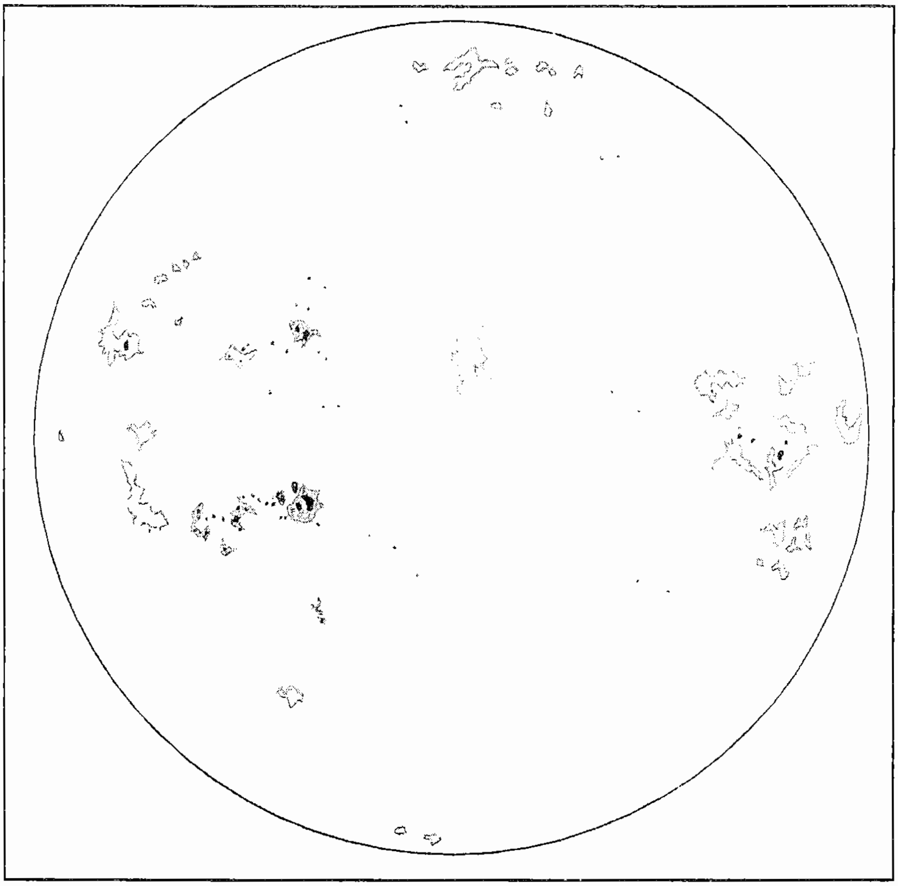

Figure 4. Whole-disk drawing by Jeffery Sandel, 1995 JAN 22, 21h08m UT. 25-cm F/6.5 Newtonian, projection with 16.3-mm eyepiece. Seeing 8-9 on A.L.P.O. 0-10 scale. North at top.

Solar Cycle 23. Rotation 1892. 1995 JAN 27.51-1995 FEB 23.85

Relative Sunspot Numbers

		Maximum		Minimum	
Type	Mean	Value	Dates	Value	Dates
R(I)	29.1	47	FEB 22	11	FEB 13
R(A)	31.4	52	FEB 19	11	FEB 12

With 13 active regions designated (AR 7833-45 inclusive), this rotation showed moderate activity. Even with this increase, the rotation's largest groups were distinctly smaller than the largest of the previous two rotations. This was the last rotation in this reporting period with a minimum above zero. The two largest regions of this rotation were **AR 7834** and **AR 7843**. The former was poorly observed by the Section; the latter only slightly better.

AR 7834 was first seen by Maxson on 1995 FEB 01, at 17h36m UT, as an E-W elongated p-spot with penumbra, followed by a collection of umbral spots with rudimentary penumbra and pores surrounding. This was a day after its maximum area and it was only observed two more times, both by Maxson. On FEB 04 there was little change in area or form in a photograph taken at 18h02m UT. By FEB 11 it was no longer visible in a whole-disk photograph.

AR 7843 was first seen by Maxson on FEB 18 as two large umbrae with a small penumbra and a tight collection of umbral spots following. Leading this group was **AR 7842**, a single small umbra with penumbra. AR 7843 was classed as Dao on FEB 19 when an excellent whole-disk image, taken by Garcia at 16h54m UT, showed dramatic change, reproduced here as *Figure 5* (p. 102). The p-spot was then two small umbrae in rudimentary penumbra followed by 3-4° by another very similar spot. This was followed in turn by only 2-3° by two larger such spots arranged N-S, themselves followed by three smaller spots with rudimentary penumbrae and surrounded by tiny umbral spots and pores arranged in an E-W elongated loop. None of the group included AR 7842 as it was only a solitary spot leading the preceding edge of AR 7843 by about 5° or more.

One poor whole-disk image on FEB 20 showed all the spots of AR 7843 as more or less in a line with the largest in the middle of the group. The class was now Eai; a region very likely to produce flares during any given 24-hour period. This was the day of maximum area, only one day before central-meridian passage. The next date for which we have data was FEB 25, when a full-disk image showed that this former Eai group had completely vanished in only three days! Only the remnants of AR 7842 could then be seen. It was a pity that this remarkable dissolution had not been witnessed by Section observers.

Solar Cycle 23. Rotation 1893. 1995 FEB 23.85-1995 MAR 23.17

Relative Sunspot Numbers

		Maximum		Minimum	
Type	Mean	Value	Date	Value	Date
R(I)	31.0	65	MAR 04	0	MAR 10
R(A)	31.9	74	MAR 04	0	MAR 10

Moderate levels of activity were maintained during this rotation with a total of 12 active regions being designated (AR 7846-57 inclusive). Almost all the activity of this rotation was concentrated in a cluster of four active regions, AR 7846-49 from 1995 FEB 26-MAR 07. Of these **AR 7846** and **AR 7848** were the largest regions, attaining visible areas of 380 and 120 millionths, respectively, at their heights. The entire cluster attained an area of 1000 millionths and may have been of naked-eye

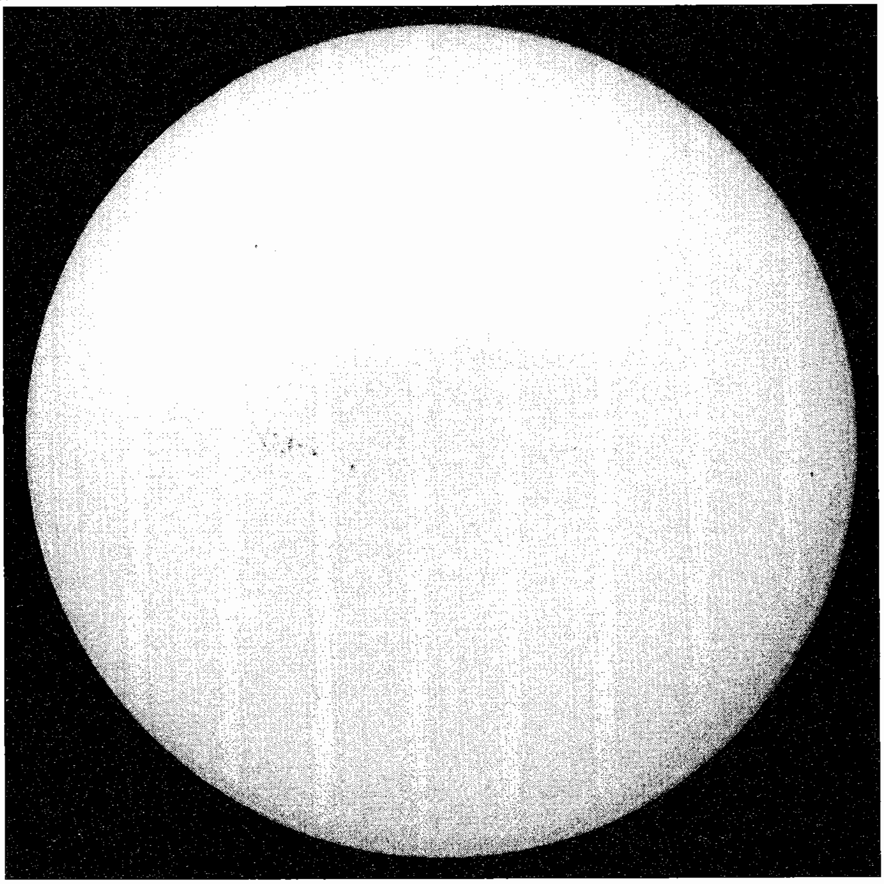

Figure 5. Whole-disk photograph by Gordon Garcia. 1995 FEB 19, 16h54m UT. 13-cm f/8 refractor, Barlow used at f/17.7. 1/1000 second exposure on Kodak Technical Pan 2415 Film using white-light full-aperture glass (yellow/orange) and ND64X Filters. Seeing 3 arc seconds. North at top.

visibility. (With proper filtration of course!) Unfortunately we have only scattered observations by the Section during this period and only the most terse remarks can be made.

Janssens was the first observer to record AR 7846, on FEB 26 (09h15m UT) and showed it to be just two spots comprising a Cao group. As the region crossed the central meridian on MAR 04, AR 7846 was seen as an Ekc group (about 260 millionths area) in a disk drawing, and a poor-quality photograph by another observer. At this time AR 7848 was in the lead in the concentration of regions. AR 7848 consisted of four umbrae in a single penumbra followed by some umbral spots. This was followed by AR 7846, containing a p-spot that had two collections of umbrae in separate but touching penumbrae followed by an E-W elongated chain of umbrae in penumbra with some small umbral spots and pores to the N. **AR 7849** was located between the previous two regions and to the N. It was a scattering of spots the p-spot of which had a rudimentary penumbra. **AR 7847** followed as a single small umbra, possibly with rudimentary penumbra. This was the last observation of these regions.

A special mention needs to be made of a rather curious observation. A single observation of an event, particularly an unusual one, cannot be considered a positive observation, only a "possible" positive observation. By presenting such an observation here it is hoped that others may step forward with observations at the same date and time to confirm or deny the anomaly. In this case, Michael Boschat of Halifax, Nova Scotia reported that on MAR 22 he observed a "thin grey line" running N-S through **AR 7854** between the single spot (a large umbra in a round penumbra) and mid-spots (about a half-dozen umbrae in a rudimentary penumbra). Solar radio observers at Nobeyama Solar Radio Observatory, for that date but several hours later, observed the entire AR as bright with a break exactly along the reported line. H-α images from Big Bear Solar Observatory show a plage edge at the position of the line but nothing else, not the filament I was expecting. The result is inconclusive unless others can supply approximately simultaneous observations. This example points out the value and usefulness of multiple observations and careful scrutiny of the situation while at the telescope.

Solar Cycle 23. Rotation 1894. 1995 MAR 23.17-1995 APR 19.45

Relative Sunspot Numbers

		Maximum		Minimum	
Type	Mean	Value	Dates	Value	Dates
R(I)	22.8	48	APR 17	0	APR 05-10
R(A)	24.2	49	MAR 23	0	APR 05-08

In this rotation, activity decreased to low levels again with only seven active regions designated (AR 7858-64). The largest of these regions was **AR 7863** with a maximum area of 300 millionths on APR 14-15 but it was covered by the Section with only a few poor-quality images. The second largest group of the rotation, **AR 7858**, was the best covered by observers.

The first observations of AR 7858, near the limb, were on 1995 MAR 25 by Maxson and Lehman between 17h and 19h UT. Two of Lehman's drawings are reproduced here (*Figures 6* and *7*, p. 104). They showed the p-spot of this Cao class group as a cluster and a line of umbrae in one small penumbra surrounded by faculae. The f-spot was a large umbra with penumbra and between these was a scattering of umbral spots. By the next day, seen at the same time, the entire group had coalesced. The p-spot had 4-6 umbrae in a single penumbra followed by just a few small umbrae in the middle and a f-spot that was a large umbra with some smaller umbrae in penumbra to the N. The leading and following spots were connected by a rudimentary penumbra that spanned the middle portion. There was still much faculae to the N and S. It would have been desirable to have had an image around 03h-04h UT to have seen an intermediate step in this coalescence.

The next observation was made on MAR 28 by Lehman at 20h50m UT. It showed further coalescence in AR 7858, such that the entire group consisted of about a dozen umbrae in a large penumbra with a projection of penumbral material to the N surrounded by about another dozen small umbrae. This was now a Dai group, at a maximum area of about 220 millionths. On MAR 29 the contraction continued as the large spot became more circular and the penumbra shrank. Its total area was decreasing rapidly. AR 7858 became slightly more elongated on MAR 30 but still consisted of about a dozen small umbrae in penumbra with three extensions from the central largest umbra; one to the N, one to the SE and one to the W. The last observation (in H-α), on APR 01 showed the large spot again becoming more circular with half as many umbrae contained within. A piece of penumbra (possibly containing small umbrae) had separated to the E and there were only a few tiny umbrae outside this.

Solar Cycle 23. Rotation 1895. 1995 APR 19.45-1995 MAY 16.69

Relative Sunspot Numbers

		Maximum		Minimum	
Type	Mean	Value	Date	Value	Dates
R(I)	11.9	40	MAY 16	0	(9 days)
R(A)	12.1	42	MAY 16	0	(9 days)

This rotation continued the previous low activity levels with only eight regions designated (AR 7865-72), most activity occurring in the last third of the rotation. The largest region was AR **7871**, which achieved a maximum area of 450 millionths on 1995 MAY 18, actually early in the next rotation. Unfortunately there were only three observations submitted for this entire rotation, all whole-disk drawings, so no summary of any of these regions can be made.

Solar Cycle 23. Rotation 1896. 1995 MAY 16.69-1995 JUN 12.89

Relative Sunspot Numbers

		Maximum		Minimum	
Type	Mean	Value	Date	Value	Dates
R(I)	17.0	43	MAY 17	0	MAY 23-27
R(A)	17.2	43	MAY 17	0	MAY 23-27

Activity sank to very low levels during CR 1896 with only five regions being designated during the whole rotation (AR 7873-77 inclusive), a mean of one every five days. However, activity was confined to the latter third of the rotation. Only one region is worthy of mention here, **AR 7877**, which attained a maximum area of 270 millionths on 1995 JUN 10-11. There were only four observations of AR 7877, which covered two days, the days of its maximum development and area. This was the best-covered region of the rotation.

The first observation of AR 7877 was by Maxson on JUN 10, at 15h25m UT. His whole-disk photograph showed the region consisting of three groupings of umbrae, with penumbrae, arranged in a rough line with a few umbral spots scattered about and between these. Both the p-spot and f-spot consisted of several larger umbrae with penumbrae, but the middle spot appeared to be a collection of small umbrae in rudimentary penumbra. By JUN 11 there had been much development. The p-spot now contained several large umbrae in penumbra with a detached portion containing several smaller umbrae to the S. This was followed by a scattering of umbral spots and pores. The main body of the middle spot was now split into two portions. The portion to the S consisted of a small cluster of umbral spots in a rudimentary penumbra followed by a larger naked

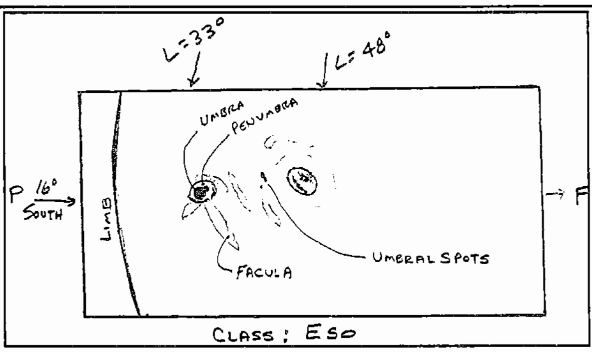

Figure 6. Drawing of AR 7858 by David Lehman. 1995 MAR 25, 18h45m UT. 25-cm f/5 Newtonian, 73X, Thousand Oaks Type II solar filter. Seeing 1.5 arc seconds.

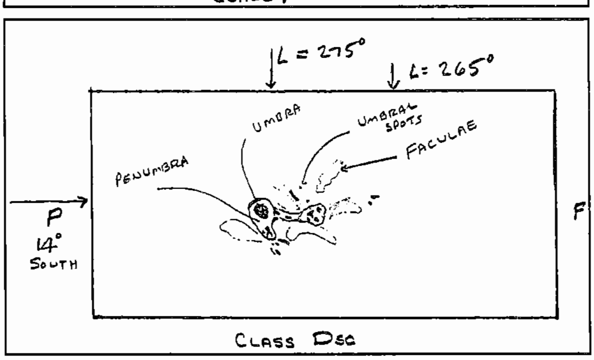

Figure 7. Drawing of AR 7858 by David Lehman. 1995 MAR 26, 17h30m UT. 25-cm f/5 Newtonian, 62X and 73X with Thousand Oaks Type II solar filter. Seeing 1.0 arc seconds.

umbra. To the N was a larger umbra with rudimentary penumbra. Two parallel trains of umbral spots led SE to the f-spot which was a collection of a half-dozen umbral spots arranged in a rough N-S line with rudimentary penumbra surrounding. This was the last observation of this group, when the group, just under 300 millionths of the disk in area, spanned about 15° on the Sun.

Solar Cycle 23. Rotation 1897. 1995 JUN 12.89-1995 JUL 10.09

Relative Sunspot Numbers

		Maximum		Minimum	
Type	Mean	Value	Dates	Value	Dates
R(I)	16.0	30	JUL 01	0	JUN 15-16
R(A)	16.8	29	(3 days)	0	JUN 15-16

This cycle saw an increase in activity from very low to low levels. There were 11 active regions designated (AR 7878-88) although they were smaller than those of the previous rotation. For the most part the groups reached a maximum development of Cao or Cai with two professional stations occasionally reporting Dai or Dao. Of the 11 regions only two were observed by the Section, **AR 7882** and **AR 7887**. The former was seen on only two images, not enough for analysis, but the latter had reasonable coverage.

The first observation of AR 7887 was a Maxson photograph on 1995 JUL 01 at 18h58m UT. The group then consisted of a p-spot that was a large spot with a good radial penumbra. Some umbrae following this in faculae. The p-spot was elongated E-W a day later, with an apron of penumbral material that fanned out to the E, following. Some umbral spots still followed this in a filigree of faculae. JUL 03 was the day of maximum development and area, when the group was classed Cao, 250 millionths in extent. Two good photographs by Garcia (in white light and H-α) captured the region that day. In the white light-image, at 16h29m UT, the p-spot was seen as a large umbra of irregular shape but elongated E-W with penumbra that was thin on the leading side and wider to the E. Following this were 4 umbral spots. In H- α, at 17h36m UT, the p-spot had much the same appearance with a N-S elongated plage following. There was a filament that extended from the following end of the p-spot to a point 5° N of the group. On JUL 04 the p-spot's umbra had broken into three large pieces and as many small ones, all arranged in a rough E-W line, with a symmetrical penumbra. The following umbral spots were gone as decay of the group seemed to be starting. There were no other observations until JUL 07 when the group was just past the CM. The p-spot was now a single tear-drop shaped umbra (probably several umbrae) with a radially symmetrical penumbra surrounding. The group was definitely smaller than on the JUL 04. On JUL 08 the p-spot was more circular but of about the same size. A high-resolution photograph taken at 14h15m UT by Garcia showed the single umbra to be crossed by several thin light bridges. The spot was quite circular with a nice symmetrical penumbra and a little cluster of pores about 4-5° to the E. On JUL 09, Maxson made the last observation of the region in a whole-disk photograph, showing it to be essentially unchanged.

Solar Cycle 23. Rotation 1898. 1995 JUL 10.09-1995 AUG 06.30

Relative Sunspot Numbers

		Maximum		Minimum	
Type	Mean	Value	Dates	Value	Dates
R(I)	11.6	23	JUL 20	0	(6 days)
R(A)	11.4	24	JUL 19	0	(6 days)

Activity was again very low during this rotation and possibly was the lowest of the reporting period. Only eight regions were designated during this rotation (AR 7889-96 inclusive) and all were small. The largest, **AR 7890**, was only 200 millionths in area and managed to get to Dko class for only one day. This low level of activity was met with a low level of interest by Section observers and only four observations and 12 spot maps (by Fan-Lin) were submitted. Only one of these observations was of AR 7890, which is not enough for analysis.

Solar Cycle 23. Rotation 1899. 1995 AUG 06.30-1995 SEP 02.54

Relative Sunspot Numbers

		Maximum		Minimum	
Type	Mean	Value	Date	Value	Dates
R(I)	13.6	41	AUG 26	0	(5 days)
R(A)	14.8	42	AUG 26	0	(3 days)

Activity was largely unchanged from the very low levels of the last previous rotation. There were one less, or seven, regions designated (AR 7897-7903) during this rotation, but, as the R(I) and R(A) would imply, they tended to be slightly larger in sunspot numbers. Only one group made it to a "D" class. There were only two observations submitted for this rotation, on opposite sides of the Sun, and only two spot maps, so no analysis of any active region is possible.

Solar Cycle 23. Rotation 1900. 1995 Sep 02.54-1995 Sep 29.81

Relative Sunspot Numbers

		Maximum		Minimum	
Type	Mean	Value	Dates	Value	Dates
R(I)	12.2	30	Sep 22 & 24	0	(7 days)
R(A)	12.7	34	Sep 23	0	(7 days)

Only six regions were given numbers by SEC (AR 7904-09), but they tended to have more spots than the groups of the last two rotations. Again, only one group got to a "D" class, **AR 7907**, which attained a maximum area of 180 millionths. Unlike the case with the Sun, there was an increase in activity among observers and enough observations were submitted to make a brief analysis of the activity of AR 7907.

This region was first observed by Keller on 1995 Sep 19 as three spots with faculae and one other spot on the limb. It was C-class at this time. This latter spot was designated as **AR 7908**. Four days later, on Sep 23, AR 7907 was seen in a Garcia photograph as having a clear leader and follower. The p-spot was a round umbra with a radially symmetrical penumbra and a few umbrae following some with rudimentary penumbrae. This was followed by AR 7908, which consisted of two umbrae in one penumbra. The next day, Sep 24, was the last day of observations. AR 7907 was then a single small umbra in penumbra as seen by Maxson in a whole-disk white-light image at 15h33m UT.

Conclusion

We were clearly near solar minimum during this reporting period. Nevertheless, observers need to be aware that observations of low activity are still of interest. At the present time we are nearing the solar activity maximum for Cycle 23 and have an embarrassment of riches when it comes to solar activity and observations, but the period near solar minimum should be used as a time to hone skills and techniques and to refurbish equipment.

As we endeavor to catch up with these Solar Summary Reports, making them more current (i.e., a year or so in arrears) it will become increasingly important for observers to submit reports in a more timely fashion. Some observations for this report were submitted only a few months before this was written. Such observations will "miss the boat" once we have caught up and this will be a loss not just for the observer, but for the entire Section.

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1) *Solar-Geophysical Data (Prompt Reports)*, Part I, no. 603, Nov., 1994.
2) ________, no. 604, Dec., 1994.
3) ________, no. 605, Jan., 1995.
4) ________, no. 606, Feb., 1995.
5) ________, no. 607, Mar., 1995.
6) ________, no. 608 Apr., 1995.
7) ________, no. 609, May, 1995.
8) ________, no. 610, June, 1995.
9) ________, no. 611, July, 1995.
10) ________, no. 612, Aug., 1995.
11) ________, no. 613, Sep., 1995.
12) ________, no. 614, Oct., 1995.
13) ________, no. 615, Nov., 1995.

Sources used for the computation of the R(A) values quoted in this report:

14) *Sky & Telescope*, *88*, no. 3, Sep., 1994, p. 103.
15) ______, *88*, no. 4, Oct.., 1994, p. 109.
16) ______, *88*, no. 5, Nov., 1994, p. 103.
17) ______, *88*, no. 6, Dec., 1994, p. 103.
18) ______, *89*, no. 1, Jan., 1995, p. 112.
19) ______, *89*, no. 2, Feb., 1995, p. 108.
20) ______, *89*, no. 3, Mar., 1995, p. 110.
21) ______, *89*, no. 4, Apr., 1995, p. 100.
22) ______, *89*, no. 5, May, 1995, p. 104.
23) ______, *89*, no. 6, June, 1995, p. 99.
24) ______, *90*, no. 1, July, 1995, p. 102.
25) ______, *90*, no. 2, Aug., 1995, p. 109.
26) ______, *90*, no. 3, Sep., 1995, p. 93.
27) ______, *90*, no. 4, Oct., 1995, p. 99.
28) ______, *90*, no. 5, Nov., 1995, p. 101.
29) ______, *90*, no. 6, Dec., 1995, p. 94.

Solar Classification Key:

Groups (Modified Zurich System)

First Letter—**A** = Single pore or non-polar group of pores. **B** = Bipolar; without penumbrae. **C** = Bipolar; penumbra on one end. **D** = Bipolar; penumbrae at both ends; length <10°. **E** = Bipolar; penumbrae at both ends; length 10°-15°. **F** = Bipolar; spots at both ends; length >15°. **H** = Unipolar; penumbra; diameter >2°.5.

Second Letter (Penumbra of Largest Spot)—**X** = No penumbra. **R** = Rudimentary penumbra partly surrounds largest spot. **S** = Small, symmetric penumbra, elliptical or circular; single umbra or compact cluster of umbrae; <2°.5 N-S. **A** = Small, asymmetric penumbra; irregular; <2°.5 N-S. **H** = Large symmetric penumbra; >2°.5 N-S. **K** = Large asymmetric penumbra; >2°.5 N-S.

Third Letter (Spot Distribution)—**X** = (Unipolar). **O** = Open; few or no spots between leader and follower. **I** = Intermediate; numerous spots between leader and follower. **C** = Compact; many large spots between leader and follower.

Magnetic Characteristics

α = Unipolar. β = Bipolar. γ = Complex polarity. δ = Opposite polarity umbrae in a single penumbra.

Flares

Class (values are areas in millionths of solar disk)—**S** = Subflare; <100. **1** = 100-250. **2** = 250-600. **3** = 600-1200. **4** = >1200.

Brilliance—**f** = Faint. **n** = Normal. **b** = Bright.

X-Ray Importance (Peak Flux in watts/sq. meter; followed by numerical multiplier)

B = 10^{-6}. **C** = 10^{-5}. **M** = 10^{-4}. **X** = 10^{-3}.

Fifty Years Ago: A Selection from The Strolling Astronomer, July 1, 1949 (Vol. 3, No. 7), "Observations and Comments," p. 8.

[C.B.] Stephenson on May 25 [1949] made a rather unusual observation of Mercury between $1^h\ 30^m$ and $1^h\ 50^m$ [UT] with a 6-inch refractor. He had an impression with both 90X and 200X, though more readily with the lower power, that the unilluminated portion of the planet was barely visible as a dark area on the brighter sky. The impression of the visibility of this dark hemisphere was heightened by a feeling that the dark limb itself could be seen. The value of i [the phase angle] at the time was 148° so that Mercury was closer to inferior conjunction than it is usually followed, and the planet's elongation from the sun was about 15°. Sunset occurred at Stephenson's station at $1^h\ 10^m$ so that he was watching Mercury by fairly bright twilight. The observation is reminiscent of the similar appearance sometimes imputed to the dark hemisphere of Venus near inferior conjunction; see, for example, The Strolling Astronomer, Vol. 2, No. 8, pg 4, 1948. Stephenson directs attention to an observation of Mercury on May 19, 1896, by Leo Brenner, who saw very clearly what Stephenson only suspected on May 25, 1949. Brenner observed Mercury between 10^h and 11^h, U.T., and on a forenoon sky. His report is in J.B.A.A., Vol. 6, pg 387. Probably using a 7-inch refractor, Brenner was astonished to see both spots on the disc and the dark side surrounded by an aureole. He says in part: "Fearing to be the victim of an optical illusion I tried various eyepieces (powers 146, 196, 242, 310, 410), changed the position of the planet in the field and shook the telescope, but both phenomena remained unchanged (respectively dancing with the illuminated disc in the same manner), so that there remained no doubt. Besides, after having made the drawing...I called Mrs. Manora, who believed for the first moment that it was Venus, as the appearance was so similar. She pronounced the dark side and the aureole to be very conspicuous objects, saying that she saw them at the first look, whilst she saw the spots on the illuminated disc later. The dark side was darker than the sky, just as I (with one single exception) have always found it in the case of Venus..." The italics are Brenner's own. Stephenson has computed the value of i to be 112° at the time of Brenner's observation. One can think of several possible explanations of this curious visibility of the dark hemisphere of Mercury (and Venus):

1. Illusion. Stephenson does not insist on the reality of his own impressions of May 25 but points out that Brenner appeared very confident. Also, on June 16, 1948, Stephenson, H.M. Johnson, and W. Lorenz all agreed that the dark hemisphere of Venus was visible and was darker than the daylight sky.

2. The silhouetting of the planet against an extensive solar corona or the Zodiacal Light, which would explain at once why the dark hemisphere would be darker than the sky-background. Probably this effect explains the common observation of the visibility of the outline of Mercury just off the disc of the sun at transits. Since Mercury was comparatively far from the sun's place in the sky on May 25, 1949, and on May 19, 1896, it would appear necessary to suppose the outer corona or the Zodiacal Light to have been abnormally bright on those dates. The aureole would now have to be supposed illusory.

3. The refraction, reflection, diffusion, etc. of sunlight in the atmosphere of the planet. This matter is not worthy of serious consideration for an aureole seen as close to dichotomy as Brenner's.

4. The occasional creation of an aurora in the planet's atmosphere by the arrival of particles emitted by the sun. Only a very rare atmosphere would here be needed. Since the planet is closer to the sun than the earth is, very extensive auroral activity might be more common. However, an aurora would tend to make the dark hemisphere brighter than the sky, whereas the observers have thought it darker, and would give rise to an aureole (Stephenson noticed none).

Jupiter and the South Temperate Dark Spot of 1998: A Preliminary Report

By: John W. McAnally, Assistant Coordinator, Jupiter Section (Transit Timings), Association of Lunar and Planetary Observers, with a Foreword by Glenn Orton, Jet Propulsion Laboratory

Abstract

This paper discusses the discovery and subsequent observations of an intense, dark spot in the South Temperate Belt of Jupiter during the 1998-1999 Apparition. The feature's physical appearance, rates of drift, and some conclusions are also presented along with an overview of the interaction of the Jupiter Section with members of the professional community.

Foreword

By Glenn Orton

Jupiter, a planet replete with observable phenomena, is a target for both casual and serious amateur astronomers. During the course of the Galileo Mission to Jupiter, it was necessary to plan well in advance the timing and pointing of instruments at atmospheric features of interest to Galileo investigators during its primary and extended missions. This requirement forged alliances between amateur astronomers and Galileo atmospheric investigators. This report details the case of a feature that came to the attention of the amateur community, and subsequently became an interesting and intriguing feature for Galileo scientists who were interested in Jupiter's atmospheric structure and dynamics. The utility of a base of amateur observations for the spacecraft was thus demonstrated. It is, in fact, only one example of several such cases for the Galileo Mission. The mission is not yet over, and the Cassini Mission observations of Jupiter and Saturn are yet to take place. While Cassini will have the benefit of a wide-field camera that was not in place for Galileo, it will not be operating so continuously that scientists looking at Saturn's atmosphere will be monitoring the development and evolution of features of great interest to the Cassini investigators. There, again, the value of amateur observations of the planet could prove invaluable.

Introduction

Due in great part to amateur astronomers, a continuous observational record of Jupiter has been maintained for over 100 years. The belts and zones of the planet exhibit periodic changes, many of which reoccur over sufficient time. These changes include the presence or absence of spots at various latitudes.

During the 1998-1999 Apparition of Jupiter, the most observed feature on the planet, second only to the Great Red Spot and the merged South Temperate Ovals, was a new, dark spot which formed in the southern portion of the South Temperate Belt (STBs). Spots and streaks have been recorded in the STB during past apparitions. The A.L.P.O. Jupiter Section staff found several examples in Section archives of disk drawings and strip sketches depicting features similar to the 1998 spot. However, the 1998 spot appears to be exceptional in its intensity.

This new feature was first reported to the A.L.P.O. Jupiter Section by Harry Pulley on 1998 Jun 20 (Universal Time [UT] is used throughout this report for dates and times). An interim report by John Rogers of the BAA [Rogers, 1998] indicated the spot had first been imaged as early as 1998 May 20. Isao Miyazaki believed he had tracked the dark spot since 1997 October and sent his files to Glenn Orton of the Jet Propulsion Laboratory (JPL). Dr. Orton correlated Miyazaki's images with IRTF [the NASA Infrared Telescope Facility on Mauna Kea] Galileo support images, and found that, at a wavelength of 4.78 microns, there had indeed been a bright spot where Miyazaki indicated [Orton, 1999]. The spot was subsequently observed on 1998 Jul 19 by Tom Dobbins, whose sighting was reported by *Sky & Telescope* magazine in its October, 1998 issue [Roth, 1998]. The sighting of this new feature stimulated great interest worldwide and led to an interesting series of events in the astronomical community.

The Observations

Pulley observed the transit of a very intense, small dark spot in the South Temperate Belt (STB) at 198° (Sys II) [System II; the rotational system of Jupiter applied to features north of the south edge of the North Equatorial Belt and south of the north edge of the South Equatorial Belt, except for the south edge of the North Temperate Belt; the assigned rotational period is 9h 55m 40.6s] on 1998 Jun 20. His was the first report of this feature received by the A.L.P.O. Jupiter Section. On 1998 Jun 25, John Sabia observed the transit of a dark spot on the STB at 197° (Sys II). Then, once again Pulley observed the transit of the following end of a dark spot on the STB at 197° (Sys II) on 1998 Jul 02. Earlier, Walter Haas had reported the timing of the preceding edge of a dark spot on the STB at 191° (Sys II) on 1998 Jun 11.

On 1998 Jul 14, Pulley again observed a transit of the spot at 194° (Sys II). On that same date James Tomney recorded the transit at 198° (Sys II). Thus the spot drifted 4° in decreasing longitude from 1998 Jun 20 to Jul 14, producing a drift rate of -5°.0/30 days; in other words, relatively stationary. On 1998 Jul 20, a CCD image obtained by Terry Platt at central meridian (CM) 167° (Sys II), definitely placed the spot on the southern edge of the STB (STBs).

By late July, 1998, the A.L.P.O. Jupiter Section staff believed there existed convincing evidence for a new feature on Jupiter and issued an Alert Message via the J-Net (Internet) on 1998 Jul 22. The feature was given the designation STB Dark Spot # 1 (STB DS #1). A copy of the alert was also transmitted to *Sky & Telescope* and *Astronomy* magazines.

After 1998 Jul 14, the drift rate of the spot increased. On 1998 Jul 19, both Claus Benninghoven and Dobbins observed a transit of the spot at 188° (Sys II). From 1998 Jul 14 to 1999 Feb 21 the dark spot drifted from 194° (Sys II) to 079° (Sys II) or -115°, giving a drift rate of -15°.47/30 days. From the later date forward, the spot exhibited this fairly constant rate of drift Also, after 1998 Jul 19 the spot was continuously observed by observers all over the world.

As the apparition continued, many simultaneous or near-simultaneous CM transit timings of the spot were made and reported to the A.L.P.O. Jupiter Section. These observations provided excellent confirmation of the spot's position at a high level of reliability. On 1998 Aug 28, Haas timed a CM transit at 171° (Sys II) and on 1998 Aug 29, McAnally timed a transit at 169° (Sys II). On 1998 Oct 31, data from Zac Pujic and Donald Parker (Parker's images are shown in *Figure 1,* below) agreed on the position of the spot at 138° (Sys II). On 1999 Feb 04, Haas, Cecil Post, and McAnally all timed a transit of the spot which yielded a position within 4° of each other, giving a mean position of 088° (Sys II). Worldwide participation was so intense there were few occasions that a transit was not reported at least twice a week.

The A.L.P.O. Jupiter Section issued another J-Net alert on 1998 Sep 21, reporting a second dark feature in the STB (STB Dark Spot #2), and received an inquiry from Glenn Orton of JPL requesting addi-

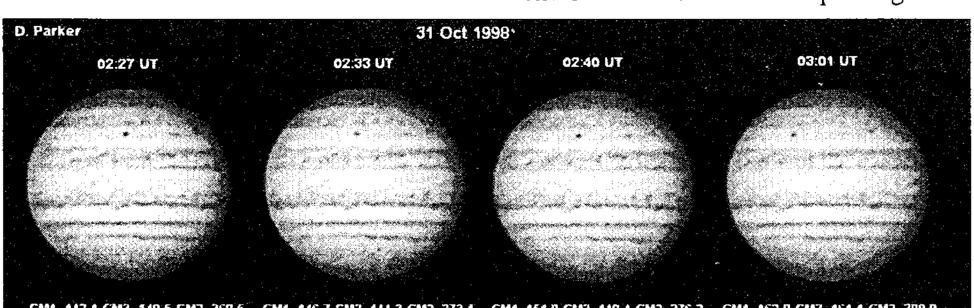

Figure 1. CCD images of Jupiter by Donald Parker, showing the central meridian transit of South Temperate Dark Spot #1 (above center). Grey-scale rendition of RGB color original. South at top.

tional data. Dr. Orton is one of the Galileo Interdisciplinary Scientists. He was especially interested in predictions of the future location of the two spots (STB DS #1 and #2). The A.LP.O. Jupiter Section provided this information along with the calculated rate of drift. Dr. Orton's intent was to observe Jupiter with the NASA Infrared Telescope Facility (IRTF) Near Infrared Camera NSFCAM from Mauna Kea for three full nights starting on or about 1998 SEP 27. At the same time, Dr. Terry Martin was to observe from Palomar Observatory using a middle-infrared camera and spectrometer. Dr. Orton also anticipated they would "capture" the dark spot with 27-micron observations made with the radiometer portion of the Galileo Photopolarimeter-Radiometer (PPR) sequence on Galileo's orbit number 17. The Palomar and IRTF coverage was of the entire disk of Jupiter. Dr. Orton also believed they would be able to get very precise positions from the 5-micron radiances on IRTF images. As the date for the special observation approached, the A.L.P.O. Jupiter Section continued to transmit new position reports to Dr. Orton. Arrangements were made for e-mail communications to be augmented, if necessary, by telephone to the IRTF summit telephone [Orton, 1998]. After the observing run, Dr. Orton indicated the observations had been productive.

As the apparition progressed, it became apparent that South Temperate Dark Spot #1 would soon arrive at the longitude of the GRS (Great Red Spot). A.L.P.O. Jupiter Section calculations indicated that the dark spot would be in conjunction with the following (higher longitude) edge of the GRS on 1999 FEB 21 and an alert message was sent via J-Net calling for observations. The center of the GRS had been steady at 066° (Sys II) and its following edge had been reported at 070°-074° (Sys II) throughout the apparition. The following edge of the Red Spot Hollow (RSH) had been reported at 079°-082° (Sys II). On 1999 JAN 27 a CCD image by Parker indicated the dark spot was located at 094° (Sys II), just 12° from the following edge of the GRS/RSH. On 1999 FEB 04, Haas, McAnally, and Post each observed the dark spot at 088° (Sys II). The following edge of the GRS was located at 072° (Sys II) on that date (the GRS appeared as a shrunken ellipse inside the RSH throughout the apparition). On 1999 FEB 21, Toshihiko Ikemura indicated the dark spot was at 079° (Sys II), just preceding the following edge of the RSH. This was the last observation obtained by the A.L.P.O. Jupiter Section. As of 1999 MAR 07, the IRTF was still following the spot, which appeared to be moving at the previously calculated rate of drift of -15°.47/30 days [Orton, 1999]. Afterward, the anticipated journey of the dark spot into or around the GRS was unreported.

PHYSICAL APPEARANCE

From the very first observation, STB DS #1 was characterized as a small, intensely dark spot in the STBs. Most observers reported visually that the intensity of the spot approached that of a satellite shadow. McAnally's first observation indicated the spot was very small and not immediately seen; however, once seen it literally jumped out at the observer and gave the appearance of a very dark and tiny "pencil spot", just south of the STB. Many CCD images were obtained during the apparition. On images obtained by Parker, the spot usually appeared darkest in green light. On color CCD images (RGB), the spot appeared dark, brownish-red to almost black. Throughout the apparition, the spot retained its small, round shape. Dr. Orton, in a message to the A.L.P.O. Jupiter Section, indicated that "at 5 microns (thermal radiation at cloud tops) from the IRTF, the dark spot shows up as a very bright feature. That means it is essentially devoid of clouds and—at our highest resolution—means it is a doughnut shaped feature—bright on the outside and dark on the interior. In the visible, that almost undoubtedly corresponds to a dark ring surrounding a lighter center..." [Orton, 1998].

CONCLUSIONS

The origin of the South Temperate Dark Spot #1 and why it should form will take further study. After its discovery, for a short period of time there was speculation that the spot might be a new impact site from a Shoemaker-Levy 9 remnant. The sighting of the spot in 1998 July spurred interest, as it was believed by some that it might be the possible appearance of impact results from SL-9 debris in the same plane as the old comet orbit that Jupiter was just passing [Orton, 1999]. This was soon discounted as the spot did not take the form of the now, well-known, impact scars. Dr. Orton believes that:

"..the visibly dark and 5-micron bright feature represents a region relatively devoid of clouds. At 27-microns, sensitive to the actual temperature of Jupiter near the pressure level of 0.3 bars, the feature appears to be warmer than its surroundings, meaning that the feature is likely to be a result of 'indirect circulation': air is being forced together, forcing it to warm up, and (based on the 5-micron information) forced to sink. The air at altitude is likely to be drier, having moved upward and all the water and ammonia having condensed away already; thus, when it descends, it will be devoid of the things that would condense and cause cloud formation- What makes such a feature dark is probably that the clouds below it are quite dark,...an interesting conclusion that is possibly pertinent to the chemistry of the clouds' particles themselves" [Orton, 1998].

According to recent information from Dr. Orton, the original dark spot faded, but has been replaced by "an equally bright (at 4.78 microns) one there now, as of last fall". He has persuaded the Near-Infrared Mapping Spectrometer (NIMS) and Solid-State Imaging (SSI) experiment teams to target this spot on Galileo orbit Callisto-22 (mid-August). There is also HST (Hubble Space Telescope) observing time scheduled at that point, and Keck time has been requested [Orton, 1999]. This feature therefore remains of great interest.

When first sighted in 1998 June, STB DS #1 was almost stationary, drifting at only -5°/30 days (*Figure 2*, p. 112). After 1998 Jul 14 the drift rate of the spot suddenly increased to, and was sustained at, -15°.47/30 days. The drift-rate of the dark spot indicates it resides in the south temperate current (STC). The STC is one of the steadiest of jovian currents, exhibiting a rate of -12°/30 days in 1990 and averaging -15°/30 days from 1880 to 1940 [Rogers, 1994]. The change in drift rate perhaps indicates the spot moved from the center of the STB to the STBs. Other dark spots were also observed in the STB during the apparition; however, none were as dark nor as compact as the South Temperate Dark Spot (STB DS #1). All exhibited a rate of drift consistent with that of the STC.

While conjunction with the GRS was unreported, the possible survival of the dark spot is of great interest. Observers are urged to attempt the recovery of this feature during the next apparition (1999/2000).

We thank the many observers who contributed data. Each one will be acknowledged by name in a future, complete apparition report. During the apparition, 90 usable transit timings of the dark spot were obtained from observers all over the world, from 1998 Jun 15 to 1999 Feb 21. Without the support of these observers, our record would be incomplete.

We also thank Glenn Orton of the Jet Propulsion Laboratory for allowing us to participate with him and his group during the apparition.

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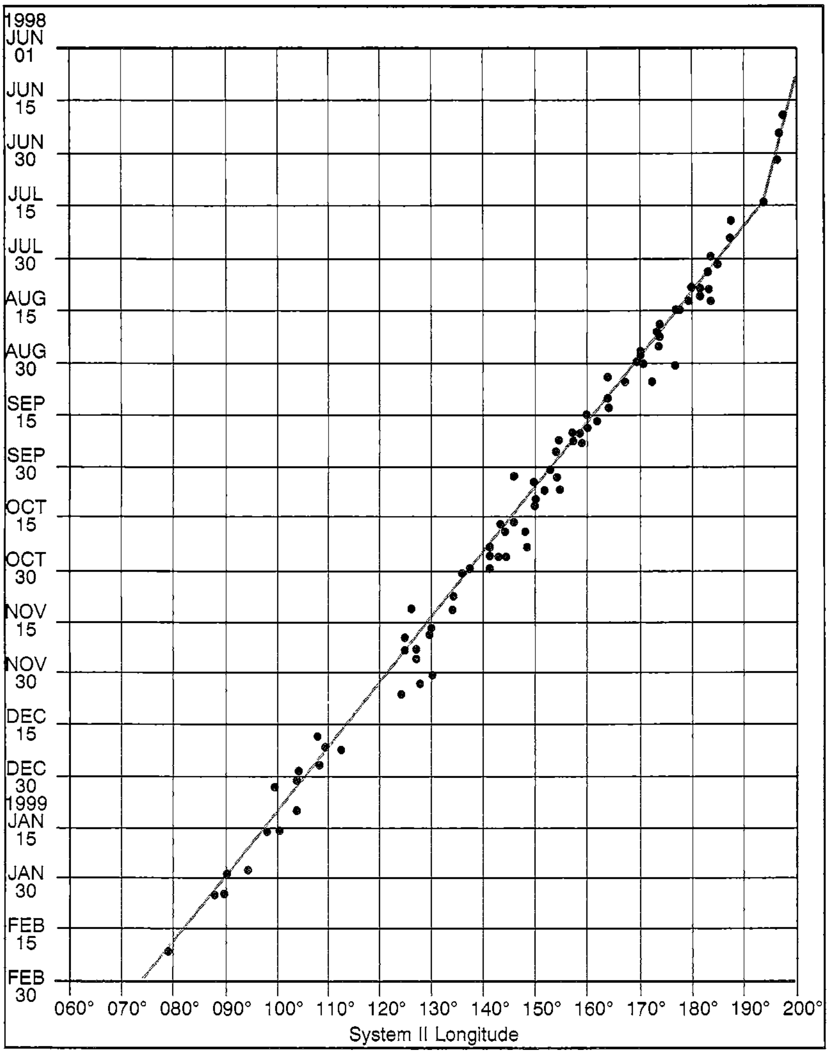

Figure 2. Drift chart of System II longitude of South Temperate Dark Spot #1 as observed during the 1998/99 Apparition of Jupiter.

Observations of Comet Hale-Bopp

By: Richard Schmude, Jr.*, Steve Micciche and Ann Donegan

Abstract

Before perihelion passage, the apparent visual magnitude of comet Hale Bopp was best represented by: $M = -0.30 + 5 \log[\Delta] + 6.86 \log[r]$. ($\Delta$ = comet-Earth distance and r = comet-Sun distance). The coma size decreased as the comet approached the Sun but increased afterwards. The degree of condensation increased as the comet approached perihelion and then dropped afterwards. The peak apparent visual magnitude was observed to be -0.6 to -0.7 during late March and early April, 1997. Steve Micciche and Ann Donegan discovered a fragment of Hale-Bopp on 1997 Mar 30 in one of their photographs; the fragment is estimated to have had an apparent visual magnitude of +8.7±0.5 and a surface area of 0.4 km^2.

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Introduction

Alan Hale, located in Cloudcroft NM, and Tom Bopp, in Stanfield AZ, independently discovered a new comet on 1995 Jul 23 [Machholz, 1996, 5]. [All dates and times in this article are in Universal Time (UT).] This was the first comet find for the second half of 1995 and was given the designation of C/1995 01, but is more commonly referred to as Comet Hale-Bopp. Within four days of discovery, the scientific community realized that Comet Hale-Bopp was unique because of its great distance at discovery. Over the next 11 months, 1008 position measurements of the comet were obtained and were used by Don Yeomans to calculate orbital elements; [Yeomans, 1997] these orbital elements are listed in *Table 1*, below, and were used in this report.

In this report, Schmude has estimated the total apparent visual magnitude, coma diameter and the degree of condensation for Comet Hale-Bopp over a 1.40-year period with 11×80 binoculars. The degree of condensation represents how diffuse or compact a comet coma is. During the study period, the comet-Sun distance, r, changed from 4.4 astronomical units [A.U.; the mean Earth-Sun distance; 149.60 million km] down to 0.9 A.U. and then back up to 2.9 A.U. The observing site remained constant for the coma size and degree of condensation studies. The magnitude measurements of Hale-Bopp were used in estimating the brightness of a fragment of Hale-Bopp discovered on 1997 Mar 30 by S. Micciche and A. Donegan.

Table 1: Orbital Elements for Comet Hale-Bopp, Determined by Yeomans (1997); Epoch 1996 Sep 04.

Element	Value
Eccentricity	0.9953
Perihelion Distance	0.9144 A.U.
Perihelion Date	1997 Apr 01.12 UT
Longitude of Ascending Node	282°.47
Argument of Perihelion	130°.57
Inclination	089°.43

Instruments and Observations

A pair of 11×80 binoculars were used in making all estimates of magnitude, coma size and degree of condensation. The procedure described by Bishop [1996, 191] was used in estimating all comet magnitudes. This method involves de-focusing the star image and comparing it to the focused image of the comet. Comparison star magnitudes were obtained from the American Association of Variable Star Observers (AAVSO) star atlas [Scovil, 1990]. The coma size was estimated by comparing it to the distance between two stars that are plotted in the AAVSO star atlas. The degree of condensation was estimated on a scale from 0 to 9; a value of 0 represents a diffuse coma and a value of 9 represents a compact coma with a bright inner coma.

The coma diameter (d) in kilometers was calculated from the equation:

$$D = \Delta \sin(d) \qquad (1)$$

where d is the estimated angular size of the coma and Δ is the comet-Earth distance in kilometers. No "aperture effect" changes or extinction corrections were made to any of the measurements in this report.

On one occasion, a 0.5-meter Newtonian telescope was used in making a large-scale photograph of the nucleus. The photograph was taken with a 35-mm camera and Kodak 100 ISO color print film. In addition, Steve Micciche and Ann Donegan used a 180-mm f/2.5 lens along with Kodak PPF 400 film to take a wide-angle picture of Hale-Bopp from Utah; this photograph shows the comet along with a comet fragment and is reproduced here as *Figure 3* (p. 117).

Visual Results

Figure 1 (below) graphs the visual apparent total magnitude estimates for Comet Hale-Bopp. The horizontal axis is the date given as days before perihelion; for example 1997 Feb 01 was 59 days before perihelion.

A total of 97 magnitude estimates were made of comet Hale-Bopp before perihelion and these data have been fitted to the two-parameter Equation (2):

$$M = H_0 + 5 \log [\Delta] + 2.5n \log [r] \quad (2)$$

where Δ and r are the comet-Earth and comet-Sun distances respectively, in A.U.; M is the total apparent visual magnitude of the comet, H_0 is the absolute magnitude and n is a variable related to how quickly the comet brightens as it approaches the Sun (H_0 and n are the parameters). The absolute magnitude (H_0) is the magnitude the comet would have were it exactly 1.0 A.U. from both the Earth and Sun. The H_0 estimates for pre-perihelion data are plotted in *Figure 2* (p. 115). The data were fitted to Equation (2) and the best least-squares fit yielded the line in Figure 2. The slope (n) and y-intercept (normalized magnitude [H_0] for a comet-Sun distance of 1 A.U.) are listed in *Table 2* (p. 115). Values for H_0 and n were determined for three situations: before perihelion, after perihelion and combined (the combined values include all data). There is some discrepancy between the pre- and post-perihelion values, but this has been observed in other comets [Whipple, 1978, 347; Green, 1995, 174]. The uncertainties are larger for the post-perihelion values because there were fewer data and the comet was lower in the sky after perihelion; the low elevations meant higher uncertainties due to atmospheric extinction. The British Astronomical Association (BAA) found values of H_0 = -0.5 and n = +2.88 based on all of their data both before and after perihelion (through April, 1997) [Shanklin, 1997, 9]. The BAA values are close to those determined from all 118 magnitude estimates in this study. The light curve in Figure 2 is similar to the one compiled by Charles Morris up through March 1997 [Aguirre, 1997a, 31].

The uncertainties for H_0 and n include both random and possible systematic errors. The random error (E_r) is calculated from the equation:

$$E_r = \sigma/\sqrt{N} \quad (3)$$

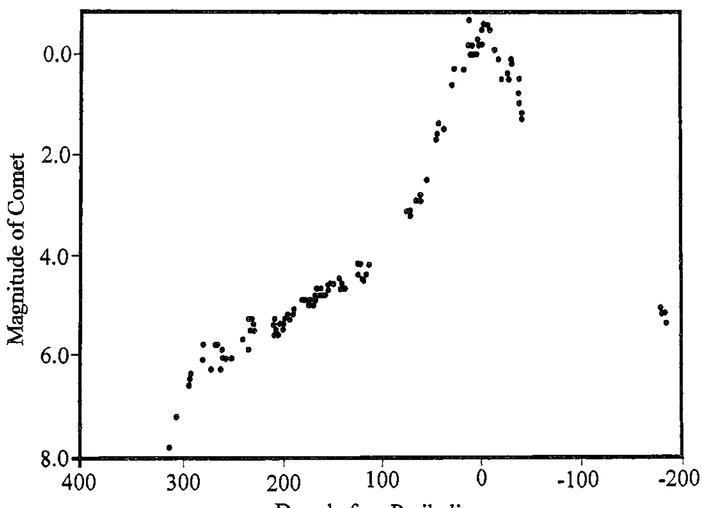

Figure 1. Graph of observed visual apparent total magnitudes of Comet Hale-Bopp, as estimated by R. Schmude using 11X80 binoculars. The horizontal axis gives the number of days before the perihelion date of 1997 Apr 01.12 UT; the negative values indicate dates after perihelion passage.

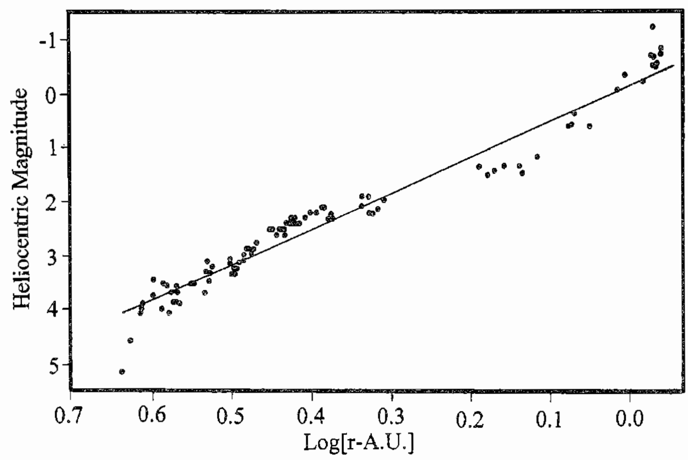

Figure 2. Graph of normalized heliocentric magnitudes of Comet Hale-Bopp (H_0). The horizontal axis gives the logarithm of the comet-Sun distance (r) in A.U.

Table 2. Values for the Normalized Magnitude (H_0) and n Calculated for Comet Hale-Bopp.

(N is the number of magnitude estimates.)

Time period	H_0	n	N
Pre-Perihelion	-0.30±0.14	+2.75±0.39	97
Post-Perihelion	-1.01±0.22	+3.23±0.69	21
All data	-0.61±0.17	+3.00±0.49	118

where σ is the standard deviation and N is the number of data points, N = 97 for the magnitude estimates made before perihelion. Before perihelion, the random error for H_0 was ±0.03 magnitudes and for n was ±0.04 magnitudes/log r, whereas the corresponding values after perihelion were ±0.05 and ±0.10. There are two potential sources of systematic uncertainty, which arise from atmospheric extinction and differences in color between the comet and the comparison stars. The magnitude of each of the two sources of uncertainty are estimated to be 10 percent before perihelion, which corresponds to ±0.1 for H_0 and ±0.275 for n. Uncertainties were 15 percent for the data after perihelion, which corresponds to ±0.15 in H_0 and ±0.48 in n. Uncertainties for "all data" values in Table 2 are an average of the pre-perihelion (weight 2) and post-perihelion (weight 1) data. The total uncertainty, U_{tot}, for H_0 (before perihelion) is calculated from:

$$U_{tot} = [(0.03)^2 + (0.1)^2 + (0.1)^2]^{0.5}$$

$$U_{tot} = \pm 0.14 \qquad (4)$$

The total uncertainty for n is calculated in a similar manner, giving values of ±0.39 before perihelion and ±0.69 after perihelion. The uncertainties for the degree of condensation and coma size were calculated from Equation 3.

The H_0 value of comet Hale-Bopp is 7 to 8 magnitudes brighter than the H_0 value for a typical comet [Whipple, 1978, 347-349] and this is undoubtedly due to the large surface area of the Hale-Bopp nucleus, which was measured as 1600 km^2 [IAU Circ. 6587].

Table 3 (p. 116) shows the average values for the degree of condensation and coma size in 50-day timespans, the mean comet-Sun distances in A.U. and the number of estimates in each time interval. As the comet approached the Sun, its coma size decreased and its degree of condensation increased; similar trends were observed for Comet Aarseth-Brewington [Machholz, 1997, 132]. Both of these trends are probably due to a combination of increasing solar wind strength and higher temperatures as the distance to the Sun decreased. Both the coma size and degree of condensation had returned to their 1996 values by 1997 Oct 01, which lends support to the suggestion that the comet-Sun distance is a controlling factor in the appearance and size of the coma.

Photographic Results

Both the tail and inner coma of the comet were photographed with the 0.5-m Newtonian telescope in Villa Rica, Georgia on 1997 Mar 16 at 11h00m UT with Kodak 100 ISO color print film. The inner coma and the planet Mars were both photographed using the eyepiece projection method at an effective focal ratio of f/120 so that the angular size of Mars served as a scale with which to measure the angular size of the inner coma.

Table 3. Estimated Values for the Degree of Condensation and Coma Diameter for Comet Hale-Bopp, with the Mean Comet-Sun Distance for Each Time Interval.

(The values in parentheses give the number of observations for each time interval.)

Days before Perihelion	Comet-Sun Dist. (A.U.)	Degree of Condensation	Coma Diameter (10^5km)
300 to 350	4.5	1.5±1.0 (2)	1.8±0.6 (3)
250 to 300	3.9	2.4±0.7 (14)	2.2±0.4 (15)
200 to 250	3.4	3.6±0.5 (14)	1.9±0.4 (13)
150 to 200	2.8	3.3±0.4 (26)	1.9±0.3 (23)
100 to 150	2.2	3.4±0.3 (14)	1.6±0.1 (10)
50 to 100	1.6	6.7±1.4 (7)	1.2±0.3 (7)
0 to 50	1.0	6.8±0.4 (9)	1.3±0.2 (7)
-50 to 0	1.0	6.9±0.2 (18)	1.1±0.2 (5)
-150 to -200	2.8	3.3±0.7 (3)	1.8±0.2 (4)

The angular size of the inner coma changed with respect to the exposure time; for example, the inner coma had an angular size of 8 arc seconds with a 30-second exposure but was only 4.5 arc seconds in a 5-second exposure. These two angular sizes correspond to respective diameters of 7700 and 4300 km. Two concentric arcs on the Sunward side of the nucleus were visible. The outer edges of these arcs were 164±1 and 314±1 arc seconds from the center of the inner coma which correspond to respective distances of 15,000 and 30,000 km. The arc closest to the inner coma was the brighter of the two. These results are consistent with the near-infrared image made by James DeYoung on 1997 Mar 24 [Aguirre, 1997b, 31]. If the rotational period of the nucleus is 11.47±0.05 hours [IAU Circ. 6583] then the mean outward velocity of the arcs can be determined from Equation 5:

$$V = S/R \qquad (5)$$

where V is the mean radial velocity of the arcs, S is their separation, and R is their rotation period. A resulting velocity of 360±30 m/s was calculated. This result is consistent with data from others [IAU Circ. 6560, 6575, and 6600].

Fragment of Comet Hale-Bopp

Steve Micciche and Ann Donegan photographed comet Hale-Bopp on 1997 Mar 30 at 03h00m UT using a 180-mm f/2.5 lens with Kodak PPF400 film; the photograph covered an area of 8°X10°. Inspecting the photograph, these two observers discovered a fragment of comet Hale-Bopp located approximately 8° behind the comet nucleus. This fragment was located approximately at Right Ascension 01h 08m and declination +52° (1950 coordinates); more precise positions will be reported by Micciche and Donegan. Their discovery photograph is reproduced in *Figure 3* (p. 117).

The fragment's brightness was compared to the brightness of seven nearby stars whose magnitudes are listed in the AAVSO Atlas [Scovil, 1990]. The fragment was estimated to be at magnitude +8.7±0.5; the large uncertainty is due to possible differences between photographic and visual magnitudes. The fragment is therefore about 9 magnitudes (or 4000 times) fainter than comet Hale-Bopp. If the dust and gas production rates per unit surface area on the fragment are equal to that of the parent body then the fragment has a surface area of 1600 km^2/4000 = 0.40 km^2. A single spherical object with a radius of 0.17 km will have a surface area of 0.40 km^2. This object is estimated to have a mass of 10^{10} kg if it is a single object with a density and surface-to-volume ratio similar to that of Comet Halley. Tozzi and co-workers [1996, 1089], however report that three fragments of Comet Hyakutake were probably swarms of particles instead of a three single objects and this may have also been the case with the Hale-Bopp fragment.

Conclusions

The absolute magnitude of Comet Hale-Bopp was calculated to be -0.30 ±0.14 based on pre-perihelion data, corresponding to a value of n = +2.75±0.39. We conclude that Comet Hale-Bopp did not become dimmer as a result of increased solar phase angle, calculating an upper limit of 0.008 mag/degree for the solar phase angle coefficient. On the other hand, we conclude that the coma size and the degree of condensation did change with comet-Sun distance. A comet fragment was photographed on 1997 Mar 30 and its magnitude is estimated to be +8.7±0.5, which is consistent with a surface area of 0.40 km^2.

Figure 3. Photograph of Comet Hale-Bopp by Steve Micciche and Ann Donegan on 1997 Mar 29, 11h00m UT. 180-mm focal length, f/2.5 lens with Kodak PPF400 Film. This reproduction covers an area about 8°.3 high × 5°.6 wide; celestial north is at the upper left and the bright star immediately above the comet's head is ω And. The comet fragment upper left) is indicated by an arrow and is shown enlarged in the inset in the upper left corner.

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A.L.P.O. Web Site Wins Griffith Observatory Star Award

The web site of the Association of Lunar and Planetary Observers (http://www.lpl.arizona.edu./alpo/) has been selected to receive the Griffith Observatory Star Award for the week of September 26-October 2, 1999, "for excellence in promoting astronomy to the public through the World Wide Web."

Although awarded each week, each Star Award is permanently awarded to its recipient. We are acknowledged, along with other recipients, at http://www.GriffithObs.org/StarAward.html. The Star Award is shown to the right. We commend the A.L.P.O. webmeister, Board member, and Solar Coordinator, Richard E. Hill, for creating and maintaining our award-winning web site.

A CELESTIAL RARITY: THE MERCURY GRAZE TRANSIT ON 1999 NOV 15

By: John E. Westfall, Coordinator, A.L.P.O. Mercury/Venus Transit Section

ABSTRACT

The Transit of Mercury on 1999 Nov 15 is a very rare event where, for some locations, the planet will graze the Sun's limb. This article describes transits in general, and the visibility zone of this event, including the regions where a partial and a total transit will occur. The viewing conditions in the Americas, the Pacific Basin, Australia and New Zealand is discussed. Equipment and visual, photographic and electronic forms of observation are covered. A section describes recording and reporting one's observations, followed by a table of local circumstances for selected places.

PLANETARY TRANSITS

A planetary transit occurs when an inferior planet, which is to say Mercury or Venus, pass between the Earth and the Sun. Typically a transit will take several hours between *Ingress* and *Egress*. *First Contact* refers to exterior limb contact during Ingress, which is over at *Second Contact*, or interior limb contact. Egress commences with *Third Contact* and ends with *Fourth Contact.*

In an average person's adult lifetime perhaps eight transits of Mercury will occur. Given weather and longitude restrictions, assuming that the person will not travel to the events, perhaps only three will be seen. Thus these are rare, but not once-in-a-lifetime phenomena. However, the November 15, 1999 Transit of Mercury is more remarkable; it is the only "graze transit" that has occurred since the invention of the telescope.

The term "graze transit" means that observers in some areas will see the planet notch the limb of the Sun, but never completely enter the disk. Observers elsewhere in the visibility zone, however, will see a complete transit with all four limb contacts. Mercury's path near the solar limb means that this event offers a unique chance to record any unusual limb-contact phenomena, such as any light or dark boundary or "aureole" around the planet, or the famous "black drop" effect. This transit will be relatively brief, only about an hour for most of the total transit zone, but ingress and egress will be unusually prolonged, lasting about 11-12 minutes for most areas, but reaching over 20 minutes near the graze line.

THE 15 NOV 1999 TRANSIT

Figure 1 (p. 120) shows where this transit will be visible; roughly the Pacific Basin, most of the Americas, Australia and New Zealand. The Americas will see the event in the afternoon, Australia and New Zealand in the morning, Alaska and Hawaii near noontime, while the Sun will be nearly overhead in Tahiti. Throughout the visibility zone, mid-transit will occur within one minute of 21h41m Universal Time.

In Figure 1, the "Graze Line" crosses the South Pacific, the Northern Territory and Queensland in Australia, and the North Island of New Zealand. Observers north of this line will see a complete transit; those to the south will see Contacts One and Four only. Sites near the graze line will be the most favorable for recording any optical phenomena associated with limb contacts. Even the maximum spacing between Mercury's limb and that of the Sun at mid-event will be only slightly over 6 arc-seconds, less than Mercury's 10 arc-second apparent diameter.

Two unusual conditions result from this being a graze transit. First, because the duration is so brief, the entire event will be visible for most of the visibility zone, with only narrow longitude bands where just ingress or egress can be seen; egress only on the western margin of the visibility zone and ingress only on its eastern margin. Second, unlike with "normal" transits, one's location will strongly affect the duration of the transit, as well as whether it will be total or partial, as is shown for three representative locations in *Figure 2* (p. 121).

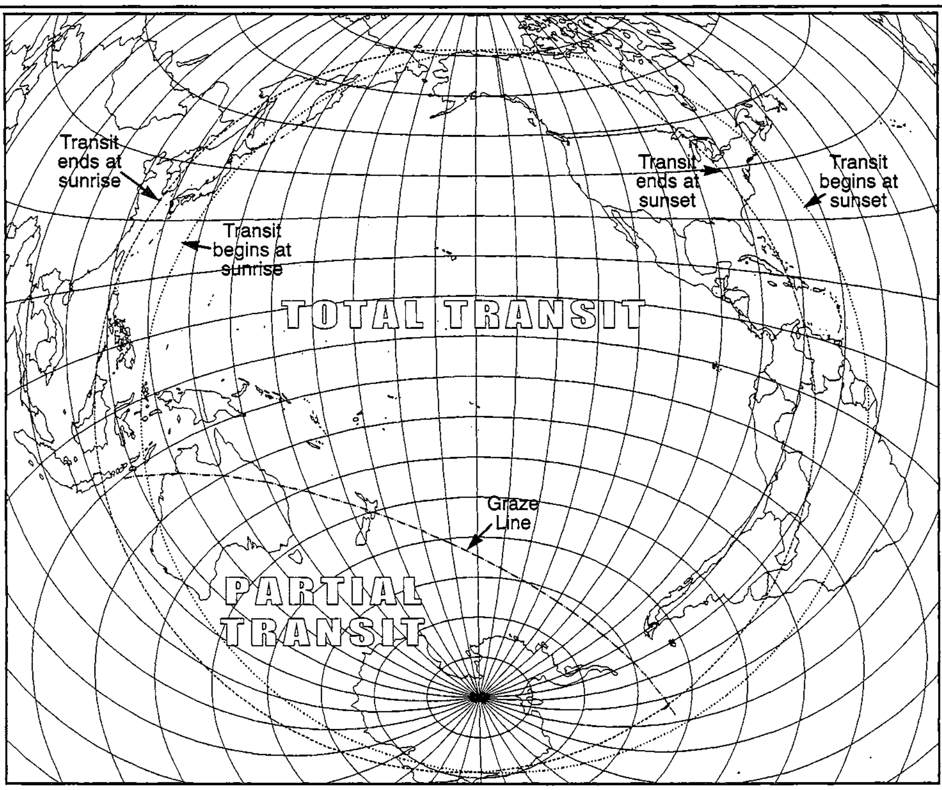

Figure 1.Visibility zone for the 1999 Nov 15 Transit of Mercury.

The View From North America

From most of the United States and Canada the entire transit will be visible in the southwestern afternoon sky. The altitude of the Sun in this area at mid-event is shown in *Figure 3* (p. 121). Note that, unfortunately, viewers in the Northeastern United States and eastern Canada will see only ingress, if they see even that. Observers in these areas, if they are free to move, should travel southwest, where the Sun will be higher in the sky and the chances of clear skies are greater; see *Figure 4* (p. 122).

Except for the critical factor of solar altitude, the transit circumstances do not differ much throughout the contiguous United States and southern Canada: ingress and egress will each last 10-11 minutes, while the entire duration will be 58-59 minutes. (Detailed forecasts for selected sites are given on pp. 127-128.)

St. Louis is a fairly typical North American vantage point, and its transit appearance has been plotted, and times given, in Figure 2.

Watching From the Pacific Basin

All the Pacific Ocean, except its westernmost part, lies in the visibility zone (see *Figure 5*, p. 123). Beside Australia and New Zealand, discussed later, this area includes many islands and island groups. In the United States proper, Hawaii appears the most favorable viewing site, assuming skies are clear; from there the limb-to-limb separation of Mercury and the Sun at mid-transit will be only 4.4 arc-seconds, ingress and egress each take 12.5 minutes, the transit duration is 56 minutes, and the solar altitude 49° at mid-event.

Farther south, in Tahiti, the mid-transit limb-to-limb spacing has dropped to 2.3 arc-seconds, ingress and egress duration has risen to almost 15 minutes, and the Sun's altitude is 89°. Indeed, as Figure 5 shows, at places like Fiji, New Caledonia, or New Guinea, the mid-transit limb-to-limb spacing has dropped to approximately 1 arc-second, while ingress and egress each last 16-18 minutes for those places. Note that the lee sides of islands offer the best chances for clear skies.

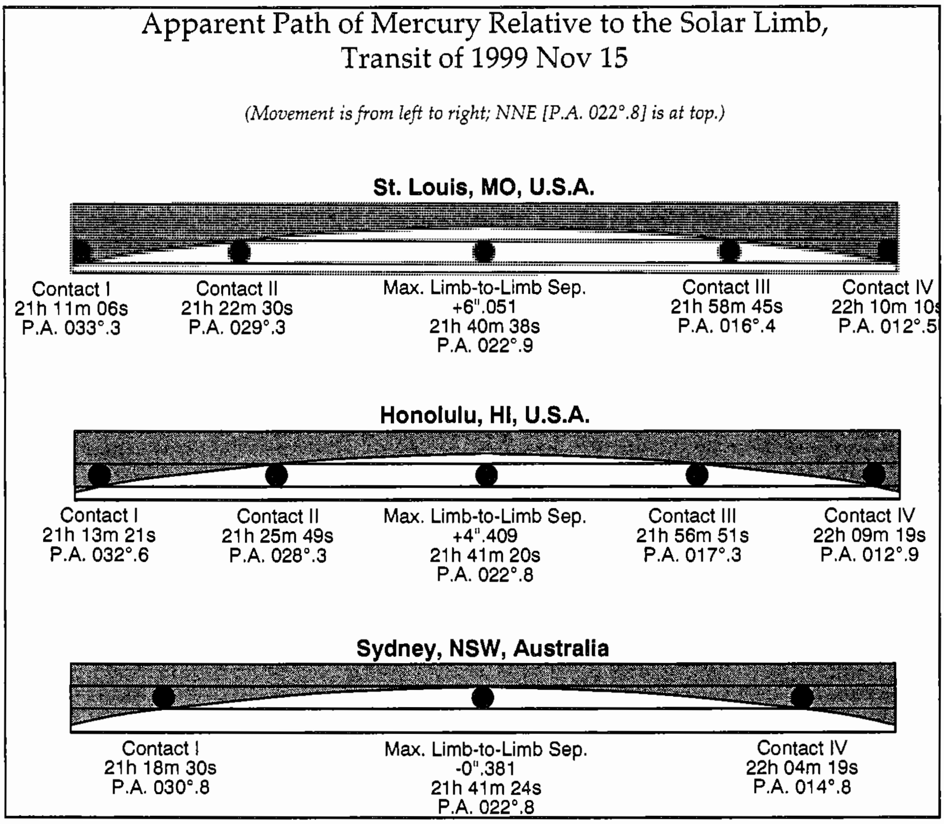

Figure 2. Path of Mercury relative to the solar limb, 1999 Nov 15, for three selected sites.

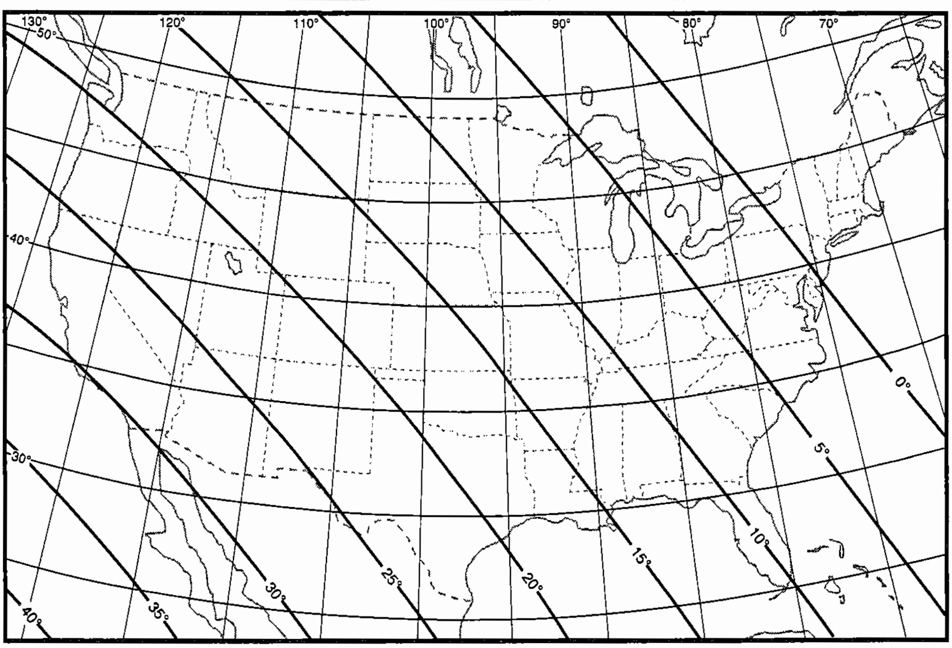

Figure 3. Altitude of Sun at mid-transit, contiguous United States and southern Canada, Transit of Mercury, 1999 Nov 15.

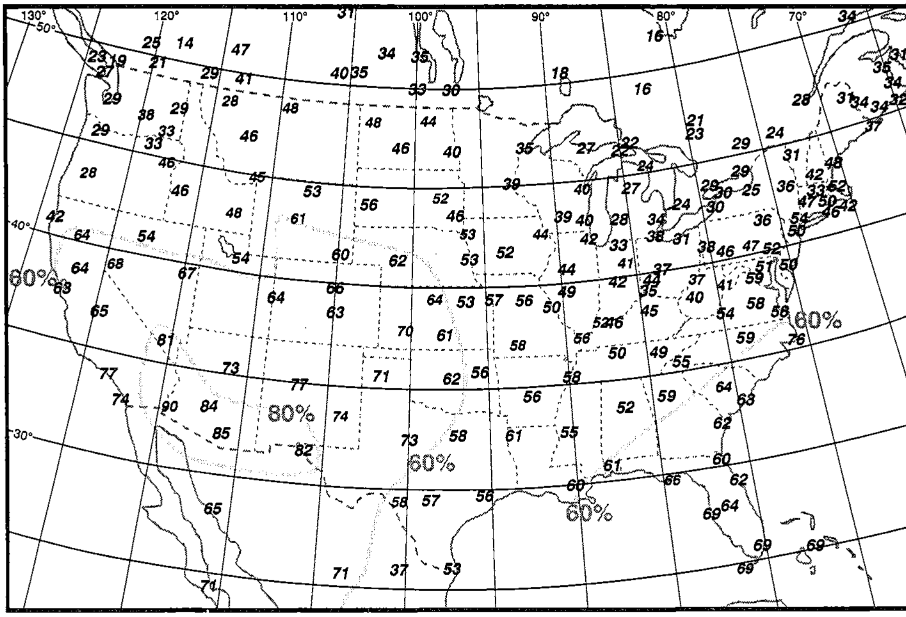

Figure 4. Percentage of possible sunshine, November mean, contiguous United States and southern Canada.

Sources: Environment Canada, U.S. Weather Service, Rudloff (1981), and Ruffner and Bair (1987).

AUSTRALIA AND NEW ZEALAND

These two countries have an opportunity to see Mercury's limb graze, or at least very closely approach, the limb of the Sun.

For southern and western Australia (*Figure 6*, p. 124), and for the South Island of New Zealand (*Figure* 7, p. 125) a partial transit will occur, such as is diagrammed for Sydney in Figure 2. In such areas, Mercury will appear only partly projected onto the Sun's disk for the entire duration of the transit, about 44-47 minutes. This will be a good opportunity to watch for any possible light phenomena on the portion of Mercury's limb when outside the Sun's disk. Also, observers in these areas who are equipped with H-α filters can attempt to see Mercury's disk silhouetted against the solar chromosphere.

The graze line crosses the Northern Territory and Queensland in Australia and the North Island in New Zealand. Observing sites near this line will be very favorable places to study the area between Mercury's "outer" (north) limb and the Sun's limb, especially as regards the "black drop" effect and the appearance of any "light bridge" between Mercury's limb and the sky. At places very near the graze line, such as Brisbane, the duration of ingress and egress can reach 22 minutes, leaving only a few minutes between Second and Third Contacts.

In Australia, the chance for clear skies in November, in Southern-Hemisphere late Spring, are good throughout most of the Northern Territory and Queensland, particularly inland from the Queensland coast where some places along the Flinders and Landsborough Highways experience more than 80 percent of possible sunshine. In New Zealand, conditions appear best near the northeast coast of the South Island and the southeast coast of the North Island.

THE TRANSIT FROM LATIN AMERICA

Almost all Latin America will be able to see this event, excepting easternmost Brazil. Because of its great latitudinal extent, the transit circumstance vary markedly over this area. In northern Mexico, at the National Observatory in Baja California, the mid-event limb-to-limb separation is 5.7 arc-seconds and ingress and egress each last 11.6 minutes. Conditions at the southern extreme are approximated by Buenos Aires, with a limb separation of only 1.6 arc-seconds and an ingress/egress duration of 15.9 minutes.

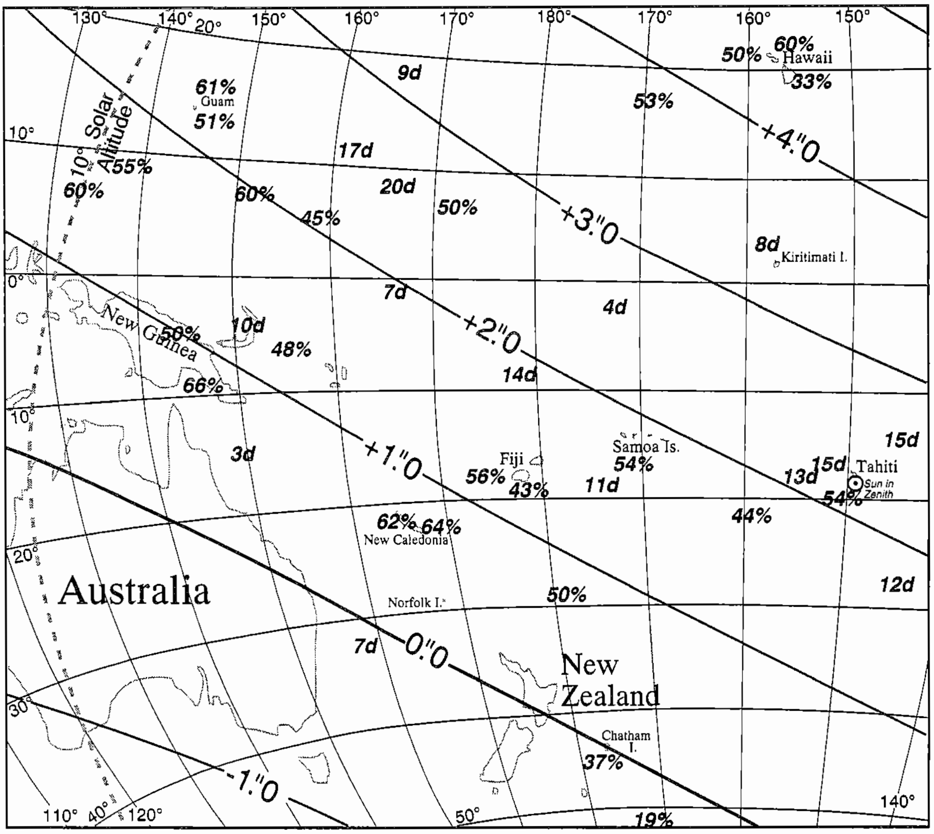

Figure 5. Transit of Mercury, 1999 Nov 15, viewing conditions for Pacific islands.

Values on diagonal lines show mid-event limb-to-limb separation; negative values indicate a partial transit. "%" is November percentage of possible sunshine; "d" is mean November days with precipitation; after Rudloff (1981) and Pearce and Smith (1998).

The Sun's altitude at mid-transit also varies considerably within Latin America. Western Mexico enjoys a solar altitude over 30°, and Central America and the west coast of South America experience altitudes of 15° or greater. The Sun unfortunately is lower in the Caribbean, Venezuela, Bolivia, Paraguay, Uruguay, and Argentina, but all these countries' territories should see all or most of the transit. Unfortunately only the western and southwestern portions of Brazil will see the transit at all, and this area does not include the metropolitan centers of Saõ Paulo and Rio de Janeiro.

Prospects for clear skies in November also differ greatly across Latin America. Some areas with particularly favorable weather conditions are western Mexico (60-82 percent of possible sunshine), the lee side of Caribbean islands (72-75 percent), the northern coast of Venezuela (56-82 percent), and the Argentine Pampas (47-78 percent).

The Far East

Unfortunately, prospects for viewing this transit from East Asia or the island groups offshore are not good because the transit occurs close to local sunrise. Sites in mainland China or Southeast Asia will see nothing of the event. Those on the east coast of Korea will, with favorable conditions, see egress very low in the sky. Conditions are better from eastern Siberia, particularly on the Kamchatka Peninsula.

The Sun will be above the horizon at egress throughout Japan, almost all the Philippines, and western Indonesia. Sadly, no population centers in this area will experience transit ingress, and, at best, egress will occur when the Sun is very low above the southeastern horizon. Added to this difficulty is the fact that the probability of clear skies is below 50 percent for most of this area. Serious observers in this region are advised to travel to the Pacific islands or to Australia.

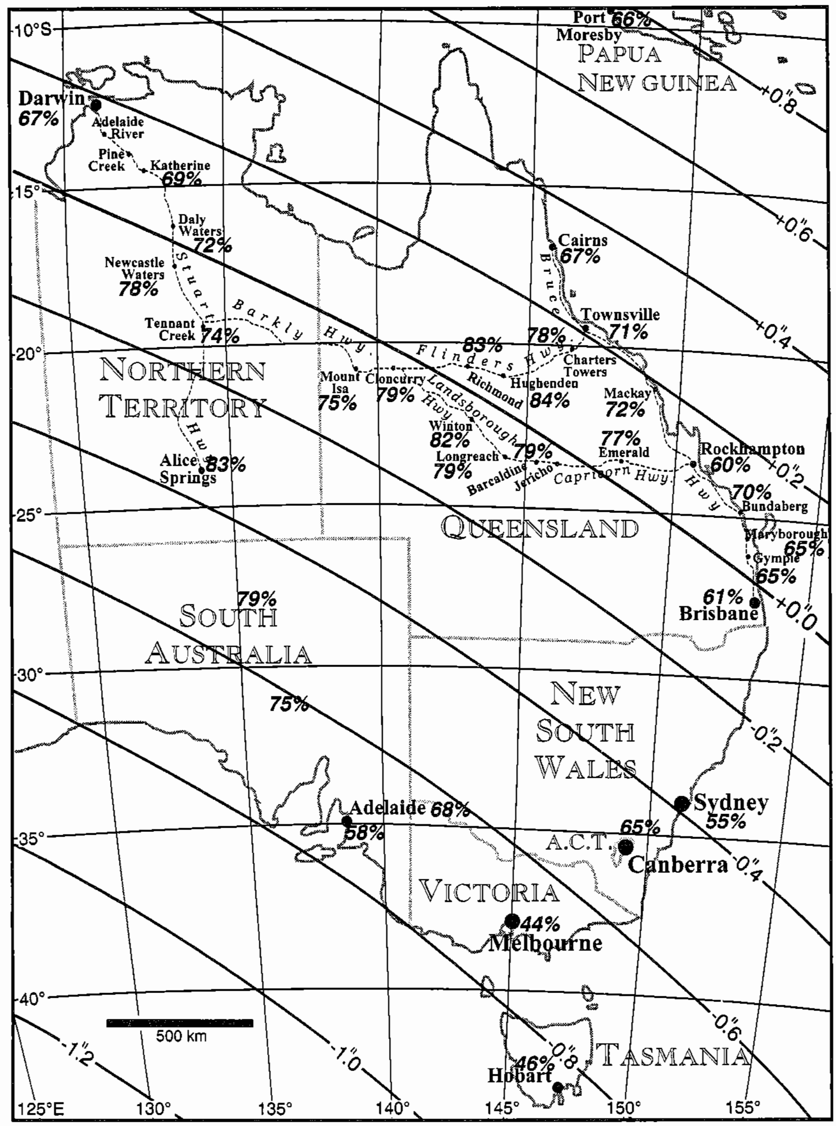

Figure 6. Transit of Mercury, 1999 Nov 15, viewing conditions for eastern Australia.
Values on diagonal lines show mid-event limb-to-limb separation; negative values indicate a partial transit. "%" is November percentage of possible sunshine).

Observing the Transit

Observing sunspots is a better analogy to transit observation than is eclipse watching; Mercury will be a small dark spot, just 10 arc-seconds across and darker than any spot's umbra. Observing the event by eyepiece projection is possible, but difficult because Mercury's diameter will be only about 1/200 that of the Sun's; only 1 millimeter on a 20-cm solar disk.

Thus direct viewing is recommended, which requires using a full-aperture solar filter, either aluminized glass or aluminized mylar. With Mercury's small apparent size, good seeing, excellent optics, and high magnification are needed for visual work. With photography or electronic imaging (CCD or video), substitute "long effective focal ratio" for "high magnification."

From any location, Mercury will always be very near the Sun's limb, so limb darkening will make the planet more difficult to make out, especially near Contact 1 and Contact 4. The limb-darkening effect is less at longer wavelengths, so using a warm-hued filter like the Wratten #12, #15, #25, or even the #29 will be helpful.

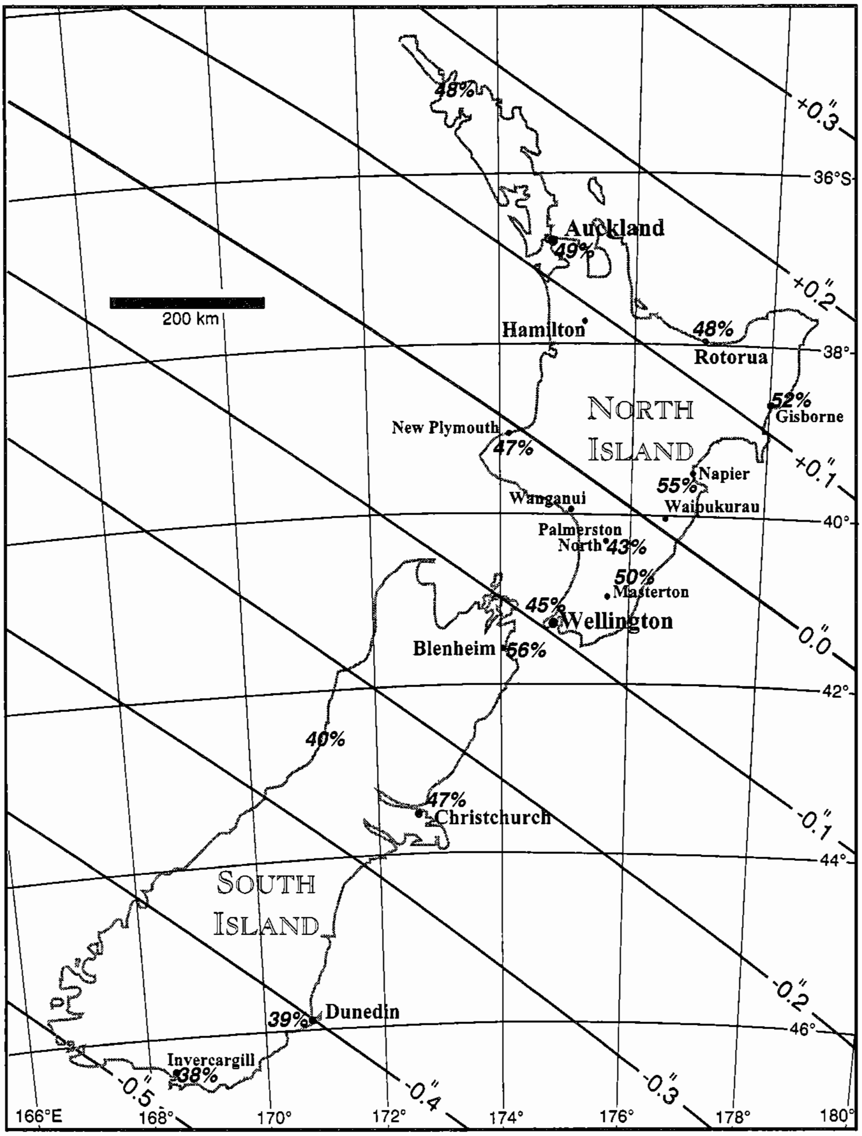

Figure 7. Transit of Mercury, 1999 Nov 15, viewing conditions for New Zealand.

Values on diagonal lines show mid-event limb-to-limb separation; negative values indicate a partial transit. "%" is November percentage of possible sunshine).

One specialized form of observation would be using an H-α filter to see the planet silhouetted against the solar chromosphere. Indeed, because Mercury's path will be very near the Sun's north pole,the planet may be visible before First Contact and after Fourth Contact, outlined against polar spicules; or even against quiescent prominences because we are approaching solar maximum.

In white light, or with a broadband filter, the following observations can be made:

Record Contact Times.—Use a short-wave receiver and a tape recorder to record the signals and your spoken comments; if you videorecord the signals, comments can go on the audio track. When transcribing, or making written notes, record timings in Universal Time to 0.1-second precision. First Contact is usually observed late, although you can run a videotape backward in order to time this event more accurately. The First, Second, and Third Contacts can usually be timed. The chief scientific value of contact timings is to accurately determine the solar diameter; the 1999 Nov 15 transit is particularly valuable for this because of the long ingress and egress durations and the fact that the planet passes very near the Sun's north pole, giving a precise polar diameter and helping to measure the amount of polar flattening. Of historical interest is determining the value of the solar parallax by comparing your times with those predicted, or with the timings made by another, far-distant, observer.

Black-Drop and Related Phenomena.—Near the time of Second and Third Contacts, the zone between Mercury's "outer" limb and the Sun's limb undergoes complex changes; rarely is there a clean break between them to give a precise contact time. Often, a filament appears for a while to connect the two limbs, giving Mercury the famous "black drop" appearance. Sometimes a greyish zone will appear between the two limbs. Recording this appearance via video, CCD, or photography will be especially valuable for this event because the limb separation will increase by only 0.4-0.9 arc-second per *minute* of time. Drawing the appearance of Mercury at intervals throughout the transit will also be useful.

Unusual Optical Phenomena.— Sometimes other unusual appearances are reported that probably are not physical phenomena but rather may be due to optical effects in the Earth's atmosphere, the telescope, the eye, or the camera. Such effects as light or dark bands around Mercury during a transit, one or more light spots on Mercury, or even a grey appearance to the planet's entire disk, were frequently reported during historical transits.

To study such phenomena, a telescope at least 90 mm in aperture is recommended, with a safe full-aperture solar filter and possibly a warm-hued eyepiece filter as well. For drawing, a magnification of 100X is a minimum, and 200X or higher if seeing allows. Given the resulting narrow field of view, an equatorial clock-driven mounting will be a great convenience.

For photography or electronic imaging, a long effective focal length and clock drive are essential. With film photography, Kodak Technical Pan 2415 is the best black-and-white emulsion, and can be used with a deep-red or H-α filter. Indeed, there seems little justification for color photography, except possibly for convenience, and to record optical phenomena due to atmospheric differential refraction (dispersion), particularly if the planet is low in the sky.

Videotaping is another way to record the transit, allowing time signals and comments to be recorded on the audio track. If recording through an eyepiece, use high-magnification. If you can remove the camera lens, use a Barlow lens or eyepiece projection to give a large image scale. Note that most CCD chips, including those used in camcorders, are sensitive into the far red and even the near infrared so deep red or near-infrared filters can often be used.

The same guidelines apply to CCD images as videotaping. During ingress and egress, take CCD images as rapidly as you can. Even with, say, 15 seconds between successive images, the spacing between Mercury's limb and the Sun's will have changed by only 0.2 arc-seconds. Thus CCD images should provide a complete record of all phenomena, even though they cannot be used for precise contact timing.

However you observe, record the necessary supporting information: Your full name, postal address, and e-mail address if applicable; observing conditions, including latitude and longitude to 1 arc-minute and elevation to 100 meters, atmospheric seeing and transparency, and any interruptions to observation; telescope type, aperture, and magnification or effective focal ratio; film type and exposure if applicable. For any image the Universal Time should be recorded to 1-second precision. Submit observations can to our Section (address below) in the form of hardcopy, NTSC videotapes, or digital JPG or GIF images.

CONCLUSION

You may wish more information to take full advantage of the observing opportunity that this unusual event offers. A 31-page *Observer's Guide to the Transit of Mercury, 1999 Nov 15* is available from the writer (P.O. Box 16131, San Francisco, CA 94116 U.S.A. $US 4.00 for orders from the United States, Canada, and Mexico; $US 7.00 for other countries; make checks out to "John Westfall"). The writer can also supply an observing form and predictions of your local circumstances for the transit if you send him a stamped self-address envelope, stating your latitude and longitude.

Undoubtedly the popular astronomy magazines will also provide information about this transit as the date approaches. Meanwhile, the table below gives predicted circumstances for selected locations throughout the area the transit will be visible. The A.L.P.O. Mercury/Venus Transit Section welcomes inquiries and, before long, your observations wherever you plan to observe within the visibility zone.

References

Espenak, Fred. 1998. "Transit of Mercury 1999." In; Bishop, Roy, ed. *Observer's Handbook 1999*. Toronto: The Royal Astronomical Society of Canada. pp. 177-180. See also Mr. Espenak's webpage: http://sunearth.gsfc.nasa.gov/eclipse/OH/transit99.html

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(Note: Mike Rushford plans a real-time webcast of the transit at: http://sunmill.uml.edu/eyes/tv.html)

Appendix. Transit of Mercury, 1999 Nov 15: Local Circumstances for Selected Sites.

Note: These predictions use ΔT = +65s and are based on the formulae and parameters given in Meeus, 1989. Within the United States, the times agree to ±1-2 seconds with those in *Astronomical Phenomena for the Year 1999.* Near the zero-maximum-separation line the differences are greater; e.g.,that publication predicts a total, rather than a partial, transit for Brisbane. The differences may be due to Meeus taking Mercury's diameter as 2439 km [Meeus, 1989, p. 16] instead of 2439.7 km as used by the U.S. Nautical Almanac Office. A negative maximum limb to-limb distance indicates a partial transit. In the column "Ing./Egr. Dur.", the values are the means of the ingress and egress duration; or only the ingress duration if egress is unobservable; the two differ at most by a few tenths of a second. Times are given as mm:ss. Altitudes are unrefracted.

Location	Contact I		Max. Limb-to-Limb Dist.				Contact IV		Ing./Egr. Dur.
	UT 21h	P.A. °	Dist. "	UT 21h	P.A. °	Alt. °	UT 22h	P.A. °	sec
United States									
Atlanta, GA	11:10	033.2	5.88	40:32	022.9	+9.3	09:55	012.5	690
Chicago, IL	11:02	033.3	6.13	40:38	022.9	+7.3	10:15	012.5	682
Denver, CO	11:15	033.3	6.06	40:47	022.9	+18.7	10:19	012.5	683
Fairbanks, AK	11:42	033.2	6.03	41:13	022.8	+6.7	10:44	012.4	685
Honolulu, HI	13:21	033.3	4.41	41:20	022.8	+49.2	09:19	012.9	748
Houston, TX	11:21	033.2	5.77	40:36	022.9	+19.3	09:52	012.6	694
Las Cruces, NM	11:27	033.2	5.82	40:45	022.9	+25.6	10:04	012.5	692
Los Angeles, CA	11:37	033.2	5.78	40:53	022.8	+29.8	10:09	012.5	693
Memphis, TN	11:10	033.2	5.95	40:36	022.9	+12.6	10:02	012.5	688
Miami, FL	11:21	033.1	5.55	40:25	022.9	+9.7	09:30	012.7	702
New Orleans, LA	11:17	033.2	5.77	40:33	022.9	+15.4	09:49	012.6	694
New York, NY	11:02	033.3	----	-----	-----	-----	------	-----	686
Pago Pago, Amer. Samoa	15:56	031.7	1.86	41:20	022.8	+68.9	06:45	013.8	915
Philadelphia, PA	11:02	033.3	6.01	40:32	022.9	-0.1	------	-----	686
St. Louis, MO	11:06	033.3	6.05	40:38	022.9	+10.7	10:10	012.5	684
San Francisco, CA	11:37	033.2	5.85	40:57	022.8	+28.4	10:17	012.5	690
San Juan, Puerto Rico	11:39	033.0	5.06	40:16	022.9	+0.7	------	-----	722
Seattle, WA	11:25	033.3	6.10	41:00	022.8	+19.5	10:34	012.4	682
Tucson, AZ	11:31	033.2	5.79	40:47	022.8	+27.5	10:04	012.5	692
Washington, DC	11:03	033.3	5.99	40:32	022.9	+1.6	------	-----	687

Location	Contact I		Max. Limb-to-Limb Dist.				Contact IV		Ing./Egr. Dur.
	UT 21h	P.A. °	Dist. "	UT 21h	P.A. °	Alt. °	UT 22h	P.A. °	sec
Latin America									
Asunción, Paraguay	14:18	032.0	2.18	40:04	022.9	+6.8	05:50	013.9	891
Bogotá, Columbia	12:14	032.7	4.40	40:14	022.9	+13.0	08:13	013.1	750
Buenos Aires, Argentina	14:59	031.7	1.56	40:05	022.9	+10.0	05:12	014.1	951
Caracas, Venezuela	11:59	032.8	4.65	40:12	022.9	+4.2	-----	-----	739
La Paz, Bolivia	13:33	032.2	2.96	40:07	022.9	+33.6	06:40	013.6	831
La Paz, Mexico	11:36	033.1	5.51	40:37	022.9	+26.8	09:38	012.6	703
Lima, Peru	13:13	032.4	3.37	40:11	022.9	+20.8	07:10	013.4	804
Mexico City, Mexico	11:44	033.0	5.32	40:34	022.9	+28.1	09:25	012.7	710
Montevideo, Uruguay	15:02	031.7	1.52	40:05	022.9	+8.4	05:09	014.1	956
Quito, Ecuador	12:29	032.7	4.16	40:14	022.9	+18.6	08:00	013.1	762
Saõ Paulo, Brazil	14:23	031.9	----	-----	-----	-----	-----	-----	---
Valparaíso, Chile	14:45	031.8	1.86	40:09	022.9	+20.4	05:34	014.0	920
Pacific Islands									
Agana, Guam	16:00	031.8	2.14	41:44	022.8	+17.5	07:28	013.8	894
Apia, Western Samoa	15:57	031.7	1.86	41:21	022.8	+67.9	06:45	013.8	916
Hanga Roa, Easter Island	14:36	032.0	2.34	40:31	022.8	+52.7	06:25	013.7	874
Kiritimati, Kiribati	14:23	032.3	3.30	41:16	022.8	+68.1	08:10	013.3	806
Nouméa, New Caledonia	17:22	031.3	0.64	41:28	022.8	+48.4	05:34	014.3	1081
Papeete, Tahiti	15:13	031.9	2.28	41:04	022.8	+88.9	06:55	013.7	878
Port Moresby, New Guinea	17:24	031.3	0.78	41:38	022.8	+27.9	05:54	014.3	1060
Suva, Fiji	16:38	031.5	1.27	41:25	022.8	+59.3	06:12	014.1	981
Australia									
Adelaide, So. Australia	18:55	030.7	-0.73	41:24	022.8	+24.8	03:54	014.9	----
Alice Springs, N.T.	18:34	030.9	-0.35	41:31	022.8	+18.9	04:29	014.8	----
Brisbane, Queensland	18:09	031.0	-0.03	41:28	022.8	+36.5	04:48	014.6	----
Bundaberg, Queensland	18:03	031.0	0.08	41:30	022.8	+35.7	04:57	014.6	1263
Caboolture, Queensland	18:08	031.0	-0.01	41:28	022.8	+36.5	04:50	014.6	----
Cairns, Queensland	17:51	031.1	0.32	41:35	022.8	+28.4	05:19	014.5	1166
Canberra, A.C.T.	18:37	030.8	-0.50	41:23	022.8	+33.4	04:11	014.8	----
Darwin, Northern Terr.	18:03	031.1	0.16	41:36	022.8	+13.3	05:11	014.5	1228
Gympie, Queensland	18:07	031.0	0.01	41:29	022.8	+36.2	04:52	014.6	1316
Hobart, Tasmania	18:56	030.7	-0.83	41:18	022.8	+31.8	03:41	015.0	----
Kingston, Norfolk Island	17:40	031.1	0.32	41:23	022.8	+49.7	05:07	014.5	1160
Mackay, Queensland	17:58	031.1	0.18	41:32	022.8	+32.4	05:07	014.5	1213
Maryborough, Queensland	18:05	031.0	0.05	41:29	022.8	+36.2	04:55	014.6	1286
Melbourne, Victoria	18:50	030.7	-0.70	41:22	022.8	+30.1	03:54	014.9	----
Nambour, Queensland	18:07	031.0	0.01	41:29	022.8	+36.4	04:51	014.6	1320
Perth, Western Australia	19:16	030.6	-1.05	41:22	022.8	+5.6	03:30	015.1	----
Rockhampton, Queensland	18:02	031.0	0.10	41:31	022.8	+33.9	05:00	014.5	1250
Sandgate, Queensland	18:08	031.0	-0.02	41:28	022.8	+36.6	04:49	014.6	----
Sydney, New South Wales	18:30	030.8	-0.38	41:24	022.8	+35.2	04:19	014.8	----
Townsville, Queensland	17:57	031.1	0.22	41:34	022.8	+29.9	05:11	014.5	1201
New Zealand									
Auckland, North Island	17:47	031.1	0.12	41:16	022.8	+53.5	04:46	014.5	1238
Blenheim, South Island	18:01	031.0	-0.13	41:13	022.8	+51.1	04:26	014.6	----
Christchurch, South I.	18:09	030.9	-0.25	41:12	022.8	+49.4	04:16	014.7	----
Dunedin, South Island	18:19	030.8	-0.41	41:11	022.8	+47.0	04:04	014.8	----
Hamilton, North Island	17:48	031.0	0.09	41:15	022.8	+53.6	04:43	014.6	1252
Hastings, North Island	17:50	031.0	0.04	41:13	022.8	+53.9	04:37	014.6	1287
Napier, North Island	17:49	031.0	0.05	41:13	022.8	+54.0	04:38	014.6	1280
New Plymouth, North I.	17:54	031.0	-0.01	41:15	022.8	+52.2	04:36	014.6	----
Palmerston North, No.I.	17:55	031.0	-0.04	41:13	022.8	+52.5	04:32	014.6	----
Waipukurau, North I.	17:51	031.0	0.01	41:13	022.8	+53.6	04:36	014.6	1307
Waitangi, Chatham I.	17:47	031.0	-0.00	41:08	022.8	+55.8	04:29	014.6	----
Waitara, North Island	17:54	031.0	-0.00	41:15	022.8	+52.3	04:36	014.6	----
Wellington, North I.	17:59	031.0	-0.10	41:13	022.8	+51.8	04:28	014.6	----
East Asia									
Davao, Philippines	-----	-----	1.23	41:42	022.8	+2.2	06:28	014.1	993
Denpassar, Indonesia	-----	-----	----	-----	-----	----	05:02	014.6	----
Petropav.-Kam., Russia	13:09	032.8	4.82	41:33	022.8	+5.5	09:57	012.8	732
Tokyo, Japan	-----	-----	3.44	41:41	022.8	+3.7	08:46	013.3	802

THE 1999 LEONID METEOR SHOWER

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

The meteor shower highlight of 1999 undoubtedly will be the Leonids. Last year this shower thrilled those who braved the cold November night, with brilliant fireballs exploding overhead illuminating the sky. Is another brilliant display in order for us this year? The answer is both "yes" and "no". Unfortunately the bright fireballs in 1998 were caused by particles located near the parent Comet Temple-Tuttle. Now that the comet is much farther away from Earth than last year, a repetition of the fireball display is unlikely. However, the strongest display of overall activity occurs, not during the year of Temple-Tuttle's perihelion, but in the year following. Predictions for the maximum rate in 1999 vary from several hundred meteors per hour to truly epic storm-like proportions of many thousands of meteors per hour. Will those rates occur where you live? This is unlikely, unless you call Europe, Africa, or Western Asia home. The Earth traverses the thickest stream of particles in only a few hours so the best rates occur for limited longitude ranges. The Earth is due to pass through this region near 1999 Nov 18, 02h 00m Universal Time. This corresponds to early afternoon for the western Pacific region; late morning for eastern Asia; early morning for western Asia, Europe, and Africa; and in the evening for the Americas and the Atlantic region. Only the regions that experience their maximum activity between midnight and dawn local time will be likely to witness the Leonids in all their glory.

The night to circle on the calendar is that of Wednesday evening/ Thursday morning, November 17/18 local time. Leonid meteors appear to originate from the "Sickle" of Leo; the head of the mythical Lion. This portion of the constellation rises near 11 pm local standard time for most locations. Do not start your observing session any earlier; no Leonid activity can be seen with Leo far below the horizon. The first meteors seen will be spectacular because they just graze the upper regions of the atmosphere, allowing them to last for many seconds, covering a long angular distance in the sky. As Leo rises higher in the east, the meteors will appear shorter as the angle between their flight and your direction of view decreases. Also, as Leo rises, less meteors are blocked by the horizon so more activity can be viewed.

Considering that the shower maximum will occur on a weeknight, many people will be unable to watch the display for an extended time. Those with a limited observing window will want to know what will be the best time to watch if Leo happens to be under the horizon at the time of maximum activity. In the Americas this will be after 11 pm on Wednesday evening, the 17th; rates will have peaked before Leo has risen but good activity should be seen the remainder of the night. From the central and western Pacific regions activity should be equally strong on the morning of the 17th and after Leo rises on the morning of the 18th. Eastern and central Asia will see the best rates between midnight and dawn on Thursday the 18th. [Note that an 11-day

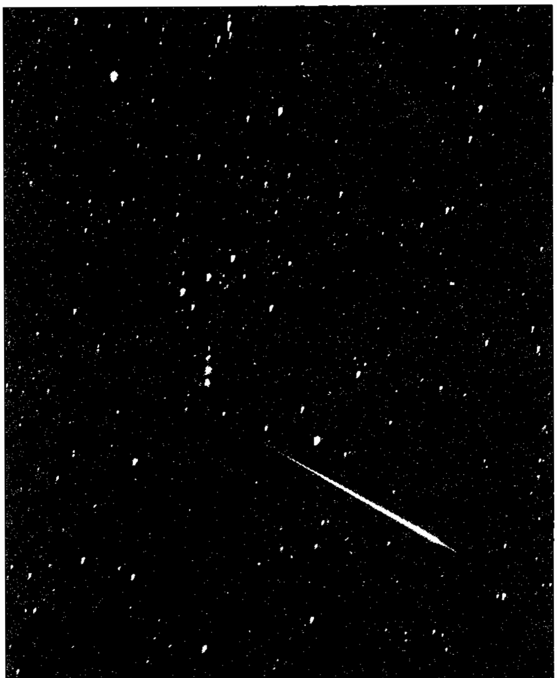

Figure 1. Leonid fireball photographed near Orion by Cecil Post, 1998 Nov 17, 11h04m-11h25m UT (meteor noted at 11h06m UT). 35-mm, f/3.5, Kodak Gold 400 35-mm Film.

Moon will interfere with meteor observing until it sets at roughly 1-2 am local time.]

Leonid meteors can be seen in any part of the sky. The most spectacular meteors (long and fast) will appear 90° from Leo. As one looks closer to Leo the meteors will tend to become shorter, slower, and more numerous. If you are watching near midnight, face east and watch the activity shoot upwards from the eastern horizon. If you look during the early morning hours, face the darkest portion of the sky, away from any interference from local lights. Keep your direction of view at least halfway up the sky so that the horizon does not block any of your field of view.

If you wish to photograph the Leonids, use film rated at ISO 400 or higher. The best camera to use is a manual single-lens reflex as the newer models with electronic shutters drain the battery quickly. Good choices for lenses are those between 28-50 mm focal length, with focal ratios of f/2.8 or faster. Use a tripod for steadiness and aim your camera high in the sky. A lockable cable release to hold the shutter open is also a necessity. For the best chance of capturing a meteor, aim the camera directly at the Sickle of Leo. The meteors seen there are short, but the odds are better of capturing one on film. To photograph more spectacular meteors (such as the Leonid pictured streaking by Orion in *Figure 1* on p. 129) aim the camera away from Leo and keep your fingers crossed! The exposure duration depends on the speed of the film and lens and the conditions of your site. Faster film (higher ISO numbers) will fog faster. A rough limit at f/2.8 for ISO 400 is 15 minutes, but 10 minutes for ISO 1000, and 5 minutes for ISO 1600. Should the night be hazy, or if light pollution is present, these exposure times should be decreased.

If you are interested in doing more than just watching the display, there are several groups dedicated to meteor observing who would interested in your hourly counts. They include the Meteors Section of the Association of Lunar and Planetary Observers (ALPOMS), the American Meteor Society (AMS), the North American Meteor Network (NAMN), and the International Meteor Organization (IMO).

The basic unit of comparison among showers is the meteors seen per hour. If you can include the sky conditions (i.e., the limiting visual stellar magnitude of the sky near the center of your field of view) on an hourly basis with your submitted observations, then one can analyze your data and compute a zenithal hourly rate (ZHR) which estimates how many shower meteors would be seen under perfect conditions. This statistic allows direct comparison with other meteor observers to determine a profile of shower activity versus time. Notice that I said, "shower meteors". A normal observing session would include both shower activity and random (sporadic) activity. The observer is encouraged to distinguish shower meteors from sporadics in order to obtain a more accurate portrait of the meteor shower under study.

Other less critical but still interesting data than should be recorded for each meteor are its color, its apparent magnitude (compared to nearby stars), and the presence of a train (which is often produced by swift meteors, persisting after they have disappeared).

Let's hope that the weather cooperates with everyone. Be sure to let us know what you see!

Useful Addresses:

ALPOMS, 161 Vance Street, Chula Vista, CA 91910-4828.
E-mail: lunro.imo.usa@prodigy. net

AMS, 1229 Clark Avenue, Tallahassee, FL 32310.
E-mail: richardson@digitalexp.com

NAMN, 1054 Anna Knapp Blvd., Apt. 32-H, Mt. Pleasant, SC 29464.
E-mail: meteorobs@charleston.net

IMO, Friedenstrasse 5, D-14109 Berlin, Germany.
E-mail: visual@imo.net

Observing the Moon: Wrinkle Ridges

By: Bill Dembowski, Coordinator, A.L.P.O. Lunar Section, Lunar Topographical Studies

Wrinkle ridges are winding, blister-like features that snake across virtually all the Moon's mare surfaces. Few ridges exceed 300 meters in height, but, on the relatively smooth mare, they are easily observed when near the terminator. Wrinkle ridges are probably the least-understood class of lunar features and there are at least six different theories to explain their formation. None of the theories claim to explain all wrinkle ridges and all the theories may play a part in their formation. One of the most common causes of wrinkle ridges appears to be subsidence. When the Moon was formed it was melted to a great depth. As it cooled, lighter minerals (such as plagioclase) rose to form the surface while heavier minerals (olivine and pyroxene) sank. After a period of solidification, radioactive decay melted the denser minerals and they seeped up through faults in the lunar surface. The heavier elements now overburdened the lighter and caused the mare surface to collapse. Wrinkle ridges formed much as the ridges in the palm of the hand form when the hand is cupped.

Subsidence plays a role in a different theory of wrinkle ridge formation. In this theory a relatively thin layer of lava subsides over an existing structure such as a crater wall. The subsiding lava, being somewhat plastic in nature, conforms to the shape of the underlying structure and forms a wrinkle ridge. Some other, less popular, theories include those that attribute wrinkle ridges to uncollapsed lava tubes, regional uplifts, and the remnants of fissure eruptions.

Wrinkle ridges often occur in complex systems, the most famous of which is Dorsa Smirnov, the Serpentine Ridge. [When named, wrinkle ridges take the Latin prefix *dorsum* (singular) or *dorsa* (plural).] Located on the eastern side of Mare Serenitatis, it is easily seen in even the smallest telescope, and is shown to the right in *Figure 1* and below (p. 132) in *Figure 2*. Dorsa Smirnov starts rather indistinctly in the north near the crater Posidonius and snakes its way south, becoming more prominent as it goes. As it approaches the southeast corner of Mare Serenitatis it is joined by another prominent wrinkle system, Dorsa Lister, which sweeps westward to the crater Bessel. Several smaller ridges, most notably Dorsum von Cotta, continue the arc which sweeps northward and east to complete the circle.

On the extreme eastern shore of Mare Serenitatis is the flooded crater le Monnier. Under a low Sun one can see how an arcing wrinkle ridge completes the missing western wall of the 61-km crater. A similar situation appears on the southern shore of Oceanus Procellarum where the missing northeastern wall of the crater Letronne is completed by a wrinkle ridge, while a second ridge marks the location of the buried central peak of this heavily damaged 91-km crater. The rest of Oceanus Procellarum contains numerous wrinkle ridges that run at every conceivable angle. Some form parallel ridges such as those south of the craters Marius and Brayley in the western portion of Oceanus Procellarum. Others virtually criss-cross each other, such as those southwest of the crater Lansberg in the south, an example of which appears in *Figure 3* (p. 132).

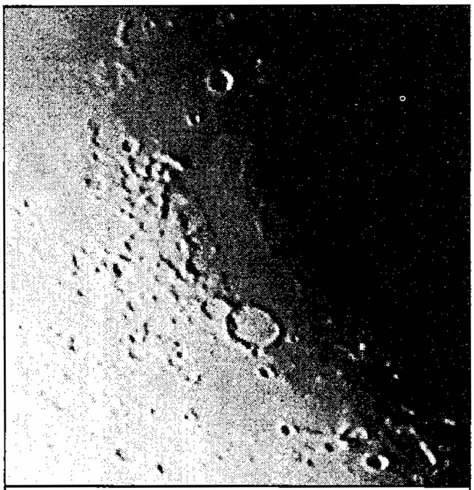

Figure 1. Dorsa Smirnov (right of center); a video frame by Doug Hansen. Colongitude 339°.25. 1998 Jun 30, 04h47m UT. 15-cm Maksotov-Cassegrain. Seeing = 3 on the A.L.P.O. Scale (0 = worst to 10 = perfect). South at top.

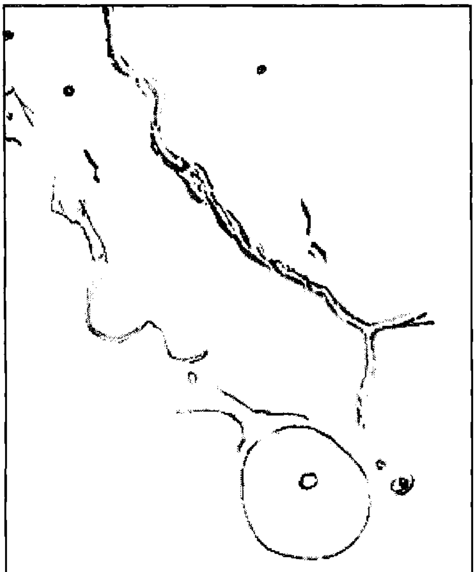

Figure 2. Dorsa Smirnov, drawn by David Lehman. Colongitude 339°.25. 1998 JUN 30, 04h47m UT, simultaneously with the video frame in Figure 1. 15-cm Maksutov-Cassegrain. Seeing = 4 (A.L.P.O.). South at top.

Mare Humorum is another fine example of how wrinkle ridges may have been formed by the subsidence of a circular basin. A fairly straight ridge runs from Gassendi in the north to Gassendi O in the east. Along the way, however, it separates and becomes a complex network that traces the eastern shore of the basin in a sweeping curve to Doppelmayer in the south.

Another circular basin, Mare Nectaris, holds a very interesting wrinkle ridge. This feature runs for approximately 200 km along the western shore of the mare from Beaumont in the south to Theophilus in the north. This wrinkle ridge is rather broad and sometimes has a braided appearance. Try observing it for several nights to see how its appearance can change. The same, of course, should be done with all wrinkle ridges. Being low-profile, complex structures, they are very subject to the interplay of light and shadow as the sun angle changes. Another system of wrinkle ridges graces the northeast corner of Mare Nectaris. These are more difficult to observe and may be an example of the subsidence of a thin lava layer over submerged craters. Look for them in the area between Gaudibert and Daguerre.

Mare Fecunditatis is another basin with wrinkle ridges of the type often referred to as "ghost craters." A cluster of a half-dozen can be seen, under a very low Sun, northeast of the crater Goclenius. Another grouping can be found surrounding the Messier-Messier A twins. A rather broad wrinkle ridge of the conventional type is Dorsa Mawson near the eastern shore of this mare.

When it comes to ghost craters, nothing can compare to Lamont in western Mare Tranquillitatis. Lying just southeast of the crater Arago, the wrinkle ridges that trace the outline of the buried crater span an impressive 75 km, as shown in *Figure 4* (p. 133). The beauty of Lamont does not end here. The circle of ridges is also the center for a spray of wrinkle ridges that radiate outward in all directions, giving the entire system a diameter of over 350 km.

The floor of Mare Crisium is almost devoid of surface features. It has only a few prominent craters but does contain a fine system of wrinkle ridges. The eastern edge of Mare Crisium is traced for 150 km in the north by Dorsa Tetyaev and for 200 km in the south by Dorsa Harker. On the western side of the mare, Dorsum Oppel runs for 300 km, as shown in *Figure 5* (p. 133). Of truly great interest, however, is the system of wrinkle ridges that crisscross the central mare surface, forming a variety of shapes and patterns.

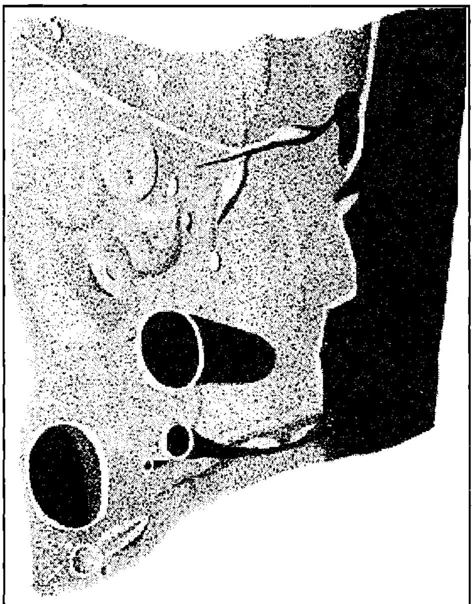

Figure 3. Drawing by Colin Ebdon of wrinkle ridges south of Lansberg D (near center). 1998 DEC 28, 18h15m-19h10m UT. Colongitude 032°.97-033°.48. 25-cm Newtonian, 183X. Seeing = II-III on the Antoniadi Scale (good-moderate). South at top.

Figure 4. The ridge-ring Lamont in western Mare Tranquillitatis. CCD image by J. Westfall, 1998 Mar 04, 03h14m UT. Colongitude 338°.48. 28-cm Schmidt-Cassegrain, f/21, 0.20 sec exposure. South at top.

A branching system of wrinkle ridges runs from the vicinity of Plato to the crater Piazzi Smyth on Mare Imbrium. Another runs from Mons Piton toward the crater Aristillus. The center of Mare Imbrium contains a number of sharply defined wrinkle ridges running in a roughly north-south direction. As these ridges are not concentric with the rim of the basin, some lunar scientists believe that they were formed by lava welling up from fissures in the lunar surface. To the northwest, the wrinkle ridges echo the shape of the basin, and at Sinus Iridum they take on a most interesting aspect. A series of parallel ridges gives the impression of waves rushing to the shore. Seeing these ridges, it is not difficult to understand why early observers thought there were seas on the Moon, although it does not take long to realize that these "waves" do not move.

Although not at all a circular basin, Mare Frigoris is not free of wrinkle ridges. Some rather intricate ridges occupy the area between the craters Fontenelle and Plato. Some parallel ridges mark the region east from there to the crater Protagoras, after which more serpentine-like ridges continue on to the far eastern shore of this mare. Indeed, even tiny Sinus Medii has some wrinkle ridges that run in a north-south direction between the craters Triesnecker and Chladni. The 5-km crater Blagg marks the southern terminus of a ridge where it branches and fades.

Perhaps the most exceptional wrinkle ridge is the one that lies, not on a mare, but within the crater Wargentin. Wargentin is the famous flooded-to-the-brim crater that lies near the southwestern limb of the Moon. Its raised floor is dominated by a system of wrinkle ridges that can resemble a crow's foot. Under a low Sun it is a wonderful sight indeed!

The author wishes to thank those observers who contributed to the illustrations used in this article, and especially Eric Douglass of Sanford, North Carolina for his help in the preparation of the text.

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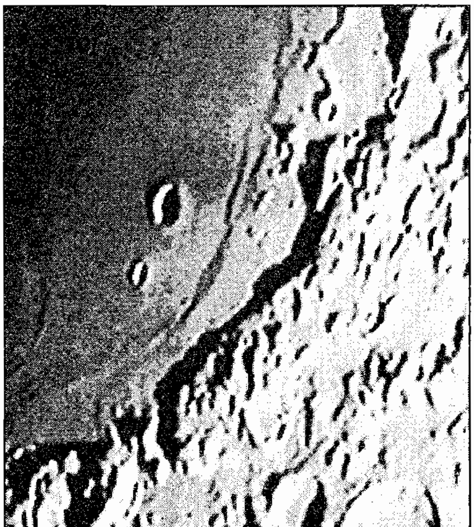


Figure 5. Dorsum Oppel in Mare Crisium, a video frame by Eric Douglass. 1997 Sep 19, 07h00n UT. Colongitude 119°.98. 10-cm refractor. Seeing = 4 (A.L.P.O.). South at top.

THE A.L.P.O. AT ASTROCON 99

Who, Where, and When

ASTROCON 99 was this year's national amateur astronomy meeting (at least as far as the United States was concerned), with the theme "A Thousand Years of Stars & Space." The event was hosted by the Spokane Astronomical Society, and we need particularly to thank this group's President, Cindy Osick, and Astrocon chair, Mickey Moreau, for a well-organized and user-friendly meeting. This was the Astronomical League's 52nd National Convention and the 50th meeting of the Association of Lunar and Planetary Observers. The other national and international groups that participated were the American Association of Variable Star Observers, the International Occultation Timing Association (IOTA) and the International Dark-Sky Association.

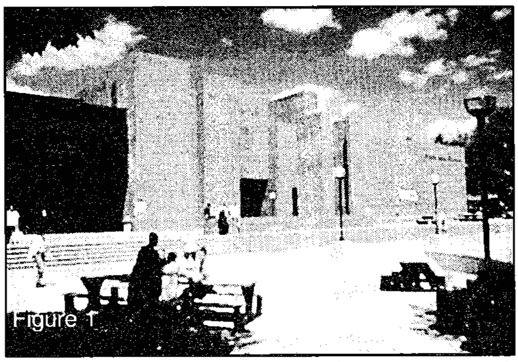


Figure 1

The conference met July 13-17 on the campus of Eastern Washington University in the small city of Cheney (about 20 miles southwest of Spokane). Most of the on-campus events were held in the Pence Union Building, a modern facility with several conference and exhibit rooms as well as a cafeteria; the main entrance of the Pence Union appears to the right in *Figure 1.*

A.L.P.O. Activities

As usual, the Association of Lunar and Planetary Observers participated in the convention in several ways: paper sessions, a display, presenting the annual Walter Haas Observing Award, and holding its annual Board meeting.

The first event in which our organization participated was a unique experience, a day-long "Bus Tour to Mars" on Thursday, July 15. The convention's site, Cheney, is located within two overlapping areas of astrogeological interest. One of these is the Columbia Plateau, a 63,000-square mile lava flow; one of the largest on earth and resembling in many ways the lunar maria. The other unique area is the Channeled Scablands, a landscape repeatedly ravaged by catastrophic flooding during the Ice Ages. This constitutes the Earth's best analogy to the Martian channels and, indeed, of the Mars Pathfinder landing site. Stops included such features as an outcrop of columnar jointed basalt near Spokane, a field of giant ripple marks, the Grand Coulee and the Grand Coulee Dam, and the spectacular Dry Falls cataract, the last shown on this issue's front cover. The last stop was in the Ephrata Fan flood deposits, a close analogy of the Mars Pathfinder landing site (except, lamentably, for the sagebrush), and we took the opportunity to deploy a replica of the Sojourner vehicle, as shown in *Figure 2*, to the left.


Figure 2

The field trip's organizer was John P. Buchanan of the Department of Geology of our host institution, Eastern Washington University, who is also an amateur astronomer, with a home-built observatory near Cheney. Dr. Buchanan hosted a fascinating field trip, enhanced by his informative and well-researched guidebook; he is the person controlling the Sojourner vehicle in Figure 2.

ASTROCON 99—A.L.P.O. Paper Session, Friday, July 16

9:00-9:45 AM	Richard Schmude, Jr., "Recent Photometric Results for Uranus, Neptune, and Pluto." (see *Figure 3*)
9:45-10:15 AM	John Westfall, "A Celestial Rarity: The Mercury Graze Transit on November 15, 1999."
10:30-11:00 AM	Walter H. Haas, "A Visual Observational Study of the Extensions of the Cusps of Venus, 1937-1998." (see *Figure 4*)
11:00-11:45 AM	Dan Troiani, "Mars in 1999."
11:45 AM-12:00 PM	Don Parker, "Exploring the Martian Arctic, 1999." (see *Figure 5*)
1:00-1:30 PM	John McAnally, "Jupiter and the South Temperate Dark Spot of 1998: A Preliminary Report." (Paper presented by Cecil Post.)
1:30-2:00 PM	Julius L. Benton, Jr., "Amateur Observations of Saturn (Then, Now, and Tomorrow)." (Paper presented by Walter H. Haas)
2:00-2:30 PM	Matthew Will, "Results of the A.L.P.O. Survey." (see *Figure 6*)
2:45-4:00 PM	A.L.P.O. Board of Directors Meeting.

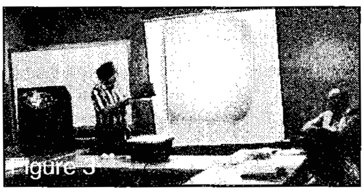


Figure 3

The formal A.L.P.O. paper session was held on Friday morning and early afternoon, July 16, although less technical versions of the papers were also delivered in public sessions on the next day, Saturday, July 17. The A.L.P.O. Program schedule for July 16 is given in the table above.


Figure 4

Regarding the A.L.P.O. papers delivered at ASTROCON 99, the Astronomical League (AL) has adopted a new position that local groups hosting AL convention may, but are not required to, publish Proceedings of the meetings. Thus it is uncertain from year to year (including 1999) whether general Proceedings will be available for AL conventions. In order to ensure that A.L.P.O. papers delivered at conventions (A.L.P.O.-only or A.L.P.O.-participating) will be available afterward, the A.L.P.O. Board has authorized the publication in the Journal, A.L.P.O. of papers delivered by A.L.P.O. members at conventions. For example, the McAnally and Westfall papers listed above have been published in this issue, and others listed above will appear in subsequent issues of this Journal.

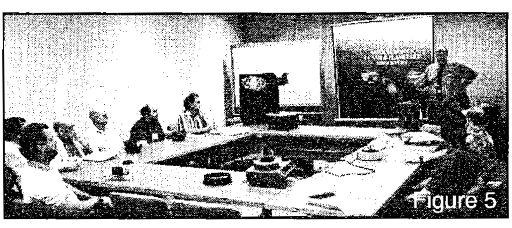


Figure 5

Not listed in the above schedule is a Saturday-only presentation by A.L.P.O. Assistant Mars Coordinator Dan Joyce about "The Solar System on TV." This dovetailed with Mars Coordinator Dan Troiani's "Mars in '99" presentation, as shown to the right in *Figure 7*, where Dan


Figure 6

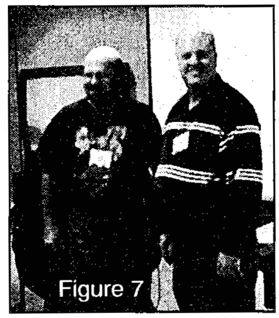
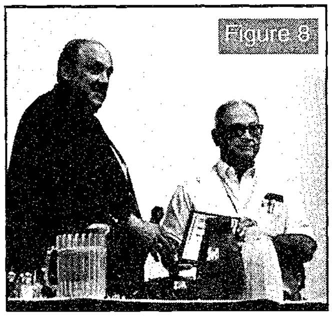


Figure 7

Joyce is on the right and Dan Troiani on the left. Also helping to promote the A.L.P.O., the Convention's "Vendor Area" housed an A.L.P.O. display prepared by A.L.P.O. Board Member and Training Coordinator Matthew Will.

The last major event was the traditional convention Banquet, on Saturday evening, July 17. The meeting's keynote speaker, astronaut F. Story Musgrave, addressed the topic "Rainbows from Space." Prior to this talk was the presentation of Astronomical League and Association of Lunar and Planetary Observer's awards. The A.L.P.O. Award was the annual Walter H. Haas Observing Award, presented to Board member and Solar Coordinator Richard E. Hill. The award was presented by A.L.P.O. Executive Director Donald C. Parker; in Rik's absence, the award was accepted for him by fellow Tucson resident Derald Nye (see *Figure 8*, to upper right).



The remaining A.L.P.O. event was the annual Board of Directors' Meeting, the results of which are reported in the "Announcements" column of this issue (p. 140). It is worthwhile noting here, however, that our Year 2000 Convention will also be with the Astronomical League and other well-known organizations, and will be held at the Holiday Inn Ventura Beach Resort in Ventura, California, July 19-22, 2000 (for more information, check the Ventura County Astronomical Society website: http://www.vcas.org/astrocon/

FURTHER SEEING DEVELOPMENTS

Our last previous issue carried an article by Walter H. Haas and Cecil C. Post, commenting on the poor seeing they had experienced in Las Cruces, New Mexico, throughout 1998. Subsequently, Prof. Haas has provided some additional comments:

> It has been gratifying to receive comments upon the article, "Is the Seeing Getting Worse?" in J.A.L.P.O., Vol. 41, No. 2, pg. 90 by Cecil Post and myself. There appears to be some consensus that the seeing is indeed growing worse over the whole country; perhaps because of more people, more houses, more paving, and so forth. I thank those colleagues who expressed their opinions either in person or over the telephone, but I hesitate to trust a poor memory to report their opinions in more detail. Perhaps some of them would like to set down their thoughts in writing to the Editor or to me as a basis for further discussion; for example, in a "Letters to the Editor" column.

The J.A.L.P.O. Editor welcomes letters narrating personal experiences regarding current seeing conditions. Coordinators also may wish to contribute; Section observers usually document their seeing conditions. Changes in seeing conditions may also have been noted at professional observatories. If seeing indeed has deteriorated, this would raise the further question as to the geographical area so affected—e.g., the Southwest United States, all North America, all the Northern Hemisphere, or the entire World?

Atmospheric seeing conditions are obviously critical to our studies, so Haas and Post have raised an important issue. In addition, the Editor proposes that observers conduct an experiment: Poor seeing often is caused by turbulence in a discrete atmospheric layer (e.g., the Jet Stream). Whether this is the case can be determined by turning your telescope on a bright star near the zenith, and then gradually racking your eyepiece *outside* focus. If there is a discrete turbulence layer, it will at some point be revealed by a Schlieren Pattern of moving turbulence cells silhouetted against the out-of-focus stellar image. You can make two measurements regarding this layer: (1) its general direction of movement (e.g., northwest), correcting for the inversion created by most telescope systems; and (2) the height of the turbulence layer, which may be found by the formula:

$$H = F(1 + F/D)$$

where H is the height of the turbulence layer, F is the telescope's focal length, and D is the distance the eyepiece was moved outside infinity focus. F and D need to be in the same units, which will determine the units of H; if millimeters, H will be inconveniently large, but it can easily be divided by 1,000 to obtain the layer's height in meters. The Editor is interested in receiving reports of such measurements; if sufficient in number, a summary article could then be published here.

A Lunar Video Gallery

A.L.P.O. member and author Thomas A. Dobbins has kindly furnished us with digital versions of lunar video images taken with a closed-circuit black-and-white CCD video camera, with 10-micrometer photosites and array dimensions of 640 columns by 480 rows (i.e., measuring 6.4X4.8 mm). The camera was used with a 14-in (36-cm) Schmidt-Cassegrain telescope, with a Barlow lens at f/34 giving a pixel size of 0.17 arc seconds, together with a Wratten 15 (deep yellow) Filter. The video images were digitized and computer-enhanced by Mr. Dobbins, with some subsequent processing by the Editor. Lunar south is towards the top in all views, which are arranged in lunar east-to-west order.

Figure 1 (right). The Messier-Messier A pair, in Mare Fecunditatis (left of center), under morning lighting. Messier (9X11 km) is the left of the two. Note the double "comet ray" extending west from Messier A, as well as the duplicity of Messier A (13 X11 km). 1999 MAR 23.

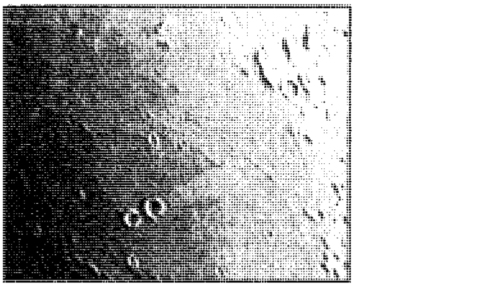


Figure 2 (above). Messier-Messier A with late afternoon lighting emphasizing low ridges in the mare. The "comet ray" is still faintly visible. 1995 JUN 17.

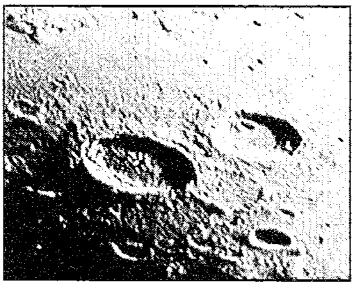
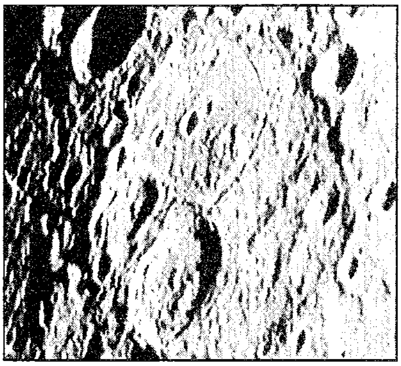


Figure 3 (above). A larger pair, Atlas (left, 87 km) and Hercules (67 km), under late afternoon lighting. Note the wall terraces and floor detail inside Atlas and the ruined crater Atlas E to its lower right. 1995 JUN 18.

Figure 4 (right). The complex, ancient formation Janssen, 190 km in diameter, dominates this frame. The afternoon lighting highlights the varied floor detail, including a rille system. The large crater below center, with a central peak, is Fabricius. 1995 SEP 21.



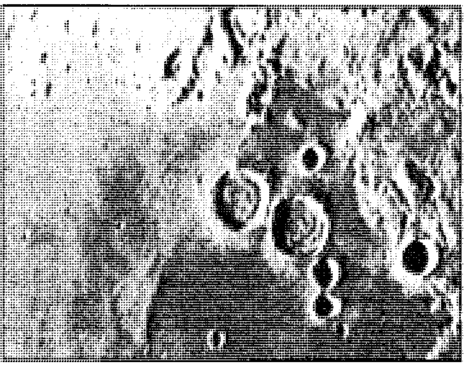


Figure 5. More pairs; near center are Sabine (left, 30 km) and Ritter (right, 31 km); below Ritter is Ritter C (upper) and Ritter B (lower). The lowlands unit is Mare Tranquillitatis. At center left is a triangle of small craters named after the Apollo-11 astronauts: Armstrong (left), Collins (center), and Aldrin (right); difficult objects with diameters 2.4-4.6 km. Morning lighting. 1999 MAR 23.

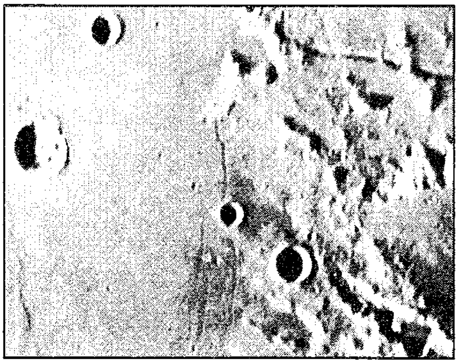


Figure 6. Just north of Figure 5, with the crater Arago (26 km) near the left margin; note the low domes to its north (down) and west (right). The Rima Ariadaeus is in the upper right. The Rimae Sosigenes (near and below center) are named after the 18-km crater Sosigenes on the mare margin at the end of the elongated depression Julius Caesar G in the lower right. Morning lighting. 1999 MAR 23.

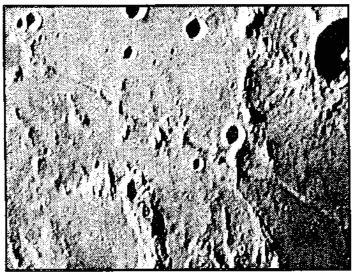


Figure 7 (above). This morning-lighting view adjoins Figure 6 on its right (west), showing the full extent of Rima Ariadaeus (upper left to lower right; 220 km in length). Other features include the ruined depression Julius Caesar (lower left; 90 km) and Agrippa (upper right corner; 46 km). 1998 DEC 26.

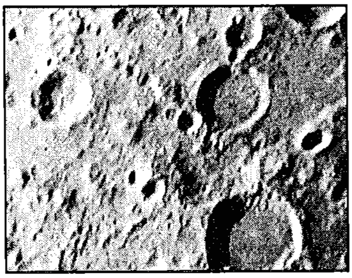
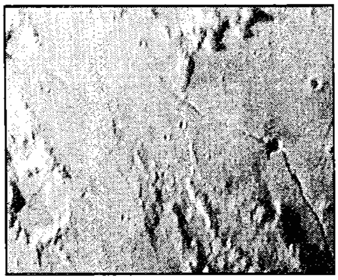


Figure 8. Abulfeda is the 62-km flat-floored crater in the lower right, located in the lunar highlands. Tangent to its upper-right wall and extending to the upper left of the frame is the Catena Abulfeda, a chain of craters perhaps attributable to the impact of a fragmented comet. Morning lighting. 1999 MAR 23.



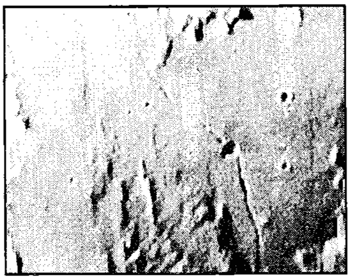


Figure 9 (far left; 1998 DEC 26) and 10 (left; 1999 MAR 24). Both views are under morning lighting. The Rima Hyginus extends 220 km and runs through the 10.6-km rimless crater Hyginus (right of center in Figure 10). West (right) of Hyginus in Figure 10 is part of the Rimae Triesnecker rille system, better shown in Figure 11 (left, below). North of (below) Hyginus is a complex volcanic tableland, often unofficially called the "Schneckenberg" (Snail Mountain).

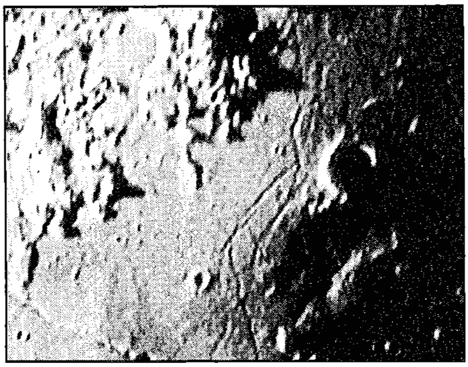


Figure 11 (left). The low morning Sun dramatically highlights the Rimae Triesnecker, considered a test object for earth-based images. Triesnecker itself (26 km) is on the terminator, right of center. Part of the Sinus Medii is in the upper-right quadrant of the frame. 1998 DEC 25.

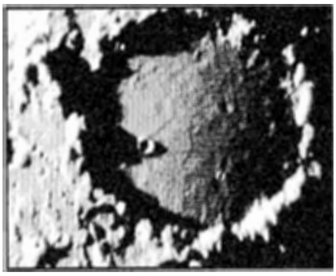


Figure 12 (above). A sunrise view of the 153-km flooded crater Ptolemaeus, whose floor contains much low relief (including shallow depressions called "saucers"), seen only under very low lighting. 1999 MAR 24.

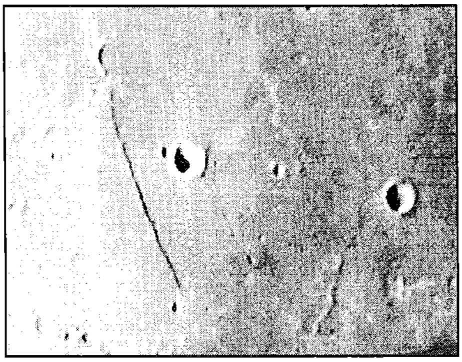


Figure 13 (above). The famous "Straight Wall" fault scarp (Rupes Recta), 110 km long, runs left of center, casting a shadow under the frame's morning lighting. The crater to its right is Birt (17 km). To Birt's lower right is the delicate Rima Birt, 50 km long, originating in the summit crater of a small dome. 1999 MAR 25.

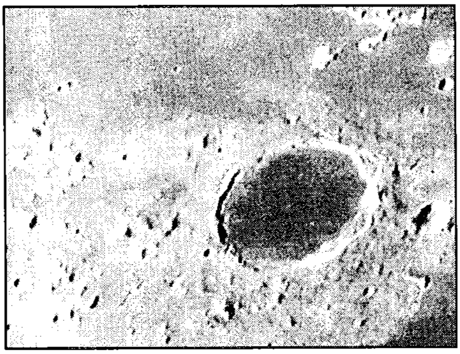


Figure 14 (above). The view features the 101-km dark-floored crater Plato. Note the faint streaks and tiny craters on its floor; the latter are considered test objects for visual observers. South of Plato is part of the Mare Imbrium, containing the Montes Teneriffe in the upper right. To the east (left) of Plato the Rimae Plato can be seen. Morning lighting. 1999 DEC 28.

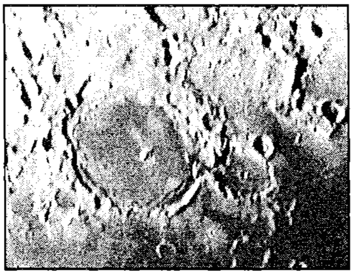


Figure 15 (left). The large crater is 105-km Pitatus, with 42-km Hesiodus on its left, both with interiors flooded by lava flows from Mare Nubium, to the north. Note the double concentric wall of Hesiodus A, on the southwest (upper right) wall of Hesiodus. Morning lighting. 1998 DEC 28.

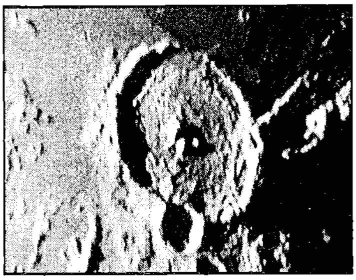


Figure 16 (above). Gassendi (110 km), on the northern margin of Mare Humorum, shortly after lunar sunrise. Gassendi is known for its intricate floor detail, including a central peak and complex rille system. Gassendi A is visible on the north (lower) rim of Gassendi. 1995 MAR 13.

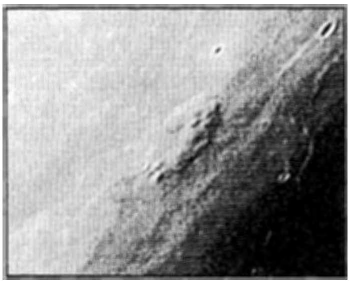


Figure 17 (left). At center is Rümker, a dome complex in Oceanus Procellarum. Seen well only shortly after lunar sunrise (in this view) or before sunset, this 55-km structure is one of several examples of post-mare volcanism in Oceanus Procellarum. 1995 MAR 13.

BOOK REVIEWS

Edited by Jose Olivarez

Mapping Time: The Calendar and its History.

E.G. Richards.

Oxford University Press, 198 Madison Avenue, New York, NY 10016-4314. 1998. 450 pages, illustrations, index. Price $35.00 cloth (ISBN 019-850413-6).

Reviewed by John Westfall

All human societies have needed to designate dates in a consistent manner, but have had to deal with incommensurable time units: the solar day, the month (lunation: 29.530589 d), and the year (mean tropical: 365.242190 d). *Mapping Time* tells the fascinating story of how these different societies have tackled this problem.

After discussing the unavoidable astronomical facts, the book describes calendar systems of many sorts beginning in prehistory and continuing forward through the French Republican Calendar. Along the way we learn about the Babylonian, Egyptian, Mayan, Aztec, and Jewish and Islamic calendars, including many others and of course the more familiar Julian and Gregorian variety.

Not confining the text to history, Richards provides the algorithms and tables necessary to convert among the many calendar systems he includes. The wealth of information is augmented by a 10-page glossary, an extensive bibliography, and appendices dealing with such niceties as astronomical constants, the names of the days of the week in 69 languages (!), and the names of the days of the year in the French Republican Calendar.

Sadly, I must report that this book was poorly edited, with frequent typographical and other errors. A few examples are: Egyptian Old Kingdom dated as "2664-5155 BC" (Table 11.1, p. 151); the date of Nativity was "AD 6" (p. 218); the destruction of the Second Temple is twice given as AD 67 (both on p. 225) and twice as AD 70 (pp. 220 and 222); rather than having "probably been extinct in Iran since the deposition of the Pahlavis", the Reformed Islamic Calendar continues in use for civil holidays; the final digit of the Khwarizmian day number is missing in Table 22.1 (p. 290); Bithynia is in north*western* Turkey, not northeastern (p. 347); 0.002 sec/cent is not 2 millionths of a sidereal day per century (p. 388; it is about 2 *hundred*-millionths); the mean tropical year formula is given to compute the synodic month (p. 388); Table 1.1 should begin with "4000 BC" rather than "400 BC" (p. 389). It is unfortunate that such an informative book is made harder to use because of the need to constantly check its facts and figures.

A.L.P.O. ANNOUNCEMENTS

[The A.L.P.O. Board of Directors met on July 17, 1999, at the convention meeting site in Cheney, Washington. Board members attending were Donald Parker (Chair), Elizabeth Westfall (Secretary), Walter Haas, John Westfall (with Richard Hill's proxy), and Matthew Will (with Harry Jamieson's proxy). The meeting was open to non-Board A.L.P.O. members, on a non-voting basis as required by our charter.]

PERSONNEL CHANGES AT THE 1999 A.L.P.O. BOARD MEETING

Richard Schmude Appointed to A.L.P.O. Board and Historical Section.—In a unanimous vote, the A.L.P.O. Board of Directors has added Richard W. Schmude, Jr. to the Board and also as Acting Assistant Coordinator of our Historical Section. In addition to being a frequent contributor to our pages, Dr. Schmude has served as Coordinator of our Remote Planets Section since 1990.

Seven Acting Coordinators Made Regular Coordinators.—In another series of Board actions, the following A.L.P.O. staff have been "promoted" from Acting to Regular status:

Solar Section: Gordon W. Garcia, Jeff Medkeff, and Jeffery Sandel.
Mars Section: Jeff D. Beish
Jupiter Section: David J. Lehman, John McAnally, and Agustin Sanchez-Lavega.

OTHER 1999 A.L.P.O. BOARD MEETING NEWS

Finances.—The A.L.P.O. has two bank accounts: (1) In Memphis, Tennessee, administered by Harry D. Jamieson, A.L.P.O. Membership Secretary/Treasurer, with a July 10, 1999, balance of $3583.37; (2) In San Francisco, California, administered by John Westfall, A.L.P.O. Editor, with a July 17, 1999, balance of $421.40. In addition, the A.L.P.O. Endowment Fund had a balance of $8896.12 as of July 9, 1999.

General Discussions; Not Resulting in Resolutions.—

(1) **Production of a CD-ROM of Back Issues of J.A.L.P.O., 1947-present.** This will probably cost in the range of $5,000-7,000, largely due to the task of scanning the back issues. Besides the initial cost, it will be necessary to produce an integrated index in order effectively to use the CD-ROM. Volumes 11-40 have been individually indexed; Walter Haas is working on an index of Volumes 1-10, while Richard Schmude is investigating producing an integrated overall index. It was also suggested that the *Minor Planet Bulletin*, and perhaps other Sections' publications, be included.

(2) **Produce a CD-ROM for New Members.** This would integrate the instructional literature and observing forms produced by the various Sections, as well as overall A.L.P.O. information.

(3) **Resurrect the A.L.P.O. Ephemeris.** Members apparently want this publication resumed. Jeff Beish is volunteered to produce some portions of it, possibly with the help of the Computing Section. It was suggested that the Ephemeris be included in the New Members' CD-ROM.

(4) **Membership Survey.** Immediately prior to the Board Meeting, Matt Will presented a summary of his survey of A.L.O. members and recently-lapsed members. His summary will appear in our next issue.

OTHER A.L.P.O. NEWS

Acting Eclipse Coordinator's E-Mail Address.—Dr. Michael D. Reynold's E-mail address, not given in the previous issue, is: reynolds@cosc.org .

Donation.—We thank A.L.P.O. member Thomas R. Williams, of Houston, Texas, for his recent generous donation of $90.00 to the A.L.P.O. (i.e., the value in excess of his simultaneous payment of two years of Sponsor membership).

Other Amateur and Professional Announcements

Roster of Upcoming Meetings

October 28-31, 1999: American Association of Variable Star Observers. Annual meeting at Four Points Sheraton, Hyannis, MA. [AAVSO, 25 Birch St., Cambridge, MA 02138. Telephone: 617-354-0484; E-mail: aavso@aavso.org; Web: http://www.aavso.org]

November 6-8: Beginning Adult Astronomy Camp. University of Arizona Alumni Association; observing from Mt. Lemmon and Mt. Bigelow. [Donald W. McCarthy, Jr., 933 N. Cherry Ave., Tucson, AZ 85721. Telephone: 520-621-4079; E-mail: dmccarthy@as.arizona.edu]

December 3-5, 1999: Planetfest '99. At the Pasadena Convention Center, Pasadena, California [The Planetary Society, 65 North Catalina Ave., Pasadena, CA 91106-2301. Telephone: 877-752-6387; FAX: 626-793-5528; E-Mail: tps@planetary.org; Web: http://planetary.org]

December 11, 1999: First Conference on Light Pollution. At the Planetario Humboldt, Parque del Este, Caracas, Venezuela. [Juan Jose Downes, telephone 582-2349188; E-mail: contaminacion-luminica@yahoo.com]

December 13-17, 1999: Fall Meeting of the American Geophysical Union. At San Francisco, California. [AGU Meetings Department, 1999 Fall Meeting, 2000 Florida Ave., NW, Washington, DC 20009. Telephone: 202-462-6900 or 800-966-2481; FAX: 202-328-0566; E-mail: meetinginfor@agu.org ; Web: http://www.agu.org/meetings/fm99top.html]

January 10-14, 2000: Physics of Space: Growth Points and Problems. At the Observatoire de Meudon, Paris, France. [E-mail: OBS2000@ulysse.obspm.fr ; Web: http://despa.obspm.fr/OBS2000]

January 30-February 3, 2000: Space Technology and Applications Forum. At Albuquerque, New Mexico. [Mary J. Bragg, University of New Mexico, Institute for Space and Nuclear Power Studies, Farris Engineering Center, Room 239, Albuquerque, NM 87131; Telephone: 505-277-4950; FAX: 505-277-8214; Web: http://www-chne.unm.edu/isnps]

January 31-February 5, 2000: Winter Star Party (WSP). Returning to Camp Wesumkee, West Summerland Key, Florida. [Fred or Lucille Heinrich, WSP Registrars, 6165 Wiggins Rd., Live Oak, FL 32060. Telephone: 904-362-5995; FAX: 904-362-5996; E-Mail: heinrich@alltel.net]

February 28-March 3, 2000: Space 2000 and Robotics 2000. At Albuquerque, New Mexico. [Web: http://www.space androbotics.org]

July 9-12, 2000: Catastrophic Events and Mass Extinctions: Impacts and Beyond. At the Institute of Geochemistry, University of Vienna, Vienna, Austria; includes postconference (July 13-16) field trips to impact sites. [Christian Koeberl, Institute of Geochemistry, University of Austria, Althanstrasse 14, A-1090, Vienna, Austria. Telephone: +43-1-31336-1714; FAX: +43-1-31336-781; E-mail: christian.koeberl@univie.ac.at]

July 9-14, 2000: International Planetarium Society Conference. At Montreal, Quebec, Canada. [O'Donoughe & Associates Event Management Ltd., 5486 Cote-Saint-Luc Road, Montreal H3X 2P7, Quebec, Canada. Telephone: 514-481-7408; FAX: 514-481-7379; E-mail: odon@cam.org]

July 19-22, 2000: Astrocon 2000. At the Holiday Inn Ventura Beach Resort in Ventura, California. This national amateur meeting will include the Astronomical League and the 51st A.L.P.O. Convention. [E-mail: astrocon2000@vcas.org; Web: http://www.vcas.org/astrocon/]

THE ASSOCIATION OF LUNAR AND PLANETARY OBSERVERS

Founded by Walter Haas in 1947, the A.L.P.O. now has about 500 members. Our dues include a subscription to our quarterly Journal *(J.A.L.P.O.), The Strolling Astronomer*, and are $23.00 for one year ($40.00 for two years) for the United States, Canada, and Mexico; and $30.00 for one year ($54.00 for two years) for other countries. One-year Sustaining Memberships are $50.00; Sponsorships are $100.00. There is a 20-percent surcharge on all memberships obtained through subscription agencies or which require an invoice.

Our advertising rates are $85.00 for a full-page display advertisement, $50.00 per half-page, and $35.00 per quarter-page. Classified advertisements are $10.00 per column-inch. There is a 10-percent discount for a three-time insertion on all advertising.

All payments should be in U.S. funds, drawn on a U.S. bank with a bank routing number, and payable to "A.L.P.O." All cash or check dues payments should be sent directly to: A.L.P.O. Membership Secretary, P.O. Box 171302, Memphis, TN 38187-1302. When writing to our staff, please provide stamped, self-addressed envelopes. Note that the A.L.P.O. maintains a World-Wide Web homepage at: http://www. lpl.arizona.edu/alpo/

Keeping Your Membership Current.—The top line of your *J.A.L.P.O.* mailing label gives the volume and issue number when your membership will expire (e.g., "41.3" means Vol. 41, No. 3). We also include a First Renewal Notice in that issue, and a Final Notice in the next one. Please let the Membership Secretary know if your address changes. Dues payments should be made directly to the Membership Secretary.

A.L.P.O. MONOGRAPH SERIES

A.L.P.O. monographs are publications that we believe will appeal to our members, but which are too lengthy for our Journal. Order them from our Editor (P.O. Box 16131, San Francisco, CA 94116 U.S.A.) for the prices indicated, which include postage; make checks to "A.L.P.O."

Monograph Number 1. ***Proceedings of the 43rd Convention of the Association of Lunar and Planetary Observers. Las Cruces, New Mexico, August 4-7, 1993.*** 77 pages. Price: $12.00 for the United States, Canada, and Mexico; $16.00 elsewhere.

Monograph Number 2. ***Proceedings of the 44th Convention of the Association of Lunar and Planetary Observers. Greenville, South Carolina, June 15-18, 1994.*** 52 pages. Price: $7.50 for the United States, Canada, and Mexico; $11.00 elsewhere.

Monograph Number 3. ***H.P. Wilkins 300-inch Moon Map.*** 3rd Edition (1951), reduced to 50 inches diameter; 25 sections, 4 special charts; also 14 selected areas at 219 inches to the lunar diameter. Price: $28.00 for the United States, Canada, and Mexico; $40.00 elsewhere.

Monograph Number 4. ***Proceedings of the 45th Convention of the Association of Lunar and Planetary Observers. Wichita, Kansas, August 1-5, 1995.*** 127 pages. Price: $17.00 for the United States, Canada, and Mexico; $26.00 elsewhere.

Monograph Number 5. ***Astronomical and Physical Observations of the Axis of Rotation and the Topography of the Planet Mars. First Memoir, 1877-1878.*** By Giovanni Virginio Schiaparelli, translated by William Sheehan. 59 pages. Price: $10.00 for the United States, Canada, and Mexico; $15.00 elsewhere.

Monograph Number 6. ***Proceedings of the 47th Convention of the Association of Lunar and Planetary Observers, Tucson, Arizona, October 19-21, 1996.*** 20 pages. Price $3.00 for the United States, Canada, and Mexico; $4.00 elsewhere.

Monograph Number 7. ***Proceedings of the 48th Convention of the Association of Lunar and Planetary Observers. Las Cruces, New Mexico, June 25-29, 1997.*** 76 pages. Price: $12.00 for the United States, Canada, and Mexico; $16.00 elsewhere.

Monograph Number 8. ***Proceedings of the 49th Convention of the Association of Lunar and Planetary Observers. Atlanta, Georgia, July 9-11, 1998.*** 122 pages. Price: $17.00 for the United States, Canada, and Mexico; $26.00 elsewhere.

OTHER PUBLICATIONS OF THE A.L.P.O.

(Checks must be in U.S. funds, payable to an American bank with bank routing number.)

Order from: A.L.P.O., P.O. Box 16131, San Francisco, CA 94116, U.S.A:

An Introductory Bibliography for Solar System Observers. Free for a stamped, self-addressed envelope. A 4-page list of books and magazines about Solar System bodies and how to observe them. The current edition was updated in October, 1998.

Order from: A.L.P.O. Membership Secretary, P.O. Box 171302 Memphis, TN 38187-1302 U.S.A:

A.L.P.O. Membership Directory. $5.00 in North America; $6.00 elsewhere. Continuously updated list of members on 3.5-in MS-DOS diskette; either DBASE or ASCII format. Make payment to "A.L.P.O." Also available as an e-mail downloaded file, given the requester's e-mail address. Provided at the discretion of the Membership Secretary.

Order from: Walter H. Haas. 2225 Thomas Drive. Las Cruces. NM 88001. USA (E-mail: haasw@zianet.com):

Back issues of *The Strolling Astronomer (J.A.L.P.O.).* Many of the back issues listed below are almost out of stock , and it is impossible to guarantee that they will remain available. Issues will be sold on a first-come, first-served basis. In this list, volume numbers are in italics, issue numbers are not, and years are given in parentheses. The price is $4.00 for each back issue; the current issue, the last one published, is $5.00. We are always glad to be able to furnish old issues to interested persons and can arrange discounts on orders of more than $30. Make payment to "Walter H. Haas."

$4.00 each: *1* (1947); 6. *8* (1954); 7-8. *11* (1957); 11-12. *21* (1968-69); 3-4 and 7-8. *23* (1971-72); 7-8 and 9-10. *25* (1974-76); 1-2, 3-4, and 11-12. *26* (1976-77); 3-4 and 11-12. *27* (1977-79); 3-4 and 7-8. *31* (1985-86); 9-10. *32* (1987-88); 11-12. *33* (1989); 7-9. *34* (1990); 2 and 4. *37* (1993-94); 1 and 2. *38* (1994-96); 1, 2, and 3. *39* (199697); 1, 2, 3, and 4. *40* (1998); 2 and 4. *41* (1999); 1 and 2.

Current Issue [*41*, 3]; $5.00.

PUBLICATIONS OF THE SECTIONS OF THE A.L.P.O.

Order the following directly from the appropriate Section Coordinator; use the address in the staff listing unless another address is given below.

Lunar and Planetary Training Program (Robertson): *The Novice Observers Handbook,* $10.00. An introductory text to the Training Program. Includes directions for recording lunar and planetary observations, useful exercises for determining observational parameters, and observing forms. To order, send a check or money order made out to "Timothy J. Robertson."

Lunar (Benton): (1) *The ALPO Lunar Section's Selected Areas Program (SAP),* $17.50. Includes a full set of observing forms for the assigned or chosen lunar area or feature, together with a copy of the *Lunar Selected Areas Program Manual.* (2) *Observing Forms Packet,* $10.00. Includes observing forms to replace the quantity provided in the Observing Kit above. Specify the Lunar Forms. (See note for Venus.)

Lunar (Dembowski): *The Lunar Observer*, a monthly newsletter, is available online at the A.L.P.O. Homepage, http://www.lpl.arizona.edu/alpo/ . Hard copies may be obtained by sending a set of self-addressed stamped envelopes to Bill Dembowski at his address in our staff listing.

Lunar (Jamieson): *Lunar Observer's Tool Kit,* consisting of a 3-1/2-in. MS/DOS diskette containing an observation-planning program and a lunar dome data base with built-in instructions. Price $25.00.

Venus (Benton): (1) *The ALPO Venus Observing Kit,* $17.50. Includes introductory description of A.L.P.O. Venus observing programs for beginners, a full set of observing forms, and a copy of *The Venus Handbook.* (2) *Observing Forms Packet,* $10.00. Includes observing forms to replace the quantity provided in the Observing Kit above. Specify the Venus Forms. (To order the above, send a check or money order made out to "Julius L. Benton, Jr." All foreign orders should include $5.00 additional for postage and handling; for domestic orders, these are included in the prices above. Shipment will be made in two to three weeks under normal circumstances. NOTE: Observers who wish to make copies of observing forms have the option of sending a SASE for a copy of forms available for each program. Authorization to duplicate forms is given only for the purpose of recording and submitting observations to the A.L.P.O. Venus, Saturn, or Lunar SAP Section. Observers should make copies using high-quality paper.)

Mars (Troiani): (1) *Martian Chronicle;* send 8-10 SASEs; published approximately monthly during each apparition. (2) *Observing Forms;* send SASE to obtain one form which you can copy; otherwise send $3.60 to obtain 25 copies (make checks out to "J.D. Beish").

Mars (Astronomical League Sales, P.O. Box 572, West Burlington, IA 52655): *ALPO's Mars Observer Handbook,* $9.00.

Jupiter: (1) "Jupiter Observer's Start-Up Kit" is available for $3.00 from David J. Lehman. (2) *Jupiter*, the newsletter of the Jupiter Section is available on the Internet at the Jupiter Section Web page or by mail: send SASEs to David J. Lehman. (3) To join the Jupiter Section's E-mail network, "J_Net," send an E-mail message to David J. Lehman at DLehman111@aol.com, write "subscribe J_Net" in the subject field. (4) *Timing the Eclipses of Jupiter's Galilean Satellites;* send a SASE with 56 cents in stamps to John Westfall. This is the project "Observing Kit" and includes a report form.

Saturn (Benton): (1) *The ALPO Saturn Observing Kit,* $20.00. Includes introductory description of ALPO Saturn observing programs for beginners, a full set of observing forms, and a copy of *The Saturn Handbook.* (2) *Observing Forms Packet,* $10.00. Includes observing forms to replace the quantity provided in the Observing Kit above. Specify the Saturn Forms. (See note for Venus.)

Comets (Machholz): Send SASEs to the Coordinator for monthly installments of *Comet Comments,* a one-page newsletter reviewing recent comet discoveries and recoveries, and providing ephemerides for bright comets.

Meteors (Astronomical League Sales, P.O. Box 572, West Burlington, IA 52655): (1) The pamphlet, *The A.L.P.O. Guide to Watching Meteors* is available for $4.00 (price includes postage). (2) The *Meteors Section Newsletter* is published quarterly (March, June, September, and December) and is available free of charge if you send 33¢ in postage per issue to Coordinator Robert D. Lunsford, 161 Vance Street, Chula Vista, CA 91910.

Minor Planets (Derald D. Nye, 10385 East Observatory Dr., Corona de Tucson, AZ 85641-2309): Subscribe to: *The Minor Planet Bulletin;* quarterly, $9.00 per year for the United States, Mexico and Canada; or $13.00 for other countries (air mail only).

Computing Section (McClure): A Computing Section Newsletter, *The Digital Lens,* is available via e-mail. To subscribe or to make contributions, contact the editor, Mike W. McClure, at: MWMCCL1 @ POP.UKY.EDU .

Mercury/Venus Transit Section (Westfall): (1) *Observer's Guide to the Transit of Mercury, 1999 Nov 15.* $4.00 for orders from the United States, Canada, and Mexico; $7.00 for orders from other countries (price includes first-class postage; please make checks payable to "John E. Westfall"). (2) The Coordinator will also compute your local circumstances (Universal Time, Position Angle, and Solar Altitude for each of the four contacts and for mid-transit) if you supply a stamped self-addressed envelope along with your latitude, longitude, and approximate elevation above sea level.

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