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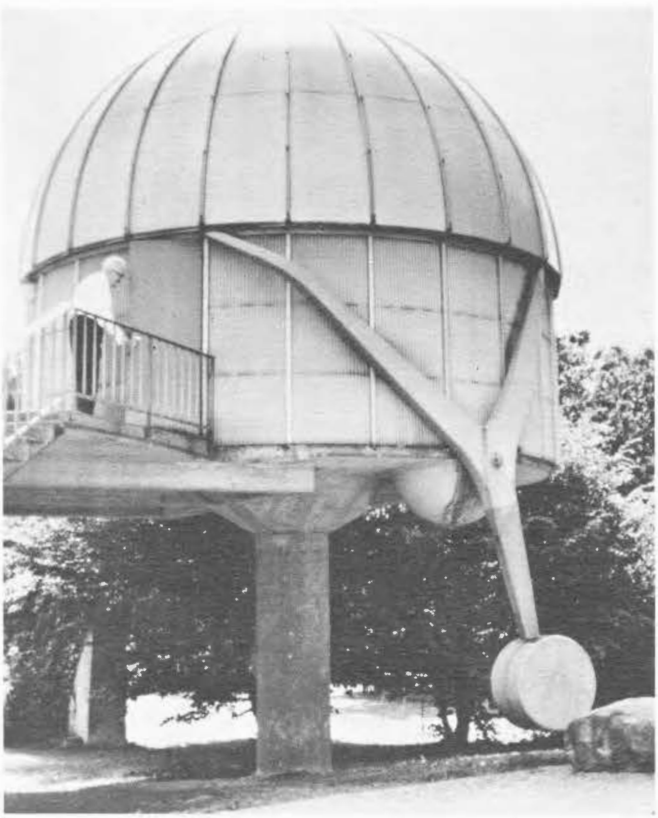

The Observatory of the Swiss Astronomical Society and the City of Schaffhausen at Schaffhausen, Switzerland. At the door is Mr. Hans Rohr, the General Secretary of the Swiss Astronomical Society. Photograph contributed by Christopher Vaucher, who visited this observatory on a trip to Europe in the summer of 1970. Text on pages 202-204.

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ALPO
Founded In 1947

IN THIS ISSUE

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OBSERVING MARS I. PLANNING AN OBSERVATIONAL PROGRAM

By: Charles F. Capen, ALPO Mars Recorder

The planet Mars is in the next orbit outside the Earth's and requires 687 days to complete its year, or just 43 days less than twice the terrestrial year. The planet Earth overtakes Mars every 2 years and 50 days on the average. The point of passing is called an opposition because Mars is then opposite the Sun relative to the Earth, with a celestial longitude difference of 180°. Figure 1 illustrates opposition positions from 1963 through 1978. It is shown that every opposition occurs in a different part of the planet's orbit, and that the opposition points rotate in a counterclockwise direction around the Sun in 15- or 17-year intervals. If the student of Mars is fortunate enough to be born at the proper time in this interval, he may experience five most favorable apparitions.

An apparition is astronomically defined as the duration of useful appearance or observability of a planet. The most favorable apparitions occur when Mars comes to opposition close to perihelion during the terrestrial months of July, August, or September when the Martian South Pole is always tilted toward the Earth. Unfavorable apparitions occur when Mars comes to opposition near aphelion during terrestrial January, February, or March when the Martian North Pole is tilted toward the Earth. The Mars and Earth orbits are closest on or about the terrestrial date of August 23, with a possible minimum distance of 34.6 million miles (55.7×10^6 kilometers) and an apparent disk diameter of 25.1 arc seconds. The two orbits are farthest apart near terrestrial February 25, when the minimum distance between the two planets can be no less than about 61 million miles (98.2×10^6 kilometers) with an apparent disk diameter of only 13.8 arc seconds. The relative apparent Martian disk sizes for aphelic through perihelic oppositions of 1963-1971 are shown in Figure 2.

Recent observational experience employing new techniques, and combined with observational perseverance, has extended the normal Martian apparition by several months. Each apparition affords an opportunity to observe the planet Mars closely during only one or two Martian seasons. Quality data from telescopic observations can be acquired during a 10- to 12-month period which is centered on the date of opposition. The beginning and duration of any given apparition is dependent upon the desired data to be collected and upon the Martian season encountered during the observational reconnaissance of the planet. In fact, visual and micrometer observations have been performed throughout a 20-month period with good data acquisition.

Aphelic apparitions allow physical observations of the Martian Arctic region with its shrinking polar cap and peripheral aspects, Arctic climatic studies, and meteorological phenomena; the equatorial region with its seasonal contrast changes, fine surface detail, and bright seasonal topographic cloud occurrences; and a section of the southern hemisphere to approximately -65° latitude. Similarly, perihelic apparitions permit the collection of observational data on the Antarctic physical aspects, the seasonal clouds and contrast changes in the equatorial region, and part of the northern hemisphere as far north as about +80° to only +65°. If observations are started early enough during the first of a series of three most favorable apparitions, it is possible to observe both hemispheres nearly equally well. The planetary aspects of the 1969 apparition had this condition.[1,2]

The phenomenon of the Martian seasons is particularly important to the collection of data, its study, and its interpretation. The Martian seasons are about 90° out of phase, or one season in advance of the terrestrial season; consequently, when oppositions occur during northern terrestrial spring observations of Mars are made during Martian summer in the northern hemisphere and Martian winter in the southern hemisphere. Similarly, when oppositions occur in terrestrial northern summer, observations are made during Martian northern hemisphere autumn and southern hemisphere spring. Oppositions that occur during terrestrial northern autumn yield Martian northern hemisphere winter and southern hemisphere summer data. Oppositions occurring during terrestrial northern winter give Martian northern spring and southern autumn seasonal aspects.

With a Mars disk diameter of only 4 or 5 arc seconds, an observing site having generally good seeing conditions, and much observational perseverance, it is possible to acquire useful visual data on general atmospheric conditions, terminator cloud motions, atmospheric opacity studies, and particularly polar region phenomena of the polar caps' physical conditions and behavior of the polar hoods. Photographic observation is usually practical with high contrast fine grain emulsions when the disk diameter is greater than

8 arc seconds. Fine surface detail can be photographed only on a disk greater than 12 arc seconds. High-resolution photography is possible when the Martian disk is greater than 20 arc seconds, which occurs only during a perihelion apparition for about 74 nights. During a most favorable perihelic apparition, such as the forthcoming 1971 apparition, the diameter of Mars is greater than 5 arc seconds for about 200 days on either side of opposition, which gives a total of 400 possible visual observation nights; and there are about 270 useful photographic nights. During an unfavorable aphelic apparition, such as occurred in 1965, there are about 160 days on either side of opposition for a total of 320 possible visual observation nights; and there are about 163 available photographic nights. Refer to Figure 3.

Using the above criteria, the 1969 apparition had about 380 possible nights for visual observation and about 190 nights suitable for photographic study. However, the author began his observation early in 1969 when the Martian disk subtended only 3.8 arc seconds in order to obtain measurements of the North Polar Cap near the Martian northern hemisphere vernal equinox. Observation was extended into the Martian southern hemisphere spring season in order to obtain South Polar Cap physical data. This apparition was terminated by the writer with a disk diameter of 3.8 arc seconds and 630 days after it began.

Several useful tabular and graphical ephemerides are compiled for each apparition by observers of Mars. A selected ephemeris for physical observations of Mars is compiled and tabulated at the beginning of each Martian apparition from The American Ephemeris and Nautical Almanac (AENA).[3] This table is best kept in a current Martian apparition loose leaf notebook along with contemporary published papers and graphs regarding the aspects of Mars. These selected data aid observers in planning an observational program, observers who are actively engaged at the telescope, and the later reduction and measurement of observations.

The observer of Mars should decide beforehand upon what particular Martian features and phenomena he desires to study and is equipped to observe and should then systematically collect data. Observations should be performed in a routine manner in order to save time at the telescope and not to overlook part of the planned observing program. Also, this procedure aids in later compilation of data for analysis, illustrations, publications, etc.

Preventive maintenance and operation tests on telescope optics, equatorial mount, and related equipment should be made well in advance of the coming most favorable 1971 Martian apparition. A basic set of color filters should be on hand, such as blue, green, and orange filters. A more advanced and complete set consists of violet, blue-green, yellow-green, red, and magenta color filters in addition to the above filters. Filter technique and application may need to be reviewed.[2,4,5] Wratten gelatin filters may be obtained from local Eastman Kodak dealers, and glass mounted filters may be purchased from Vernonscope & Co., N. Y. or Optica b/c, Calif. Visual 3x5 inch data cards for use at the telescope may be prepared in advance by drawing a 42-mm. diameter circle on each card above the record list: Mars, date (terrestrial date and Martian date), time (U.T. and Mars C.M.), telescope and ocular power, filters, seeing and transparency estimates, and observational remarks. Photography of Mars can be performed with medium to large aperture amateur telescopes (10-24 inches) with steady mounts. A medium speed panchromatic black and white film with good contrast characteristics can be used with orange-red, blue, and violet filters.[6,7] Positive color photography has been very successful at these apertures, and the images of Mars may be tricolor separated with filters or projected for study and measurement.[8] Films can be purchased in advance and stored safely in a freezer or refrigerator for a year.

This paper is the first of a series of short and practical articles concerned with observations of Mars.

References

1. Capen, C. F. and Capen, V. W., "The Planet Mars in 1969," Sky and Telescope, Vol. XXXVII, No. 3, March, 1969.

2. Capen, C. F., "The Observer and Mars in 1969," Journal A.L.P.O., Vol. 21, Nos. 7-8, April, 1969.

3. Capen, C. F., "Observing Mars in 1967," Sky and Telescope, Vol. XXXIII, No. 4, April, 1967.

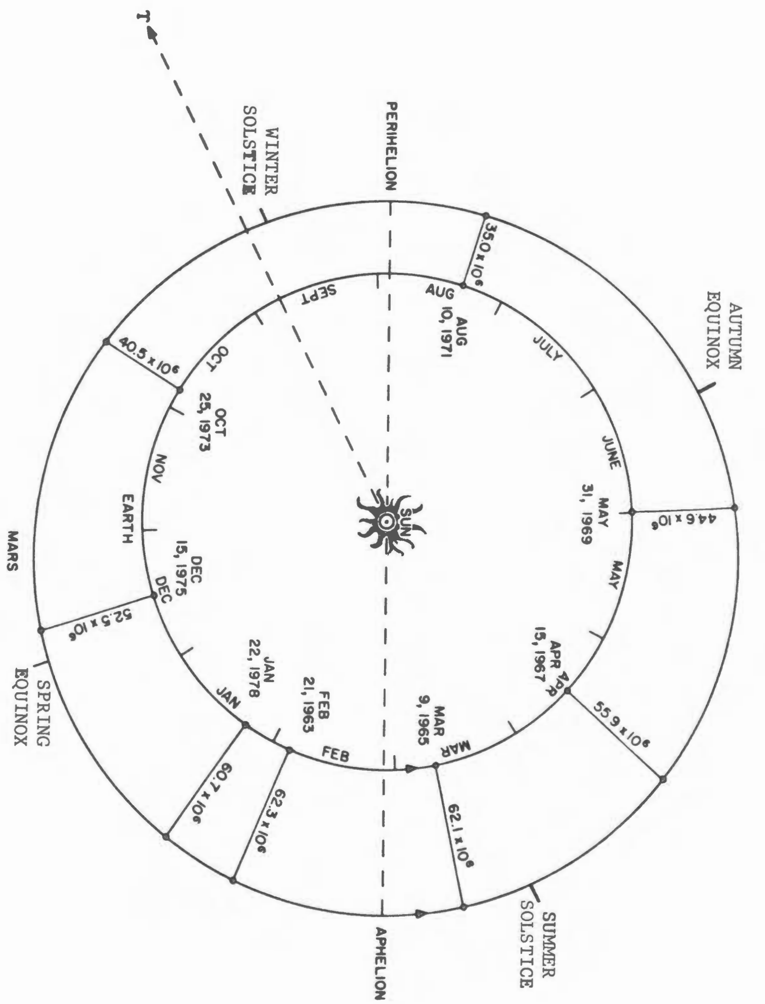
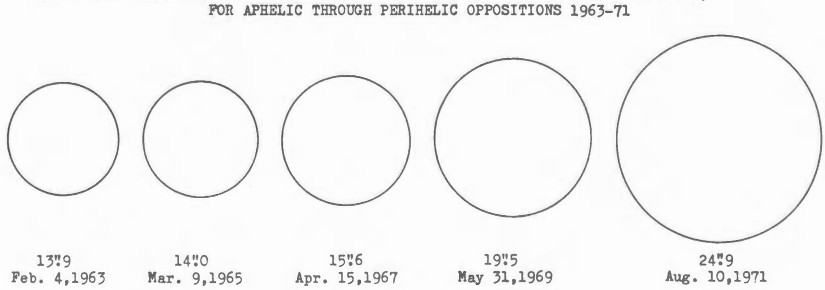


Figure 1. Heliocentric chart of the orbits of the earth and Mars, showing oppositions of Mars from 1963 to 1978. The distance between the two planets in miles at each opposition is marked. The orbit of Mars is also marked to show the beginning of each season in the northern hemisphere and the perihelion and aphelion longitudes.

FIGURE 2. RELATIVE APPARENT MARTIAN DISK SIZES, IN SECONDS OF SUBTENDED ARC, FOR APHELIC THROUGH PERIHELIC OPPOSITIONS 1963-71



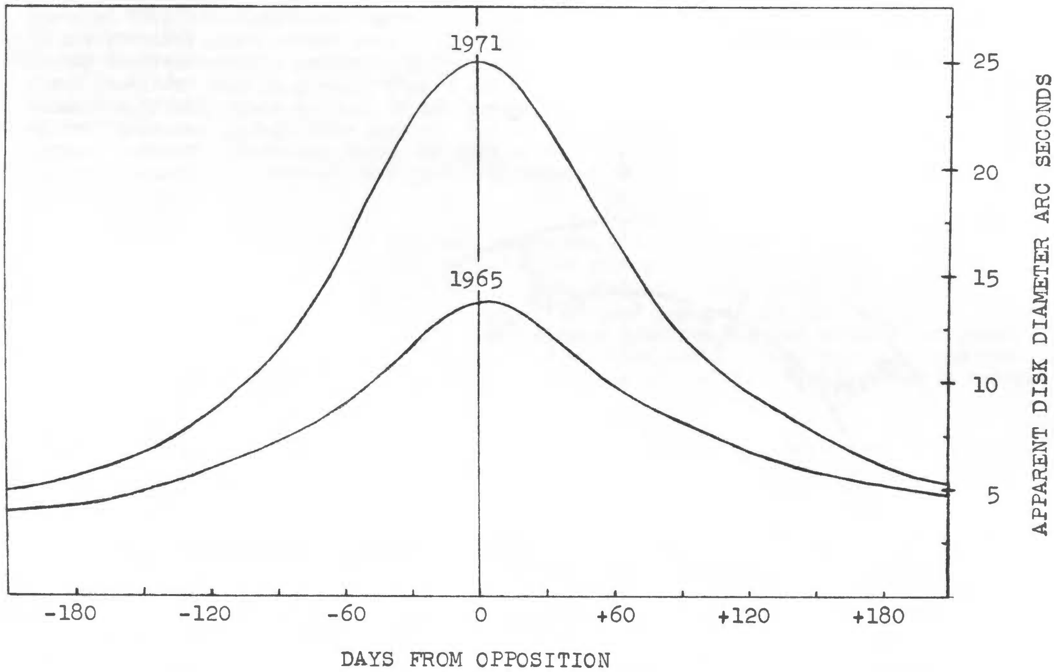


Figure 3. Comparison of apparent diameter of Mars in seconds of arc as a function of days from opposition for the unfavorable 1965 apparition and the favorable 1971 apparition. See also text of Mr. Capen's article.

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4. Capen, C. F., "Filter Techniques for Planetary Observers," Sky and Telescope, Vol. XVII, No. 10, August, 1958, pp. 517-520.

5. Eastman Kodak Co., Kodak Wratten Filters for Scientific and Technical Use, 22nd edition, Pub. No. B-3, Rochester, N. Y., 1965.

6. Eastman Kodak Co., Astrophotography With Your Camera, Kodak Pamphlet No. AC-20, Rochester, N. Y.

7. Capen, C. F., "The Amateur and Solar System Photography," Review of Popular Astronomy, Vol. LXI, No. 545, June, 1967, pp. 6-11.

8. Capen, C. F., "Simultaneous Multicolor Planetary Photography," Journal A.L.P.O., Vol. 21, Nos. 9-10, July, 1969, pp. 174-176.

TOTAL LUNAR ECLIPSE--FEBRUARY 10, 1971 (U.T.)

By: John E. Westfall, ALPO Lunar Recorder

The total lunar eclipse of February 9/10 (local time), 1971, will be visible in its entirety throughout North America. As this will be the first lunar eclipse so favorably visible since April, 1968, A.L.P.O. members are encouraged to make and submit observations of this event. The eclipse magnitude will be 1.313, where 1.000 or greater indicates a total eclipse.

Lunar Eclipse Schedule: February 9/10, 1971

	U.T.	EST	CST	MST	PST
Moon enters Penumbra	04:38.2	23:38.2*	22:38.2*	21:38.2*	20:38.2*
Moon enters Umbra	05:52.0	00.52.0	23:52.0*	22:52.0*	21:52.0*
Totality Begins	07:03.2	02:03.2	01:03.2	00:03.2	23:03.2*

	U.T.	EST	CST	MST	PST
Middle of Eclipse	07:44.7	02:44.7	01:44.7	00:44.7	23:44.7*
Totality Ends	08:26.2	03:26.2	02:26.2	01:26.2	00:26.2
Moon leaves Umbra	09:37.4	04:37.4	03:37.4	02:37.4	01:37.4
Moon leaves Penumbra	10:51.3	05:51.3	04:51.3	03:51.3	02:51.3

*February 9th; February 10th otherwise.

A number of useful observations of lunar eclipses may be made with a small telescope, binoculars, or even the naked eye. Forms for recording and submitting lunar eclipse observations may be obtained from the writer, and the methods for making these observations are described on pp. 22-24 of the A.L.P.O. Lunar Observer's Manual, which is obtainable from Lunar Recorder Charles Ricker. The following types of observations are particularly useful and, with the exception of number 2, are to be submitted to A.L.P.O. Editor, Walter H. Haas.

1. Timing (to ± 0.1 min.) umbral contacts and the beginning and end of totality.

2. Timing (to ± 0.1 min.) first and last umbral contacts for selected craters (listed on the lunar eclipse observation form mentioned above). These timings should be sent to: Sky and Telescope, 49-50-51 Bay State Road, Cambridge, Massachusetts 02138.

3. Observing and/or photographing selected lunar features both immediately before and immediately after their immersion in the umbra in order to detect possible eclipse-induced Transient Lunar Phenomena (TLP's). Some suggested features are: Alphonsus, Aristarchus, Atlas, Conon, Eratosthenes, Grimaldi, Linné, Messier-Pickering, Plato, Riccioli, Ross D, and Stöfler.

4. General descriptions, sketches, and photographs of umbral and penumbral shading, color, and visibility, including descriptions of the sharpness and form of the edge of the umbra. The Danjon Scale is recommended for describing eclipse luminosity.

5. Searching for possible lunar meteors during totality, using a magnification low enough to show the entire lunar disk. This eclipse will occur during the Alpha Aurigid meteor shower, which may enhance the possibility of lunar meteors, particularly in the northern and eastern (IAU) limb areas. Simultaneous observations of lunar meteors by different observers and different locations are particularly desirable.

6. Estimating the apparent magnitude of the moon at different times during the eclipse, particularly during totality and at mid-eclipse. Three methods for doing this are described in the A.L.P.O. Lunar Observer's Manual.

SATURN CENTRAL MERIDIAN EPHEMERIS, 1971

By: John E. Westfall

The two tables on pages 186 and 187 give the longitudes of Saturn's geocentric central meridian (C.M.) for the apparent disk (i.e., as corrected for phase) for 0^h, U.T. for each day in 1971. "System I" applies to the NEB, EZ, and SEB, while "System II" applies to the remainder of the ball, except the NPR and SPR (for which the rotation period is uncertain). Users are cautioned that latitude-dependent rotation rates for Saturn are less agreed-upon than for Jupiter, but the longitudes calculated from the accompanying tables will generally produce conveniently small drift rates.

These tables, except for the incorporation of the phase correction (never exceeding $0^\circ.18$) are a continuation of the tables for 1970 published in The Strolling Astronomer, Vol. 22, Nos. 1-2 (Jan., 1970), pages 34-36. The System I sidereal rate is assumed to be $844^\circ.00$/day (period = $10^h 14^m 13^s.1$), and the System II sidereal rotation rate is assumed to be $812^\circ.00$/day (period = $10^h 38^m 25^s.4$).

Example.--Find the Saturnian C.M. longitudes for System I and System II for $13^h 14^m$, U.T., on 16 August, 1971:

	System I	System II
C.M. at 0^h U.T., 16 Aug., 1971	$180^\circ.4$	$156^\circ.5$
+ Motion in 13^h	+097.2	+079.8

LONGITUDE OF CENTRAL MERIDIAN OF APPARENT DISK

	SYSTEM I -- 0^h U.T.											
Day	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
1	136°.5	018°.2	246°.6	125°.7	240°.9	120°.6	237°.7	120°.4	004°.9	127°.0	014°.2	137°.1
2	260.5	142.1	010.4	249.5	004.7	244.5	001.7	244.4	129.0	251.1	138.3	261.2
3	024.4	266.0	134.3	013.4	128.6	008.4	125.6	008.4	253.0	015.2	262.4	025.3
4	148.4	029.9	257.9	137.2	252.4	132.3	249.5	132.4	017.1	139.3	026.5	149.4
5	272.3	153.8	022.0	261.0	016.3	256.2	013.5	256.4	141.1	263.4	150.6	273.4
6	036.3	277.7	145.8	023.9	140.2	020.0	137.4	020.4	265.2	027.5	274.7	037.5
7	160.2	041.5	269.7	148.7	264.0	143.9	261.4	144.4	029.2	151.5	038.8	161.6
8	284.2	165.4	033.5	272.5	027.8	267.8	025.3	268.4	153.3	275.6	162.9	285.6
9	048.1	289.3	157.4	036.4	151.7	031.7	149.2	032.4	277.3	039.7	287.0	049.7
10	172.1	053.2	281.2	160.2	275.6	155.6	273.2	156.4	041.4	163.8	051.1	173.8
11	296.0	177.0	045.1	284.1	039.4	279.5	037.1	280.4	165.4	287.9	175.2	297.8
12	060.0	300.9	168.9	047.9	163.3	043.4	161.1	044.4	289.5	052.0	299.3	061.9
13	183.9	064.8	292.7	171.7	287.1	167.3	285.0	168.4	053.6	176.1	063.4	185.9
14	307.8	188.7	056.6	295.6	051.0	291.2	049.0	292.4	177.6	300.2	187.5	310.0
15	071.8	312.6	180.4	059.4	174.8	055.1	172.9	056.4	301.7	064.3	311.6	074.0
16	195.7	076.4	304.3	183.2	299.7	179.0	296.9	180.4	065.8	188.4	075.7	198.1
17	319.6	200.3	068.1	307.1	062.6	302.9	060.8	304.4	189.8	312.5	199.8	322.1
18	083.5	324.1	192.0	070.9	186.4	066.8	184.8	068.5	313.9	076.6	323.9	086.2
19	207.4	088.0	315.8	194.8	310.3	190.7	308.8	192.5	078.0	200.7	088.0	210.2
20	331.4	211.9	079.6	318.6	074.1	314.6	072.7	316.5	202.1	324.9	212.1	334.3
21	095.3	335.7	203.5	082.5	198.0	078.5	196.7	080.5	326.2	089.8	336.2	098.3
22	219.2	099.6	327.3	206.3	321.9	202.4	320.7	204.6	090.2	213.1	100.3	222.3
23	343.1	223.4	091.2	330.1	085.7	326.4	084.6	328.6	214.3	337.2	224.4	346.4
24	107.0	347.3	215.0	094.0	209.6	090.3	208.6	092.6	338.4	101.3	348.5	110.4
25	230.9	111.2	338.8	217.8	333.5	214.2	332.6	216.6	102.5	225.4	112.6	234.4
26	354.8	235.0	102.6	341.7	097.4	338.1	096.5	340.7	226.6	349.5	236.7	358.4
27	118.7	358.9	226.5	105.5	221.2	102.0	220.5	104.7	350.6	113.6	000.8	122.5
28	242.6	122.7	350.3	229.4	345.1	226.0	344.5	228.8	114.7	237.7	124.9	246.5
29	006.5	-----	114.2	353.2	109.0	350.9	108.5	332.8	238.8	001.8	249.0	010.5
30	130.4	-----	238.0	117.0	232.9	113.8	232.5	116.8	002.9	126.0	013.0	134.5
31	254.3	-----	001.8	-----	356.7	-----	356.4	240.9	-----	250.1	-----	258.5

MOTION OF THE CENTRAL MERIDIAN

01^h -- 035°.2	09^h -- 316°.5	17^h -- 237°.8	10^m -- 005°.9	1^m -- 000°.6
02 -- 070.3	10 -- 351.7	18 -- 273.0	20 -- 011.7	2 -- 001.2
03 -- 105.5	11 -- 026.8	19 -- 308.2	30 -- 017.6	3 -- 001.8
04 -- 140.7	12 -- 062.0	20 -- 343.3	40 -- 023.4	4 -- 002.3
05 -- 175.8	13 -- 097.2	21 -- 018.5	50 -- 029.3	5 -- 002.9
06 -- 211.0	14 -- 132.3	22 -- 053.7		6 -- 003.5
07 -- 246.2	15 -- 167.5	23 -- 088.8		7 -- 004.1
08 -- 281.3	16 -- 202.7			8 -- 004.7
				9 -- 005.3

Example of longitude computation (continued)	System I	System II
+ Motion in 10^m	+005°.9	+005°.6
+ Motion in 4^m	+002.3	+002.3
C.M. at 13^h14^m U.T., 16 Aug., 1971	285°.8	244°.2

More realistically, the above longitudes would be rounded off to 286° and 244° respectively. Note that if the calculated longitude exceeds 360°, we substract 360°.

SATURN, 1971

LONGITUDE OF CENTRAL MERIDIAN OF APPARENT DISK

SYSTEM II -- 0^h U.T.

Day	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
1	176°.4	146°.2	198°.6	165°.8	041°.1	008°.8	245°.9	216°.5	188°.9	070°.9	046°.0	288°.9
2	268.4	228.1	290.5	257.7	132.9	100.7	337.8	308.5	280.9	163.0	138.1	021.0
3	000.3	330.0	022.3	349.5	224.8	192.6	069.7	040.5	013.0	255.0	230.2	113.1
4	092.3	061.9	114.0	081.4	316.6	284.4	161.7	132.5	105.0	347.1	322.3	205.2
5	184.2	153.8	206.1	173.2	048.5	016.3	253.6	224.4	197.1	079.2	054.4	297.2
6	276.2	245.7	297.9	264.0	140.3	108.2	345.6	316.4	289.1	171.3	146.5	029.3
7	008.2	337.5	029.8	356.8	232.2	200.1	077.5	048.4	021.2	263.4	238.6	121.4
8	100.1	069.4	121.6	088.7	324.0	292.0	169.4	140.4	113.2	355.5	330.7	213.4
9	192.0	161.3	213.4	180.5	055.9	023.9	261.4	232.4	205.3	087.6	062.8	305.5
10	284.0	253.2	305.3	272.4	147.7	115.8	353.3	324.4	297.3	179.7	154.9	037.6
11	015.9	345.1	037.1	004.2	239.6	207.7	085.2	056.4	029.4	271.8	247.0	129.6
12	107.9	076.9	129.0	096.1	331.4	299.6	177.2	148.4	121.5	003.9	339.1	221.7
13	199.8	168.8	220.8	187.9	063.3	031.5	269.2	240.4	213.5	096.0	071.2	313.8
14	291.8	260.7	312.7	279.7	155.2	123.4	001.1	332.4	305.6	188.1	163.4	045.8
15	023.7	352.6	044.5	011.6	247.0	215.3	093.0	064.5	037.6	280.2	255.5	137.9
16	115.6	084.4	136.4	103.4	339.9	307.2	185.0	156.5	129.7	012.3	347.6	229.9
17	207.5	176.3	228.2	195.3	070.7	039.1	277.0	248.5	221.8	104.4	079.7	322.0
18	299.5	268.2	320.1	287.1	162.6	131.0	008.9	340.5	313.8	196.5	171.8	054.0
19	031.4	000.0	051.9	018.9	254.5	222.9	100.9	072.5	045.9	288.6	263.9	146.0
20	123.3	091.9	143.8	110.8	346.3	314.8	192.8	164.5	138.0	020.7	356.0	238.1
21	215.2	183.8	235.6	202.6	078.2	046.7	284.8	256.6	230.1	112.8	088.0	330.1
22	307.1	275.6	327.4	294.5	170.1	138.6	016.8	348.6	322.1	204.9	180.1	062.2
23	039.1	007.5	059.3	026.3	261.9	230.5	108.7	080.6	054.2	297.0	272.2	154.2
24	131.0	099.4	151.1	118.1	353.8	322.4	200.7	172.6	146.3	029.1	004.3	246.2
25	222.9	191.2	243.0	210.0	085.7	054.4	292.6	264.6	238.4	121.2	096.4	338.2
26	314.8	283.1	334.8	301.8	177.5	146.3	024.6	356.7	330.5	213.3	188.5	070.3
27	046.7	014.9	066.6	033.7	269.4	238.2	116.6	088.7	062.5	305.4	280.6	162.3
28	138.6	106.8	158.5	125.5	001.3	330.1	208.6	180.8	154.6	037.6	012.7	254.3
29	230.5	-----	250.3	217.4	093.2	063.0	300.6	272.8	246.7	129.7	104.8	346.3
30	322.4	-----	342.2	309.2	185.0	154.0	032.5	004.8	338.8	221.8	196.8	078.3
31	054.3	-----	074.0	-----	276.9	-----	124.5	096.9	-----	313.9	-----	170.4

MOTION OF THE CENTRAL MERIDIAN

01^h -- 033°.8	09^h -- 304°.5	17^h -- 215°.2	10^m -- 005°.6	1^m -- 000°.6
02 -- 067.7	10 -- 338.3	18 -- 249.0	20 -- 011.3	2 -- 001.1
03 -- 101.5	11 -- 012.7	19 -- 282.8	30 -- 016.9	3 -- 001.7
04 -- 135.3	12 -- 046.0	20 -- 316.7	40 -- 022.6	4 -- 002.3
05 -- 169.2	13 -- 079.8	21 -- 350.5	50 -- 028.2	5 -- 002.8
06 -- 203.0	14 -- 113.7	22 -- 024.3		6 -- 003.4
07 -- 236.8	15 -- 147.5	23 -- 058.2		7 -- 003.9
08 -- 270.7	16 -- 181.3			8 -- 004.5
				9 -- 005.1

OBSERVING THE MOON: THE SPACECRAFT VERSUS THE TELESCOPE

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

Introduction

At the Las Cruces meeting of the A.L.P.O., in 1968, a paper of the writer's was presented, titled "What the Orbiter Photographs Don't Tell Us." The following paper is a rewritten version of the 1968 one, intended for the interest of A.L.P.O. members who did not hear the original, and has been expanded to take into consideration the more recent photography by the Apollo lunar missions.

* * * * * * *

In these days one often hears the opinion that the lunar photographs taken by the Orbiter and Apollo missions have made further earthbased observations of the moon purposeless. One can understand this viewpoint when one considers that the five Orbiter missions alone, in 1966-67, secured 1,950 photographs covering over 99 percent of both lunar hemispheres with far higher resolution than the best earthbased observations, photographic or visual. Since then, the five Apollo lunar expeditions (Apollo-8, -10, -11, -12, and -13) have secured thousands of frames of additional photography, often of resolution and photographic quality superior even to the Orbiter photographs. Although their high resolution is perhaps the most valuable aspect of Orbiter and Apollo photographs, many of them are useful also because they are vertical views, showing features without the foreshortening that confuses the earthbound observer. Naturally, too, spacecraft photographs are our only source of knowledge about the moon's far side.

It is reasonable to give Orbiter-IV photographs special attention here because this spacecraft furnished photographs of the most interest to selenographers. Orbiter-IV photographed almost all the earthside lunar hemisphere on a series of photographs at a comparable scale and illumination. In other words, Orbiter-IV produced its own "Photographic Atlas". Frontside coverage by Orbiter-IV was from an altitude of about 2,700 to 2,900 kilometers, with a telephoto lens of 610 millimeters focal length (giving a scale equivalent to about 90 meters focal length for a terrestrial telescope!). The ground resolution of these photographs averaged about 80 meters, which is the theoretical resolution of a 100-inch telescope--assuming <u>perfect</u> seeing!

Although they represent an impressive technological triumph, it is easy to expect too much from the Orbiter-IV photographs, and the same caution applies to the other Orbiter missions as well. For example, except where two photographs overlap, each feature is shown at only one particular instant--that of exposure. The first consequence of this is that features are shown under only one lighting. The altitude of the sun at each frame center usually was about 20°; and, since the east-west extent of a frame was about 12° on the moon, the usual solar altitude range was then about 14° to 26°. Furthermore, all frontside photographs show areas under morning lighting, with the sun above the (IAU) eastern horizon. One result of this is that the (IAU) east inner walls of most craters are lost in shadow, while the illuminated (IAU) west inner walls tend to be overexposed. This problem is familiar to the amateur, or professional, who has attempted lunar photography; but he has the option of taking other photographs under different solar lightings, or of taking a series of photographs with the same lighting but with different exposure times.

The particular range of solar altitudes characteristic of the Orbiter-IV photographs (and of most other Orbiters) was a good compromise for showing most lunar relief features. With a much higher sun there would be too few shadows, and with a much lower sun there would be too many. However, by the nature of things, a compromise cannot satisfy everyone so that students of some particular types of features are bound to be disappointed. Features with slopes less than about 10° are not brought out in most Orbiter views because their slopes are not shaded. Most domes and ridges, therefore, are not visible as elevations, although they often are evidenced by their tones or by secondary features upon them. On the other hand, some lunar features are not well shown because the sun is too low. Such features are the famous bands found on the inner walls of some craters, as well as crater ray systems. The tonal detail on Orbiter photographs is thus not comparable with the topographic detail.

The subject of lunar tones leads to another problem that the Orbiter photographs cannot solve--the question of lunar change. For example, even were crater wall bands photographed by the Orbiters, only a single aspect of the bands would be visible. Actually, the appearance of wall bands changes greatly during the course of a lunation. More generally, the Orbiter photographs give no direct evidence as to lunar tonal variations.

The situation is similar with Transient Lunar Phenomena (TLP's)--none have been photographed from lunar orbit. In fact, in order to detect TLP's, a whole fleet of Orbiters, or manned spacecraft, would be required, keeping areas of suspected, short-duration phenomena under constant scrutiny. Obviously, this experiment would be prohibitively expensive.

The photographs accompanying this paper illustrate some of the points made above for the specific case of the Aristarchus-Herodotus Region. Readers will realize that it is difficult to preserve in reproduction the finer detail and tones on the original prints.

Figure 4 is perhaps the most detailed (highest-resolution) existing earthbased photograph of the area of Aristarchus and Herodotus, taken by the Lick Observatory 120-inch reflector, at colongitude 57°.3. The effect of foreshortening is shown by the apparent elliptical shapes of craters, which are actually approximately circular.

Figure 5 is the same photograph shown in Figure 4, but it has been approximately corrected for foreshortening. It is evident, due to low sun, that considerable surface deatil is lost in shadow; but, as already pointed out, the terrestrial observer has the opportunity to take other photographs under different lightings.

For comparison, Figure 6 is an Orbiter-IV photograph of the same area, taken on May 22, 1967, at colongitude 67°.4 (Orbiter-IV frame H-150). Even in this greatly-reduced reproduction, the superior resolution of the Orbiter photograph is obvious. However, a statistical sampling of 696 points in this photograph showed that 11 percent of its area is seriously underexposed, 18 percent is seriously overexposed, and 5 percent is lost in shadow. Thus, about one-third of the photograph is only marginally usable, or is not usable at all. This over- and under-exposure can be corrected for to some extent--as indeed was done with the later Orbiter-V photographs of the same area--but the shadow areas reamin <u>terra incognita</u> as far as the Orbiters are concerned.

The same area under high solar illumination is shown in Figure 7, and was taken by the Lick Observatory 120-inch reflector at colongitude 148°.8. The extremely complex pattern of tonal detail in this photograph is not indicated at all in the Orbiter views.

Fortunately, many of the limitations inherent in the Orbiter photographs do not apply to the more recent Apollo photographs--certainly one justification of "man in space". Apollo photographs have been taken under a wide variety of lightings, from views showing the terminator areas to views with an almost-vertical sun. During single Apollo missions, some features have been photographed repeatedly on successive orbits, over a time range of a number of hours rather than the split-second of the Orbiter frames. It should be mentioned also that many Apollo photographs were better exposed than most Orbiter views since the astronauts had the advantage of the "experience" of the Orbiters and also took the opportunity to adjust exposure to meet varying lighting and albedo conditions. Finally, because of their relatively low orbital altitudes, the Apollo photographs often have resolutions superior even to the Orbiter frames.

Indeed, so spectacular are most Apollo photographs that there is little doubt that such photography has the potential of replacing most, if not all, earthbased observation. This potential, however, has not yet been realized; nor is it likely to be realized in the immediate future, because the full potential of lunar orbital photography can be realized only by a fleet of orbiting spacecraft, spaced in orbits of varying inclination, continually photographing and rephotographing all the moon's surface under different lightings and at different times in order to detect possible short-term phenomena and long-term changes.

Present and planned Apollo missions give us a much more restricted view of the moon's surface than such purely theoretical optimum coverage. The spectacular photographs now available are limited to only a fraction of the moon's surface. High-resolution views are restricted to areas near the orbital track, while vertical, unforeshortened views are possible only directly below the spacecraft. Because of the low orbital inclination of all Apollo missions to date, such coverage is limited to areas near the lunar equator, although future missions may photograph areas farther north and south. In summary, Apollo photographs, although generally of excellent quality, are useful only for a small part of the moon's surface. That they can be valuable in such cases is shown by Figure 8, which is an oblique photograph of the area of the Hyginus Cleft, as taken by the Apollo-10 astronauts.

We must conclude that there still is, and will be for some time, a need for continued earthbased lunar observation; and amateur observers can help to fill this need. The field open for new contributions is more limited than in the past, but careful observational programs will still yield dividends in the following types of studies:

1. Topographic studies under low lighting of low relief features, such as domes, ridges,

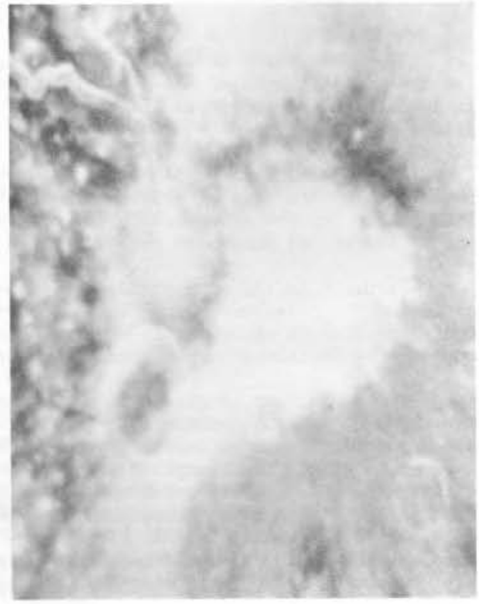

Figure 4. The region of Aristarchus, Herodotus, and Schröter's Valley, photographed by the Lick Observatory 120-inch reflector at colongitude 57°.3 (low morning lighting). The crater Aristarchus, 40 kilometers in diameter, is right of center. The effect of foreshortening is shown by the apparent elliptical shape of Aristarchus and other craters. The resolution of this photograph is about 400 meters. North is at the top.

Figure 7. The light rays and other tonal features near Aristarchus are shown in this photograph by the Lick Observatory 120-inch reflector at colongitude 148°.8 (near local noon). Such features are visible only under a high sun and thus are not seen in the Orbiter view in Figure 6. North at top.

Figure 5. This photograph is a reproduction of that shown in Figure 4, but has been approximately corrected for foreshortening by means of optical projection. North at top.

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saucers, and terminator deformations.

2. Topographic studies under high solar illumination of lunar "steep places".

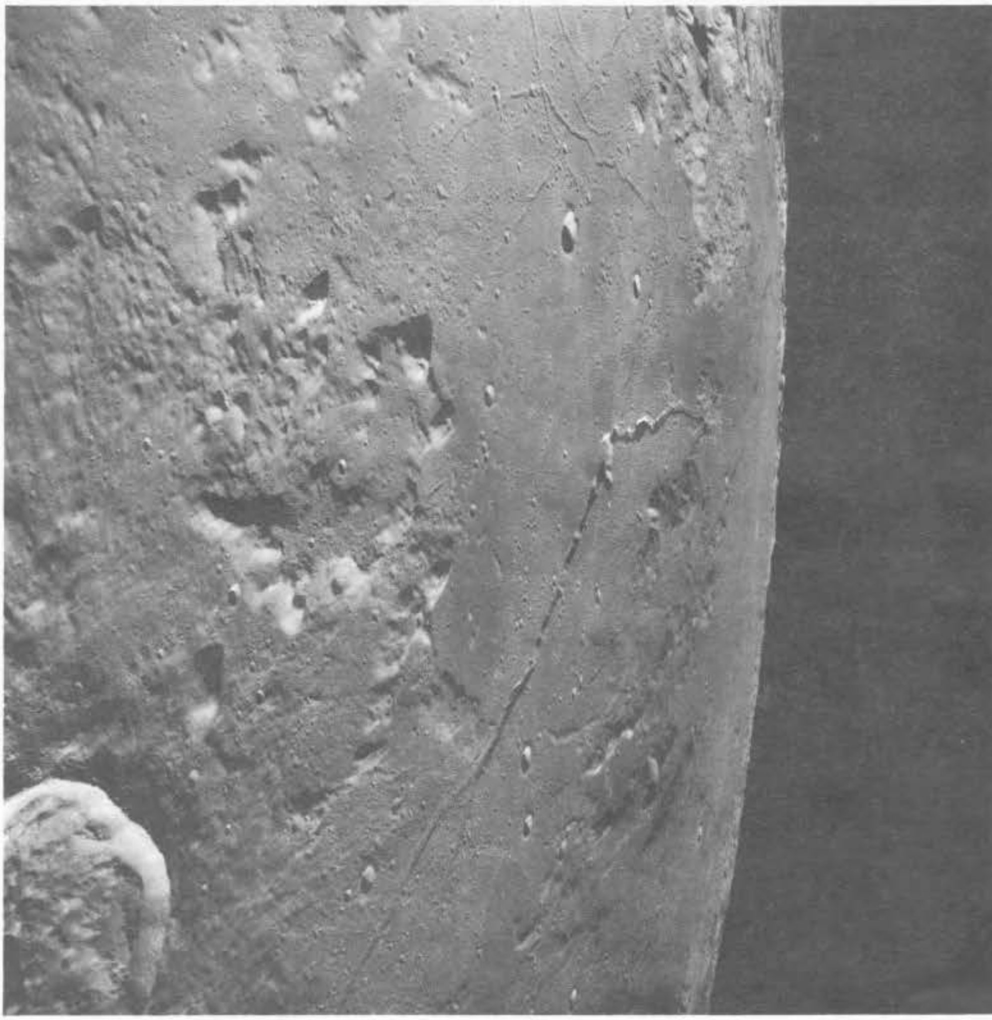
3. Topographic studies with medium solar altitudes after full phase to study relief obscured by shadows in the Orbiter and Apollo frontside frames.

4. Studies under a large range of solar lightings to investigate lunar tones and their possible changes.

5. Continuing surveys for Transient Lunar Phenomena.

It is important to emphasize that Orbiter and Apollo photographs can and should be used in conjunction with amateur observing programs. First, such photographs make excellent bases for outline maps, particularly if one converts them to the Orthographic Pro-

Figure 8. Apollo-10 photograph AS10-32-4811, available in the A.L.P.O. Lunar Photograph Library. This view looks northward across Mare Vaporum, with the crater Hyginus (10 kms. in diameter) and its famous cleft system right of center. A portion of the Triesnecker cleft system is near the top margin, and the Apennine Mountains are near the horizon. The large crater partly visible in the lower left is Agrippa, 46 kilometers in diameter.



jection so that they will resemble the telescopic appearance of features. On the other hand, the relative lack of foreshortening in many orbital photographs is a great help in the interpretation of topography and relative positions, particularly in the limb areas. Also, small details whose nature is not clear from earthbased views usually can be unambiguously identified on Orbiter or Apollo frames. For example, many central peaks previously thought to have hill-top craterpits have no such depressions detectable in Orbiter or Apollo photographs. Finally, Transient Lunar Phenomena observed from earth often may be identified with specific topographic features seen in the orbital photographs.

In summary, the Orbiter and Apollo photographs are unique and indispensable tools for the selenographer, but they are all the more valuable when used to supplement earthbased observations rather than to replace them.

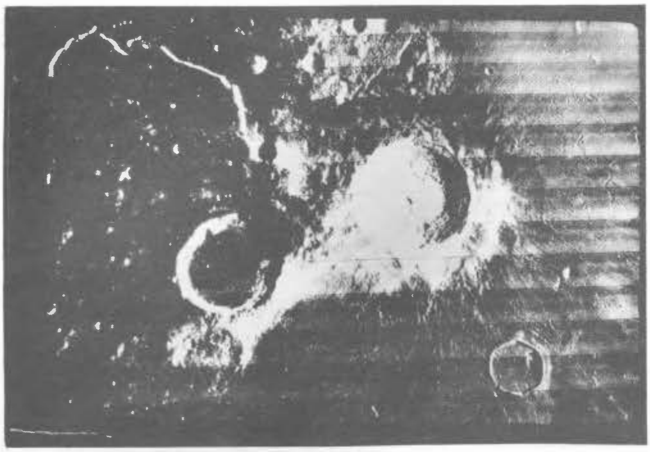


Figure 6. The Aristarchus-Herodotus Region on Orbiter-IV frame H-150, which is in the A.L.P.O. Lunar Photograph Library. This view was taken on May 22, 1967, at colongitude 67°.4. On the original photograph, resolution is about 80 meters, or about five times finer than in Figure 4. North at top.

A.L.P.O. OBSERVATIONS OF THE 1970 MERCURY TRANSIT

By: Richard G. Hodgson, A.L.P.O. Mercury Recorder

(Paper read at the A.L.P.O. Convention at Sacramento, California, August 20-22, 1970.)

1. Introduction

On May 9, 1970 the planet Mercury transited the solar disc as seen from the Earth. A considerable number of persons (134+) observed this event, the first since November 7, 1960, as evidenced by a recent report in Sky and Telescope magazine.[1] The report here is based on the 13 observations reported to the Mercury Recorder as of August 5. Unfortunately, the Recorder himself did not see the event, having been clouded out in Northwestern Iowa.

Those who reported were:

Name	Location	Contact Timings	Instrument
1) Blundell, Bruce	Jamaica, N. Y.	III, IV	50-mm. refr.
2) Bortle, John E.	Stamford, Conn.	III, IV	60-mm.f/15 refr.
3) Boyar, Daniel	Massapequa, N. Y.	III, IV	155-mm. f/8.2 Newtonian.
4) Eppert, Chet B.	Philadelphia, Pa.	III, IV	155-mm. f/10 Newtonian.
5) Gordon, Rodger W.	Nazareth, Pa.	-----	88-mm. Questar.
6) Krisciares, Kevin L.	Napierville, Ill.	-----	155-mm. f/8 Newtonian.
7) Levine, Joel Levine, Mark Lovi, George Cruz, Eloy Omar	Brooklyn College Observatory, Brooklyn, N. Y.	III, IV	18-cm. f/15 refr.
8) Lowe, Andrew	Ardrossan, Alberta	-----	70-mm. refr.
9) Milligan, Thomas	Jamaica, N. Y.	III, IV	155-mm. f/8 Newtonian.
10) Osawa, Toshihiko	Hyogo-ken, Japan	I	60-mm. refr.
11) Shaver, John	Villa Park, Ill.	-----	20-cm. f/14.9 Newtonian. 155-mm. f/5 Newtonian.
12) Yajko, Robert A.	Leechburg, Pa.	III	100-mm. & 55-mm. refrs.
13) Wessling, Richard J.	Milford, Ohio	-----	32-cm., stopped to 13-cm., Newtonian.

The contribution of all of these observers is very much appreciated. Five of the above observations, i.e. those of Blundell, Bortle, Eppert, Levine et al., and Yajko, were also reported to Sky and Telescope magazine and figured into their computations of the event.[2]

2. Predicted and Observed Times of Contacts

First Contact

The only observation received of First Contact was that of Toshihiko Osawa of

Japan, at 134°45' E. long. and 34° 14' N. lat.: Observed $4^h18^m50^s$, (Computed, Predicted) $4^h19^m23^s$, O-C - 33^s (all in U.T.). This is a rather large difference, and in an unexpected direction. (Five observations cited in Sky and Telescope had residuals ranging from - 1^s to + 39^s with an average of + 14^s).[3] Osawa was unable to secure a timing of Second Contact.

Third Contact

Observations of Third Contact in Universal Time were as follows:

	Observed	Computed	O-C
Blundell	$12^h\ 10^m\ 15^s$	$12^h\ 10^m\ 27^s$	-12^s
Bortle	10 27	10 26	+ 1^s, slight black drop
Eppert	10 34	10 28	+ 6^s
Levine et al.	10 51.4	10 27	$+24^s$
Mulligan	10 35	10 27	+ 8
Yajko	13 06 *	13 28	-22^s

*Given as $12^h10^m25^s.5$ in letter to ALPO; figure used is from Sky and Telescope.

Of these six observations, the range of residuals is from -22^s to $+24^s$; the average is $+5^s$. Thus our average observer noted Third Contact 5 seconds after the predicted time. The Sky and Telescope analysis found an average of -8^s and a median of -6^s for Third Contact based on 118 observations.[4]

Fourth Contact

The Fourth Contact was reported as follows, in U.T.:

	Observed	Computed	O-C
Blundell	$12^h\ 13^m\ 41^s$	$12^h\ 13^m\ 27^s$	$+14^s$
Bortle	13 12	13 27	-15
Eppert	13 31	13 29	+ 2
Levine et al.	13 30	13 28	+ 2
Mulligan	13 45	13 27	+18

3. Black Drop Effects

When inferior planets transit the Sun there is often a dark filament connecting the dark planetary disc with the solar limb just after Second Contact and just before Third Contact. This is commonly the "Black Drop" effect, and is most pronounced in the case of the planet Venus. Both Bruce Blundell and Rodger Gordon reported looking for and not finding any Black Drop effect just prior to Third Contact on May 9. On the other hand, John Bortle noted that "approximately fifteen seconds before Contact III a faint filament appeared connecting Mercury with the limb."

In the case of Venus the Black Drop effect is largely due to that planet's dense atmosphere; in the case of Mercury, which has no significant atmosphere, the cause of the effect is uncertain.

4. Satellite Search

Due to its proximity to the Sun, it is difficult to search for possible satellites of Mercury except during transits or total solar eclipses. The May transits are more favorable for this task than November transits since Mercury is closer to the Earth during May transits, and any satellites would be somewhat easier to observe.

John Shaver searched the vicinity of Mercury during the May 9 transit - up to about 30 Mercury diameters - for any possible minor satellites. Using an 8-inch reflector he found no evidence of any satellites. This would mean that there are no satellites larger than about 150 miles (240 kms.) in diameter unless they were hidden by the planet at time of observation, which is highly unlikely. Other studies with larger instruments made previously have yielded negative results down to about 50 miles (80 kms.) in diameter. Further searches with large instruments would be of interest.

Figure 9. Photograph of transit of Mercury across the sun on May 9, 1970 by Toshihiko Osawa with a 60-mm. refractor at $4^{h}47^{m}8^{s}$, U.T. Mercury is dark, round, and about 3/16 of an inch from the sun's limb.

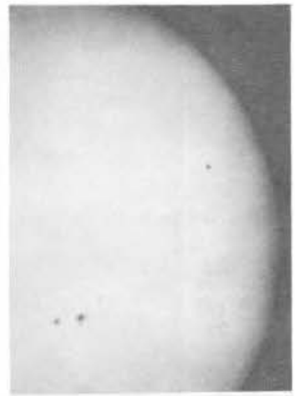


Figure 10. Photograph of Mercury transit on May 9, 1970 by T. Osawa. 60-mm. refr. $5^{h}13^{m}42^{s}$, U.T. Mercury about 3/8 of an inch from sun's limb.

5. The Diameter of Mercury

Transits of Mercury present an opportunity to measure the planet's diameter if instruments of fairly large aperture are employed. None of the A.L.P.O. members reporting observations on May 9 undertook any measures of Mercury's diameter. John Bortle comments, however, that "Mercury appeared to be significantly larger than remembered for the November 1960 transit." That, of course, would be the case in view of Mercury's greater proximity in May transits.

6. Sunspot Opportunity

Several observers noted that Mercury transited a large sunspot on the solar disc. Rodger Gordon commented "For a while (about 5 minutes) the planet and umbra of the spot blended into one . . . . It's too bad some radio telescope might not have been observing the transit as it passed over the sunspot. A valuable opportunity for monitoring the radio emission from the portion of the Sun may have been missed. Of course no one could predict Mercury would pass over the spot."

7. The Next Transit of Mercury

The next transit of Mercury will occur on 1973, Nov. 10, and will be visible in part of North America as an early morning event. A.L.P.O. members should keep this date in mind.

References

1. Sky and Telescope, Vol. 40, No. 1 (July, 1970), pp. 20-24.

2. Ibid.

3. Ibid., p. 22.

4. Ibid.

LUNAR NOTES

By: Charles L. Ricker and Harry D. Jamieson, ALPO Lunar Recorders

I. An Exemplary Observational Study of Atlas, by Charles L. Ricker

Since the last "Lunar Notes", observations have been received from the following observers: Inez Beck, who has continued her series on Eratosthenes; Greg Redfern;

Steven Szczepanski, who has been observing Plato regularly for some months, and is now observing Atlas; Richard Wessling, who is also equipped to take fine photographs; and Christopher Vaucher, who has concentrated upon Atlas and Alphonsus.

The accompanying observation of Atlas (Figure 11) was carried out by Christopher Vaucher, using only a 2.4" telescope. Along with the drawing, extensive written notes were received, from which the following account is extracted:

"L and P are two very similar dark and nearly circular areas. Both of them are about the same size, although L is definitely better defined around the edges than P is. I have a theory on this fact. After careful consideration, I believe the reason that L is better defined than P is this: L is totally surrounded by a hilly, highland area that is brighter in intensity than the area surrounding P. Since L appears to be much lower in elevation than the surrounding area, and since the highland area is brighter than the crater floor, it appears that the point where F and G meet L is very definite; and this sharpness is enhanced since the intensity difference between L and its surrounding area is greater than the intensity difference between P and its surrounding area. Also, the difference in elevation is not so great for P as for L. I estimated that L is about intensity 2.5 and very well defined, while I estimated P to be about 3 (being definitely not so dark as L was). This was only estimated after careful comparisons with L, the crater floor, and of course the Mare tone.

"I have a new area to report to you in this observation. This area is marked as S, lying between the highland area G and the crater floor H. This area is reasonably well-defined, and about as well defined as D and J, being also larger than D or J. This is the first time this area has been seen by me, and it was so well seen that I at first could not believe that I had never seen it before. It appears that this area is another large peak, like the central peaks but larger than any of the central peaks. I estimated area S as a definite 7 in intensity, like all the central peaks. Again, I think this area is another peak, higher that the crater floor, and even higher than the highlands area bordering it. Seeing conditions deteriorated just as I started observing Atlas, and I estimated the seeing as 4 tonight. The crater floor of Atlas I estimated as being intensity 6."

The numerical intensities cited are on a scale of 0 (shadows) to 10 (most brilliant features).

The foregoing account is a model of what can be accomplished by a skilled observer using a very small telescope, and his brain. Mr. Vaucher is to be commended for his fine efforts. All of his observations are accompanied by extensive written notes, which point out many things which may be missed by the Recorder, and which make interpretation of the drawings much easier. The Recorder studied available photographs of the region, including Orbiter IV photos, and they do not confirm or refute Mr. Vaucher's ideas. The Orbiter photos show an extensive rille system associated with the dark patches, which are very similar to ones on published photographs of Alphonsus; and no doubt the dark patches in both formations are of similar origin.

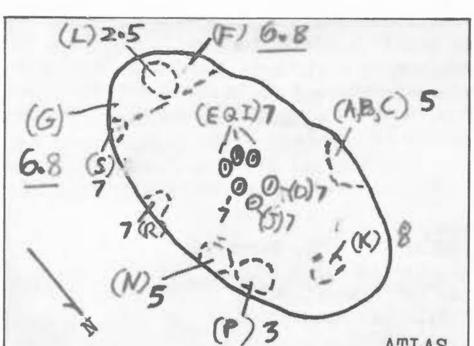


Figure 11. Drawing of the lunar crater Atlas by Christopher Vaucher on October 13, 1970, 3^h29^m to 4^h0^m, U.T. 2.4-inch refractor. 63X. Seeing 4 (scale of 0 to 10 with 10 best), transparency $4\frac{1}{2}$ (limiting magnitude). Colongitude $65^\circ 9$. The letters on the sketch are Mr. Vaucher's own identifications. The numbers are estimated intensities on a scale of 0 to 10, with 10 brightest.

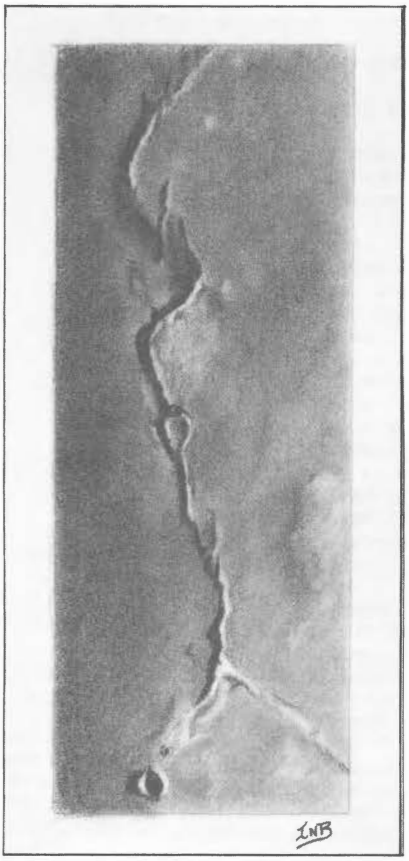


Figure 12. Drawing of the Serpentine Ridge in Mare Serenitatis by Mrs. Inez Beck on June 24, 1970 at 8^h41^m, U.T. 6-inch reflector, 152X. Seeing 9, transparency 6½ (same scales as for Figure 11). Colongitude 152°.9. See also accompanying text by Harry D. Jamieson.

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II. Heights along the Serpentine Ridge, by Harry D. Jamieson

As a class of features, ridges seem to have been pretty much ignored by most students of the Moon until very recently. These usually inconspicuous objects are really only well seen under low lighting, and can be quite difficult to draw with accuracy. Mrs. Inez Beck's drawing of the Serpentine Ridge in the (IAU) eastern basin of Mare Serenitatis is one of the best that this writer has ever seen, and is here presented as Figure 12. Readers may want to compare this fine work with a good photograph of the region, such as OLA B3-e.

At present, the A.L.P.O. Lunar Section is undertaking a study of the vertical dimensions of ridges, faults, and other previously ignored features in order to complete our knowledge of general topography. The Serpentine Ridge has been under study for some time now, and some selected values for heights along its length can now be announced. At the following xi and eta coördinates, heights have been measured from OLA B3-e as follows:

+367	+506	880 meters
+374	+475	900 "
+383	+454	1600 "
+388	+430	1700 "

The above values are, of course, very approximate. However, they should serve to give a rough idea of just how low these objects are, compared to their respectable width. Much more information is needed about the heights of ridges, for these are at best only poorly known. Readers searching for a challenging study are heartily invited to contact the writer for more information. Readers are also reminded that the needed evaluation of accidental and systematic errors in observations of the heights of ridges requires a substantial body of data, preferably from many different participating lunar observers.

JUPITER IN 1965-66: ROTATION PERIODS

By: Phillip W. Budine, A.L.P.O. Assistant Jupiter Recorder

The highlights of the 1965-66 apparition were: a revival of the Circulating Current, the continued observations of an abnormally slow portion of the North Equatorial Current, the continued prominence of the three long-enduring white South Temperate Zone ovals, the prominence of the Red Spot, and most important, observational evidence perhaps for the first time, of vorticity in the Great Red Spot.

Some data pertinent to the apparition follow:

Date of Opposition: 1965, December 18.
Dates of Quadrature: 1965, September 23; 1966, March 13.
Declination of Jupiter: +23° (at opposition).
Equatorial Diameter: 47.6 seconds (at opposition).
Zenocetric Delination of Earth: +2°.4 (at opposition).
Magnitude of Jupiter: -2.3 (at opposition).

This report is based on 4,645 visual central meridian transit observations submitted by five observers. Fifty-four per cent of these transits (2,446) form usable drifts for 105 Jovian spots distributed in 11 different atmospheric currents. The contributing observers are listed below by name and by number of transits submitted along with station of observation and telescope(s) employed.

Budine, Phillip W.	Binghamton, N. Y.	10-in. refl.	2050 t.
Farrell, Joanne	Binghamton, N. Y.	3-in. & 4-in. refrs.	194 t.
Heath, Alan W.	Long Eaton, Nottingham, England	12-in. refl.	27 t.
Pollak, Charles	Binghamton, N. Y.	8-in. refl.	1135 t.
Reese, Elmer J.	New Mexico State University Observatory	8-in., 12-in. & 16-in. refls.	1327 t.

The distribution of transit observations by months is as follows:

1965, July	53	1965, November	703	1966, March	419
August	120	December	896	April	62
September	571	1966, January	652	May	28
October	609	February	532		

In the tables which follow, the first column gives an identifying number or letter to each object. The second column indicates whether the object was dark (D) or bright (W) and whether the preceding end (p), center (c), or following end (f) was being observed. The third column give the first and last dates of observation; the fourth column, the longitudes on those dates. The fifth column gives the longitude at opposition, on December 18, 1965. The sixth column gives the number of transits. The seventh column indicates the number of degrees in longitude that the marking drifted in 30 days, negative when the longitude decreased with time. The eighth column shows the average rotation period for the current in hours, minutes, and seconds.

S.S. Temperate Belt, System II

No.	Mark	Limiting Dates	Limiting L.	L.	Transits	Drift	Period
1	Wc	Nov. 28-Dec. 22	288°- 273°	275°	13	-15°.0	9:55:20
					Mean rotation period:		9:55:20

S. Temperate Current (S. edge STB, STeZ), System II

No.	Mark	Limiting Dates	Limiting L.	L.	Transits	Drift	Period
F	Wp	Aug. 21-Apr. 17	119° -318°	40°	44	-20°.0	9:55:13
1	Wc	Aug. 21-Apr. 17	127 -330	48	48	-20.0	9:55:13
A	Wf	Aug. 21-Apr. 17	136 -337	57	37	-20.0	9:55:13
B	Wp	Aug. 27-Mar. 27	227 - 98	160	25	-18.5	9:55:15
2	Wc	Aug. 27-Mar. 27	240 -105	168	27	-18.5	9:55:15
C	Wf	Aug. 27-Mar. 27	247 -123	175	31	-18.5	9:55:15
D	Wp	Jul. 30-May 15	23 -213	298	43	-18.0	9:55:16
3	Wc	Jul. 30-May 15	31 -215	304	47	-18.0	9:55:16
E	Wf	Jul. 30-May 15	39 -224	317	44	-18.0	9:55:16
					Mean rotation period:		9:55:14.6

The three long-enduring white ovals of the $STeZ_n$ remained prominent throughout the 1965-66 apparition. The mean length of each oval was as follows: FA, 17°; BC, 18°; and DE, 17°. The center of the Red Spot was in conjunction with the center of FA on January 21, 1966 at longitude 26° (II); see graph accompanying this paper.* During the period from January 16 to January 20 FA's velocity was slightly decreased as it was approaching conjunction with the Red Spot. Oval FA shifted 3° in the direction of increasing longitude during this period.

Red Spot Region, System II

Mark	Limiting Dates	Limiting L.	L.	Transits	Drift	Period
RSp	Jul. 5-Apr. 6	14°-15°	15°	79	+0°.875	9:55:41.8
RSc	Jul. 5-Apr. 6	25 -26	26	87	+0.875	9:55:41.8
RSf	Jul. 5-Apr. 6	36 -37	37	68	+0.875	9:55:41.8
				Mean rotation period:		9:55:41.8

*Mr. John Ledbetter and others at the Physical Science Laboratory of New Mexico State University assisted in preparing the graph, Figure 14 on page 201, for publication.

The Red Spot was very conspicuous during the entire apparition. All observers agreed that it was darker than in 1964-65. It was generally recorded at its darkest during the period from mid-December, 1965 to mid-March, 1966. During the period from December 11, 1965 to April 24, 1966 Heath describes its color as a "beautiful pink". He also noted the Red Spot to be more nearly circular than in 1964-65. The mean length of the Red Spot for the apparition was 22°.

The most startling bit of evidence during this apparition was the evidence of vorticity in the Red Spot. On November 24, 1965 a small dark spot was observed on the north edge of the South Temperate Belt; it was moving in the direction of the Red Spot. This spot was moving at 3°.6 per day in the direction of decreasing longitude in System II. It was quite apparent that the spot was under the influence of the Circulating Current-South Branch. See Marking No. 3 in the Circulating Current-South Branch table and the graph for the motion of this spot. By January 6, 1966 the spot had reached the following border of the Red Spot Hollow; by Jan. 7 it was located at the following end of the Red Spot; on January 10 it was at the south edge of the Red Spot; by January 11 it was on the south-preceding edge of the Red Spot; and by January 17 it had returned to the following end of the Red Spot area. The spot was recorded by ALPO observers until January 25. Figure 13 is a sample view of the circulating spot.

Spot No. 3 was recorded photographically by E. J. Reese and B. A. Smith of the New Mexico State University Observatory. They recorded it first in mid-December, 1965 and observed it until January 20, 1966. Their records indicate a movement of -3°.4 per day and a period of $9^h53^m21^s$. A.L.P.O. observations give a movement of -3°.6 per day (-107°.5 in thirty days) and a period of $9^h53^m14^s$. See the graph for the interesting behavior of this spot. Spot No. 3 circled around the Red Spot in a period of nine days.

Circulating Current-South Branch (STB_n), System II

No.	Mark	Limiting Dates	Limiting L.	L.	Transits	Drift	Period
1	Dc	Aug. 21-Sep. 26	107° - 60°	----	14	-46°.0	9:54:38
2	Dc	Nov. 13-Nov. 28	64 - 5	----	13	-56.2	9:54:24
3	Dc	Nov. 24-Jan. 25	217 - 2	----	30	-107.5	9:53:14
4	Wc	Jan. 7-Mar. 17	164 - 95	----	16	-28.7	9:55:01
					Mean rotation period		
						Nos. 1 and 2:	9:54:31
						Nos. 3 and 4:	9:54:08

Circulating Current-North Branch (SEB_s-South Edge), System II

No.	Mark	Limiting Dates	Limiting L.	L.	Transits	Drift	Period
1	Dc	Oct. 28-Dec. 2	225°-309°	----	18	+82°.2	9:57:34
2	Dc	Jan. 10-May 4	283 - 50	----	34	+36.3	9:56:30
3	Dc	Jan. 4-Mar. 17	221 - 18	----	19	+65.5	9:57:11
4	Dc	Feb. 18-Mar. 17	298 -358	----	14	+60.0	9:57:03
					Mean rotation period: (Without No. 1)		9:56:55

N. Edge SEB_n, EZ_s, System I

No.	Mark	Limiting Dates	Limiting L.	L.	Transits	Drift	Period
1	Dc	Aug. 25-Sep. 19	7° - 21°	----	13	+14°.0	9:56:00
2	Wc	Dec. 28-Jan. 29	73 - 85	----	14	+11.0	9:55:56
3	Wc	Dec. 1-Feb. 5	52 -110	71°	24	+41.0	9:56:37
4	Wc	Mar. 31-May 3	40 - 55	----	16	+15.0	9:56:01
5	Wp	Nov. 25-Dec. 27	123 -145	136	14	+20.8	9:56:09
6	Wc	Aug. 30-Dec. 27	57 -147	141	20	+22.5	9:56:11
7	Wf	Nov. 25-Dec. 27	134 -155	150	13	+20.8	9:56:09
8	Wp	Feb. 6-May 4	153 -193	----	17	+13.8	9:56:00
9	Wc	Feb. 6-Apr. 11	158 -191	----	16	+15.0	9:56:01
10	Wf	Feb. 6-Apr. 11	165 -199	----	17	+15.5	9:56:02
11	Dc	Aug. 12-Sep. 20	143 -168	----	15	+24.0	9:56:14
12	Wc	Feb. 11-Apr. 9	238 -255	----	17	+ 8.9	9:55:53
13	Dc	Aug. 4-Oct. 7	320 -356	----	21	+16.4	9:56:03
					Mean rotation period: (Without Nos. 2, 3, & 12)		9:56:05
					Nos. 2 and 12:		9:55:55

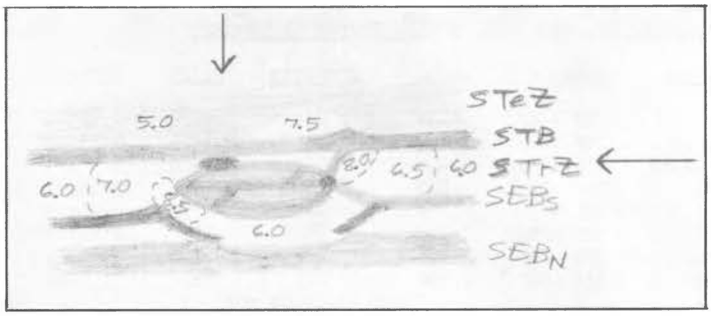

Figure 13. Rough sketch of Red Spot on Jupiter and its vicinity by Walter H. Haas on January 11, 1966, 2^h5^m–2^h45^m, U. T. 6-inch refl., 298X. Seeing 4-5 (scale of 0 to 10 with 10 best). Transparency 6 (limiting magnitude). C.M.$_2$ = 7° - 31°. The arrows point to a dark condensation at the edge of the Red Spot. This condensation made a complete circuit around the Red Spot in a period of about nine days, indicating that the Red Spot is a vortex. The South Temperate Zone oval FA is almost in conjunction with the Red Spot. The intensity-numbers on the sketch are on a scale of 0 (shadows) to 10 (brightest features).

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N. Equatorial Current (S. Edge NEB, EZ$_n$), System I

No.	Mark	Limiting Dates	Limiting L.	L.	Transits	Drift	Period
1	Dc	Aug. 27-Dec. 1	1°- 10°	----	26	+ 2°.8	9:50:34
2	Wc	Aug. 25-Dec. 3	27 - 11	----	18	- 4.9	9:50:24
3	Dc	Aug. 25-Dec. 3	36 - 14	----	22	- 6.7	9:50:21
4	Wc	Aug. 30-Feb. 8	44 - 11	11°	29	- 6.0	9:50:22
5	Wc	Aug. 30-Nov. 28	61 - 45	----	20	- 5.2	9:50:23
6	Dc	Aug. 21-Jan. 22	70 - 43	50	31	- 5.2	9:50:23
7	Wc	Aug. 21-Oct. 28	79 - 72	----	17	- 3.0	9:50:26
8	Dc	Aug. 30-Oct. 28	81 - 80	----	6	- 0.5	9:50:29
9	Dc	Aug. 21-Sep. 29	100 - 98	----	5	- 1.5	9:50:28
10	Wc	Aug. 30-Nov. 17	104 -101	----	18	- 1.1	9:50:29
11	Wc	Nov. 15-Jan. 25	80 - 69	80	25	- 4.6	9:50:24
12	Dc	Oct. 28-Feb. 19	98 -110	103	42	+ 3.1	9:50:34
13	Wc	Aug. 11-Apr. 18	116 -241	180	47	+14.9	9:50:50
14	Dc	Aug. 11-May 15	132 -272	192	61	+15.1	9:50:50
15	Wc	Aug. 11-Sep. 13	147 -149	----	5	+ 2.0	9:50:33
16	Dc	Aug. 21-Oct. 4	156 -198	----	15	+20.8	9:50:58
17	Wc	Oct. 13-Mar. 3	176 -210	198	32	+ 7.1	9:50:40
18	Wc	Aug. 24-Apr. 30	210 -268	217	43	+ 6.9	9:50:39
19	Dc	Aug. 24-Dec. 29	217 -223	222	22	+ 1.4	9:50:32
20	Wc	Aug. 24-Dec. 29	237 -230	235	22	- 1.6	9:50:28
21	Dc	Sep. 14-Jan. 22	250 -289	260	23	+ 8.9	9:50:42
22	Wc	Aug. 4-Dec. 2	260 -285	----	30	+ 6.3	9:50:38
23	Dc	Aug. 4-Oct. 18	272 -281	----	20	+ 3.6	9:50:35
24	Dc	Aug. 4-Apr. 3	289 -323	303	54	+ 4.2	9:50:36
25	Dc	Aug. 4-Apr. 9	305 -340	340	58	+ 4.2	9:50:36
26	Wc	Sep. 14-Apr. 8	305 -332	327	43	+ 3.9	9:50:35
27	Wc	Sep. 26-Nov. 13	333 -349	----	16	+ 9.4	9:50:43
28	Dc	Aug. 11-Dec. 10	334 -355	----	26	+ 5.3	9:50:37
29	Wc	Aug. 11-Jan. 13	344 -350	347	29	+ 1.5	9:50:32
30	Dc	Nov. 25-May 16	251 -281	255	42	+ 5.2	9:50:37
31	Dc	Oct. 4-Nov. 24	246 -256	----	6	+ 5.9	9:50:38

Mean rotation period: 9:50:32
(Without Nos. 13, 14, & 16)
Nos. 13, 14, & 16: 9:50:53

Spots 13 and 14 are two prominent spots which had been observed in 1964-65 and were still being recorded during the 1965-66 apparition as features rotating in the abnormally slow portion of the N. Equatorial Current. Spot 16 was also rotating in the slow current of the North Equatorial Belt-South edge.

N. Tropical Current (N. Edge NEB, NTrZ), System II

No.	Mark	Limiting Dates	Limiting L.	L.	Transits	Drift	Period
1	Wc	Aug. 21-Jan. 20	65° -348°	5°	31	-15°.1	9:55:20

N. Tropical Current (N. Edge NEB, NTrZ), System II (Cont.)

No.	Mark	Limiting Dates	Limiting L.	L.	Transits	Drift	Period
2	Dc	Aug. 21-Jan. 1	98°- 43°	51°	24	-12°.2	9:55:24
3	Wc	Jan. 7-Mar. 15	158 -123	----	16	-15.2	9:55:20
4	Wc	Aug. 27-Oct. 26	258 -227	----	15	-15.5	9:55:19
5	Wc	Aug. 25-Jan. 5	296 -235	247	26	-13.6	9:55:22
6	Dc	Aug. 25-Dec. 29	307 -251	258	22	-13.0	9:55:23
7	Wc	Aug. 25-Jan. 10	315 -254	263	29	-13.0	9:55:23
8	Dc	Sep. 13-Jan. 10	312 -265	275	25	-11.8	9:55:24
9	Wc	Oct. 24-Feb. 6	314 -267	292	24	-13.4	9:55:22
				Mean rotation period:			9:55:22

N. Temperate Current (NTB, NTeZ), System II

No.	Mark	Limiting Dates	Limiting L.	L.	Transits	Drift	Period
1	Dc	Dec. 25-Jan. 23	53°- 80°	----	14	+27°.0	9:55:04
2	Dc	Aug. 25-Oct. 7	328 -348	----	10	+13.3	9:55:22
				Mean rotation period: (Without No. 1)			9:55:22

N.N. Temperate Current (NNTB, NNTeZ), System II

No.	Mark	Limiting Dates	Limiting L.	L.	Transits	Drift	Period
1	Dp	Aug. 30-Jan. 1	26°- 13°	15°	28	-3°.1	9:55:36
2	Dc	Sep. 14-Jan. 9	31 - 23	25	25	-2.5	9:55:37
3	Df	Sep. 14-Jan. 9	45 - 36	36	24	-2.3	9:55:37
4	Dc	Sep. 9-Oct. 18	159 -174	----	15	-10.7	9:55:26
5	Dp	Aug. 24-Oct. 31	195 -193	----	16	-0.9	9:55:39
6	Dc	Sep. 9-Oct. 31	204 -202	----	5	-1.1	9:55:39
7	Df	Sep. 3-Oct. 31	218 -214	----	7	-2.1	9:55:38
8	Dp	Dec. 2-Feb. 5	284 -276	285	18	-3.6	9:55:36
9	Dc	Nov. 28-Feb. 18	292 -287	295	22	-1.8	9:55:38
10	Df	Dec. 2-Jan. 30	300 -297	300	18	-1.5	9:55:39
11	Dc	Aug. 30-Sep. 23	355 -359	----	5	-4.0	9:55:35
				Mean rotation period: (Without No. 4)			9:55:37

N.N.N. Temperate Current (NNNTB, NNNTeZ), System II

No.	Mark	Limiting Dates	Limiting L.	L.	Transits	Drift	Period
1	Dc	Aug. 21-Oct. 13	107°- 66°	----	15	-23°.0	9:55:09
2	Wc	Aug. 21-Oct. 13	113 - 75	----	15	-21.1	9:55:12
3	Dp	Aug. 27-Oct. 16	250 -210	----	17	-23.5	9:55:08
4	Dc	Aug. 27-Oct. 28	261 -225	----	18	-17.1	9:55:18
5	Df	Aug. 27-Oct. 4	271 -245	----	6	-20.0	9:55:13
				Mean rotation period:			9:55:12

BOOK REVIEWS

Star Atlas of Reference Stars and Nonstellar Objects, Smithsonian Astrophysical Observatory, 1969. The MIT Press. $18.50 boxed. Available from Herbert A. Luft, Box 91, Oakland Gardens, N. Y. 11364.

Reviewed by Mike Rogers

The Smithsonian Astrophysical Observatory's new star atlas consists of 152 charts, each on 11- by 14-inch heavy paper, and covering the entire sky down to visual stellar magnitude 9. Together with nonstellar objects and a few somewhat fainter stars, the Atlas plots almost 625,000 objects. Tab sheets divide the charts into eleven bands of declination, and there is a general index sheet listing the limits for each band of declination. On the sheets themselves there is a grid that divides the charts into degrees of declination and minutes of right ascension, a diagram showing the location of the sheet in relation to the adjacent charts, and a stellar magnitude key. An interpolation reseaux plastic overlay is provided further to subdivide the charts. Finally, a handy

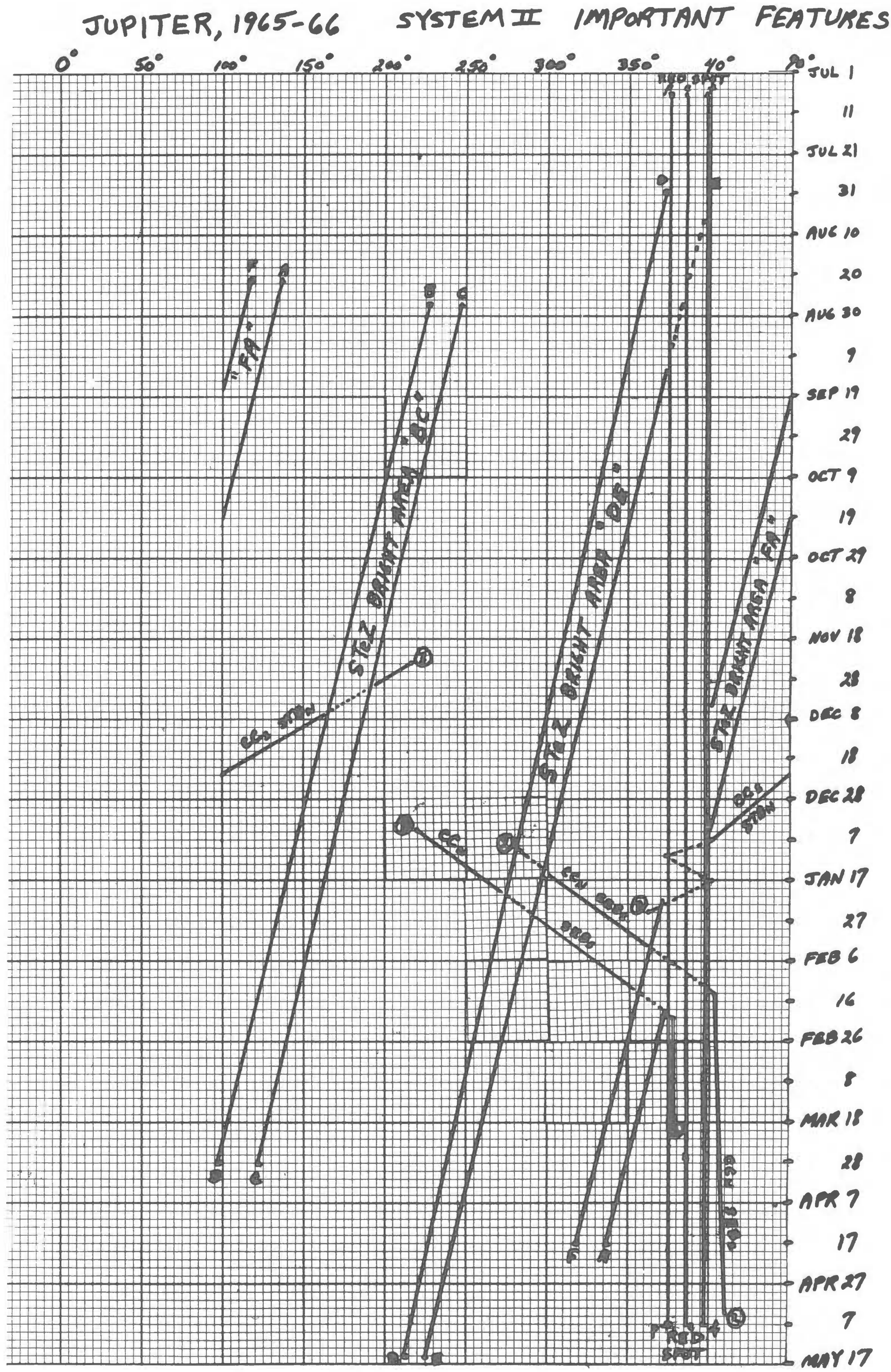

Figure 14. Chart to show drifts, longitude vs. time, of selected features on Jupiter in System II during the 1965-66 apparition. Based on observations by the ALPO Jupiter Section. Graph drawn by Phillip W. Budine. See text of his accompanying article.

booklet explains the use of the indices, lists the sources other than the Smithsonian Astrophysical Observatory Catalogue, and provides constellation orientation charts for the Atlas.

There are a number of advantages in this Atlas. The charts are excellent for indoor use such as photographic keying. They are extremely accurate and complete, and any suspected object can be checked with confidence on the charts. Comets, asteroids, and variable stars can be plotted with utmost precision. In addition, the case (box) is very attractive and makes the heavy (7 3/4 pounds) Atlas easily transportable.

There are, however, a number of disadvantages to the Atlas. The charts are very crowded so that it becomes difficult to mark many objects without obliterating many of the stars. Likewise, there are too many identical non-stellar object symbols. There are so many objects that it is impossible to differentiate between them without looking up their exact coördinates. Finally, the individual charts are much too difficult to orient and to use at the telescope. Using these charts at the telescope is about as easy as looking at the stars through the wrong end of a pair of binoculars.

In conclusion, this Atlas is not well suited to general use by the average amateur.

Note by Editor. We thank Reviewer Rogers for his helpful and informative evaluation of the S.A.O. charts. It is perhaps proper to add, however, that the charts were developed for use by professional astronomers in rather specialized research and unquestionably serve this primary purpose very well.

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1971 Celestial Calendar and Handbook, by C. F. Johnson, Jr. 48 Roberts Street, Watertown, Conn. 06795. 38 pgs., price $1.50, postpaid in U.S.A., Canada, or Mexico.

Reviewed by Rodger W. Gordon

Many times an amateur needs basic information to plan ahead for various observing projects he's undertaking. Most of the time he has to search through several journals, almanacs, magazines, etc. to get all the facts he requires; and this is quite time-consuming.

Amateurs not already familiar with past editions of the above work will find the booklet by Mr. Johnson a most valuable piece of literature as it contains much basic information in an easy-to-use guide suitable for use right at the telescope. Included are tables listing phenomena for Jupiter's moons, eclipses, occultations, planetary aspects, time signals, minor planets, meteor showers, variable stars, double stars, and galactic and extra-galactic objects. A finder chart for Uranus and Neptune is of special interest to those who wish to follow the fainter outer planets. A very handy feature of the book is the celestial calendar (printed in black on a yellow background) listing the events according to date. Many blocks in the calendar spaces are left blank to allow the observer to jot in notes or to plan a particular observing project in advance.

A key map of Jupiter's belts and zones is given, and would-be planet observers are directed to inquire of the A.L.P.O. if their interest warrants it.

In short, this is a handy little book to have around when one needs basic information in 1971 on the spur of the moment.

TRAVELING IN EUROPE AND THE OBSERVATORY OF THE SWISS ASTRONOMICAL SOCIETY

By: Christopher Vaucher

At 8:00 A.M. (PDT) on June 19, 1970, I left Portland, Oregon on a Trailways Bus, destined for the International Airport at Vancouver, B.C. On arrival at the airport, our plane was delayed for three hours while a malfunction was repaired. We took off at 9:00 P.M., winging our way to London, England. We arrived in London on June 20, 1970, at 5:00 P.M., London Time. I stayed in and around the London area for three days, living with some of my relatives. Among things of interest that I visited were the Cutty Sark, the Parliament Buildings, and, of course, the London Planetarium. The London Planetarium is housed in a rather old building; nevertheless, the show called "Constellations of the Northern Hemisphere" was indeed very interesting, and even more so when one knows that the projector is a Carl Zeiss.

After spending three days in London, I boarded a British European Airways jet going to Geneva, Switzerland. By the afternoon of June 24th, I had cleared Swiss Customs and had met my grandfather at the airport. We almost immediately boarded a fast electric train heading for the southeastern side of Lake Geneva where my grandfather lives. By nightfall we had reached his house, just in time to see a beautiful sunset. My grandfather's house commands a fantastic view of the Rhone River Valley. On three sides of us were the Alps, and on the fourth side the Rhone Valley ran into the Lake. For two weeks we visited the area around the village of Collombey (canton Valais), where I made my temporary residence. Then on July 5th, a Swiss friend of mine and I decided to take a one-week trip together to visit quickly the German-speaking part of Switzerland. The night before, I had called Dr. Herrmann, the President of the Swiss Astronomical Society, and had informed him that I was coming to Schaffhausen, Switzerland for a brief visit. We arranged the date and the time of the meeting, which was to be on July 9th, at 12:30 P.M. Dr. Herrmann and Mr. Hans Rohr (the General Secretary) were to meet me for lunch, and a later trip to the Observatory built by the Swiss Astronomical Society. After visiting Bern, Lucerne, Interlaken, Zug, and Zürich, on the evening of July 8th, our train finally came into the station at Schaffhausen. Words cannot describe the beauty and quaintness of this town by the Rhine River. All of the streets and houses are very clean. Inside of the city, all of the small streets are made of red brick; indeed, paving the streets with blacktop is illegal within the city limits. After getting off the train, my friend and I looked for a modest priced hotel for two nights. We found a very nice hotel near the train station. That evening, I toured the town and visited the castle. The castle is on a large hill overlooking and seeming to dominate the town. All along the hillside between the castle and the town are vineyards, where a good quality wine is produced. Other places of interest were the old monastery-church, with the tall medieval stone tower, touring boats on the Rhine River, and the little specialty shops all along the minor streets.

On the morning of July 9th, 1970, we traveled by train eastwards to the village of Stein-am-Rhein. Here, in the center of town, all of the houses are painted on the outsides, imitating beautifully woven tapestries. We spent most of the morning here, and then took a boat on the Rhine back to Schaffhausen to meet Dr. Herrmann and Mr. Rohr.

At 12:30 I met both men at Mr. Rohr's pastry-specialty shop in Schaffhausen. After a brief but interesting talk, we went out to lunch at a German restaurant having wonderful German cuisine with Swiss wine. We stayed there a while discussing Mr. Rohr's new book called <u>Strahlendes Weltall</u>, in English <u>Beams from Outer Space</u>, which will be translated into English and on the market by early spring in 1971. It will be published by the Viking Press (New York, New York) and will be translated by Professor A. Beer of Cambridge.

After eating a tremendous lunch and dessert, we got in Dr. Hermann's new Audi, and headed up a hill above Schaffhausen where the ten-year-old Observatory is located. A photograph of this Observatory appears on the front cover of this issue. The Observatory is very interesting for a number of reasons. First, the roof is a dome, but unlike a standard observatory dome, this one does not open to make a slit for the telescope. Instead, the whole dome lifts up and then slides off and swings down until the entire sky is visible. The dome is then out of sight, and perpendicular to the ground. This procedure is accomplished by means of two massive counterweights attached to two long, Y-shaped steel rods placed on either side of the Observatory. This design, when first built, was unique; and there is an article about it in the September, 1960 issue of <u>Sky and Telescope</u>. The dome had to be built this way because the entire sky must be seen, as the Observatory was to be used mainly to teach classes. Secondly, the whole Observatory is built four meters above the ground, mainly to get above most of the surrounding vegetation, and to be well above the heavy snows in winter. On the other side of the raised cement platform, across from the actual Observatory, is an aluminum housing with a seating capacity of 25-30 people (recently this has been expanded to hold more people), meant to be a type of classroom. The platform is 20 meters long by 6 meters wide. The actual telescope is a 26-cm. (about 10") reflecting Newtonian on a permanent German type, very heavy duty mount. The telescope tube as well as the mount is made of a special kind of aluminum. The mounting rests on a rectangular cement pillar going straight into the ground, not even touching the Observatory floor so as to make the telescope more vibration free. Another interesting thing is that the stairway is free-standing, also to reduce vibrations. The Observatory was built by amateurs of the Swiss Astronomical Society, and only the materials for construction were paid for. Because of lack of funds, and the fact that it had to be built on spare time, the Observatory took two years to build. The total cost of the materials for the Observatory was 66,000 Swiss Francs, or about $2,870.00.

Many of the Observatory details described above can be seen in the front cover photograph.

The original plan for the construction of the Observatory (Project 1) was abandoned. The only difference between Project 1 and the actual Observatory was the dome. In Project 1 the roof was conical, and a crane was planned to be built permanently into the ground beside the Observatory in order to lift off the roof and to get it out of the field of view. The main reason why this first project was abandoned was that it was considered to be too dangerous. There are strong winds in the winter, and many things might happen to the crane holding the dome. So, Project 2 called for a dome with two massive counterweights. The advantages of this system are: firstly, the dome is built in one piece, secondly, there are no freezing problems like there would have been using a crane, and thirdly, there is no danger in this system. Another advantage is that the dome is cranked off (very smoothly) and out of sight, which would not have been the case if the crane had been used. The counterweights are filled with concrete; and when the dome is slid off, the moving weight is 4 tons. This Observatory belongs to the city of Schaffhausen as well as to the members of the S.A.S.

After visiting the Observatory, I mentioned that I had not yet seen the nearby Rhinefalls, and immediately we drove to them! After a short walk around them, we left the falls and went back to the city, where, sadly, we said farewell to Dr. Herrmann. Mr. Rohr and I went back to his pastry shop and discussed the programs of the S.A.S., as well as astronomy in general. Mr. Rohr has been the General Secretary of this society for over thirty years. In the end, I said goodbye to him also, and on the next day finished my trip through German Switzerland.

We stayed in Switzerland until August 2nd, then took a Swiss Air jet to Paris. I stayed in France (mainly in Normandy) for the next 25 days, and on August 26th took a jet back to London. In London I stayed only long enough to transfer to an Air Canada jet going to Vancouver, B.C. The trip lasted a full twelve hours, and we landed at Vancouver International Airport on August 26th, at about 5:00 P.M., Pacific Daylight Time. There, my parents met me; and a few days later we traveled back home to Portland.

The author wishes to thank Dr. Herrmann and Mr. Rohr for the extreme friendliness and coöperation that they extended to him during his visit with them, and hopes to repay them in kind should they decide to visit the United States.

LIGHTWEIGHT TELESCOPE DESIGNS

By: Victor Nikolashin, Optical Sciences Center, University of Arizona

I have been interested in improving the designs of amateur telescopic systems.

Recently, while preparing to move my 10" Cassegrainian out to a place where a grazing occultation of a 6th magnitude star with the moon could be witnessed, I saw the necessity to design light-weight large aperture systems which would be easier to transport and less headache to set up. Figures 15-17 show an initial effort at a lightweight telescope design. The basic specifications of the telescope are:

Mirror Diameter	= 8"
Primary focal length	= 35"
Effective focal ratio	≈ f - 14
Total telescope weight	= 25 pounds

The telescope has the capability that it can be completely disassembled and packed into a medium sized suitcase. The front secondary and rib will disconnect from the support rod, and next the rod is removed from the plate which holds the entire telescope to the equatorial mounting. Then the primary mirror cell is folded down against this mounting plate, after the primary shield is removed. The focusing device is unscrewed and is packed separately. Finally, the mounting plate is disconnected from the mount and is put into the suitcase along with the mount.

The optical surfaces for this instrument were generated out of CerVit, but this material is not a requirement for good performance. It is also to be noted that the mirror is extremely thin, about 0.25 inches at the edge. A standard 8" blank could be used in the place of such a thin one. The thin mirror's performance has been quite good. Checking the system's accuracy by looking at a star near the horizon with a shearing interferometer and one at the zenith has shown deflections to be less than

1/10 λ. At present a mathematical analysis is scheduled to be conducted in order to determine the exact deflectional errors.

Figure 15. A light-weight 8-inch Cassegrainian designed and built by Victor Nikolashin. See his text on page 204.

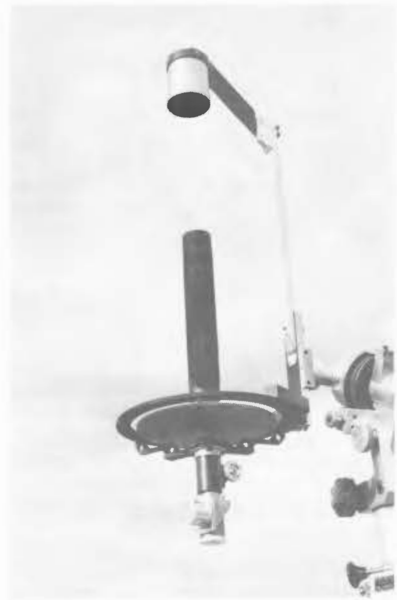

Figure 16. Closer view of optical components and their supports in Mr. Nikolashin's 8-inch Cassegrainian reflector. One support rod holds entire telescope to equatorial mounting.

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Figure 17. Alternate view of 8-inch Cassegrainian. See also text.

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I have also been experimenting with two more designs which will be tested in the near future. The one design which has the secondary mounted in the center of the shield tube (Figure 18) has possibilities of being used as a design for large aperture "light buckets". Here any image degradation due to the spider support would be minimized because of the use of low power optics. The system is a 12-inch system of f-8.2 focal ratio. All the optics are generated on aluminum substrates. I am trying to visualize how effective amateur telescopes can be made out of this material.

Figure 19 shows my six-inch guide telescope which I recently rebuilt to be used on the side of my ten-inch Newtonian-Cass. Since packing space is at a minimum in our mobile home, I designed this scope to be readily completely dismantled. The large telescope has this same feature but still takes up room.

It is my hope here to show how the amateur astronomer can lighten his telescope so as to minimize the normal headaches acquired during transportation to adequate ob-

Figure 18. Light-weight 12-inch Cassegrain designed and built by Victor Nikolashin. The front secondary is here mounted in the center of the light-shield tube.

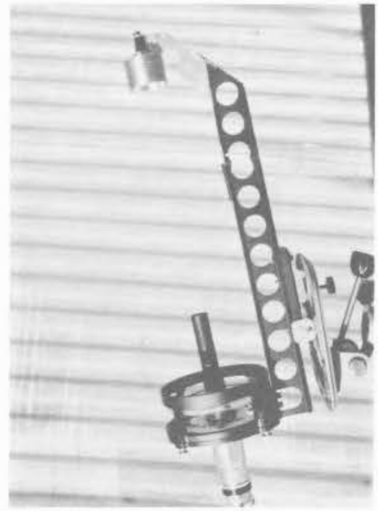

Figure 19. Light-weight 6-inch guide telescope designed and built by Mr. Nikolashin for use with his conventional 10-inch Newtonian-Cassegrainian.

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serving sites. It will be my further hope in the future to show how even larger aperture systems can be mounted sturdily, while still minimizing their overall weight.

I hope that such design information would prove to be of some interest to ALPO members. I gladly welcome any comments and criticisms.

Postscript by Editor. Author Nikolashin is working for his Doctor of Philosophy Degree in Optical Sciences at the University of Arizona. The article above is constructed from two letters he wrote in the autumn of 1970. If the presentation is poor, the fault is the Editor's. Both Author and Editor hope that these ideas will be of interest to many of our readers.

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In reply to some obvious questions about his special light-weight telescope designs, Mr. Nikolashin expresses the opinion that his optical systems are readily collimated to the accuracy compatible with the seeing. In other words, he is usually limited by the seeing rather than by the telescope's potential performance. Dewing of the exposed optical surfaces at night appears to be no worse than with telescopes that have tubes. He has used the telescopes during star parties, and the exposed mirrors and secondaries have not appeared to offer any special problem with public viewing.

THE BRIGHTNESS OF IAPETUS

By: the Rev. Kenneth J. Delano

(Paper read at the A.L.P.O. Convention at Sacramento, California on August 20-22, 1970.)

Of all the satellites in the Solar System, Saturn's eighth satellite, Iapetus, is the most interesting one for a telescope owner to watch. In orbiting Saturn once every 80 days, Iapetus always appears to be about two magnitudes brighter at its western than at its eastern elongation. No other satellite in the Solar System displays such an amplitude of brightness variations so definitely associated with orbital position. Daniel Harris, writing in PLANETS AND SATELLITES, lists seven other satellites which show rotational variations in magnitude, none of which comes close to equaling Iapetus in that regard. The satellites and their rotational variations in magnitude are as follows:

Iapetus	— 2.12	magnitudes
Europa	— 0.34	"
Triton	— 0.25	"
Io	— 0.21	"
Rhea	— 0.20	"
Ganymede	— 0.16	"
Callisto	— 0.16	"
Moon	— 0.08	"

Most authorities affirm that Iapetus varies from the 10th magnitude at western elongation to the 12th at eastern elongation. Harris, for example, gives 10.2 and 12.3 as the magnitude limits. His figures are based on a grand total of 15 observations made at McDonald Observatory from 1951 to 1953. However, J. B. Sidgwick, in his book OBSERVATIONAL ASTRONOMY FOR THE AMATEUR, credits Iapetus with having a greater brightness than most texts give. According to Sidgwick, Iapetus ranges from approximately 9.5 to the 11th magnitude.

My own observations of Iapetus began on September 19, 1968 and ended on February 16, 1969. During this period, magnitude estimates of Iapetus were made on 53 nights. A 12½-inch Newtonian reflector with an Erfle eyepiece giving 150X was used, and the actual field of view was 23 minutes of arc. Since Iapetus is less than 10 minutes of arc from Saturn at its greatest elongations, its brightness could always be directly compared with the more closely orbiting satellites. Magnitude estimates of Iapetus were made by comparing its brightness with that of Titan, Rhea, Dione, and Tethys. I assumed (as often as possible) Titan to be relatively stable at magnitude 8.4. Accordingly, I found an average magnitude of 10.61 for Tethys, 10.57 for Dione, 9.92 for Rhea, 8.39 for Titan, and 9.75 for Iapetus. Thus in its mean magnitude, Iapetus was almost 2/10ths of a magnitude brighter than Rhea!

Iapetus was observed varying from magnitude 9.0 at western elongation to magnitude 10.6 at eastern elongation. This variation of 1.6 magnitudes is comparable to the commonly cited amplitude of two magnitudes. However, I found Iapetus to be no less than a full magnitude brighter at both eastern and western elongations than the commonly given values of 10th and 12th magnitudes.

At the conclusion of my observations which were made during the 1968-69 apparition of Saturn, an article by Patrick Moore appeared in the February, 1969 issue of THE JOURNAL OF THE BRITISH ASTRONOMICAL ASSOCIATION. Moore had observed Iapetus from July 15, 1966 to February 7, 1967 and found that "maximum is more than a magnitude brighter than the official estimate, and minimum almost a magnitude brighter." Using the 10-inch refractor at Armagh Observatory, Moore had recorded Iapetus as having attained magnitude 8.7 at western elongation and 11.1 at its eastern elongation. Moore commented in his report that: "Though the mean magnitude of both Iapetus and Rhea works out at 9.8 according to my series, Iapetus can become about a magnitude brighter than this, and much brighter than Rhea can ever get. Consequently, it is reasonable to assume that Iapetus is the larger of the two by a considerable margin, whereas the B.A.A. HANDBOOK gives a diameter of 800 miles for Rhea and only 700 for Iapetus."

Actually, with my 1968-69 observations I had unknowingly confirmed Moore's 1966-67 finding that Iapetus' mean magnitude is very close to Rhea's, i.e., more than a magnitude brighter than the commonly cited mean magnitude of 11.0. While our mean magnitude values are in very good agreement, we differed in the amplitude of variations recorded. Moore found a difference of 2.4 magnitudes in 1966-67, whereas I recorded a range of only 1.6 magnitudes between Iapetus' appearances at western and eastern elongations in 1968-69.

Observations of Iapetus' brightness were made during the 1968-69 apparition by two other persons whose results are noted in the February, 1970 issue of THE JOURNAL OF THE BRITISH ASTRONOMICAL ASSOCIATION as follows: "Parkins comments that Iapetus appeared to him almost as bright as Titan, and brighter than Rhea at western elongation. A very good series of satellite observations was made by Nightingale who stated that he feels the maximum magnitude of Iapetus appears to be about 9.2, but never as bright as 9.0."

To account for the difference between recent observations of Iapetus' brightness and the commonly given values of 10th and 12th magnitudes, we could say that Iapetus has brightened in the past few years. However, differences between visual and photometric determinations of Iapetus' brightness need to be investigated further. For example, R. W. Paine of Hadleigh, England also observed Iapetus in 1968-69 and made 10 photometric measurements using a 9.4-inch reflector; and he recorded magnitudes of 10.23 to 12.39 for Iapetus. His results are briefly noted in the June, 1969 issue of SKY AND TELESCOPE and are in marked contrast with the estimates of visual observers for that year.

I again observed Iapetus with my $12\frac{1}{2}$-inch telescope during Saturn's 1969-70 apparition, and once again found its mean magnitude to be about the same as Rhea's. In 39 nights of observation between October 16, 1969 and February 25, 1970, Rhea's mean magnitude was 9.84, and Iapetus' was 9.81. However, this time I recorded a maximum of 8.6 at western elongation and a minimum of 11.5 at eastern elongation. This amplitude of 2.9 magnitudes is almost twice as great as my 1968-69 value and one-half magnitude greater than Moore's 1966-67 results. I found Iapetus 1/10th of a magnitude brighter than Moore's 8.7 value and 4/10ths of a magnitude fainter than his 11.1 minimum magnitude.

In making magnitude estimates of Saturn's satellites, one must keep in mind that due to the glare of the planet and the scattering of its light, the more remote a satellite is from Saturn's globe and rings the more conspicuous it will appear as compared with less distant satellites; and consequently, there is a tendency to overestimate the more distant satellites' brightness. The best occasion for estimating Iapetus' magnitude at or near western elongation occurs when Titan is also far removed from the glare of the planet. Thus on October 31, 1969, Titan and Iapetus could be readily compared since Titan was 3' of arc to the east and Iapetus was $5\frac{1}{2}$' of arc to the west of Saturn. They were then judged to be at magnitude 8.4 and 8.9 respectively. On January 26, 1970 Titan and Iapetus were both at their greatest western elongation (3' and 10' of arc respectively from Saturn), Titan being estimated at magnitude 8.4 and Iapetus at magnitude 8.9.

Iapetus invites the attention of all telescope owners, both the possessors of a 2- or 3-inch telescope (which is capable of at least showing Iapetus at maximum brightness) as well as the owners of larger telescopes and perhaps photometers too. While it is most desirable to make magnitude estimates of Iapetus at every point along its orbit, the small telescope owner can still contribute valuable information by comparing Iapetus at western elongation with 8.4-magnitude Titan and 9.8-magnitude Rhea. The positions of Saturn's satellites are given for every year in THE AMERICAN EPHEMERIS AND NAUTICAL ALMANAC. During the coming 1970-71 apparition, Iapetus will be at its greatest western elongation on December 16, 1970 and again on March 6, 1971. Observations made during the two weeks preceding and the two weeks following those two dates by a sufficient number of observers could result in the attainment of a general agreement on just how bright does Iapetus become at its western elongations.

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METEORITIC IMPACTS AS GEOLOGIC FEATURES

By: Craig L. Johnson

When the moon is observed through even the smallest of telescopes, it is immediately apparent to the most casual observer that its surface is covered with a great profusion of circular formations. These range in size from over one hundred and fifty kilometers in diameter down to the limits of telescopic resolution, and follow no regular distribution pattern. While the Earth shows no great multitude of such features, they are far from being totally absent. This paper is an attempt to study the characteristics and origin of such features on the Earth and moon, and to draw some tentative conclusions regarding the types of causative agents.

What are the observed characteristics of these formations, found in small numbers on Earth and by the thousands on Luna? The gross features are as follows: they are circular (or in some cases, mildly elliptical), have elevated rims and flat floors markedly below the level of the surrounding terrain, do not correspond in type with geologic structures in the surrounding areas, and follow a random pattern of distribution. In the case of lunar craters, many are surrounded by bright rays; these take the form of light colored streaks radially distributed around the crater and extending outward in some cases for over one thousand, five hundred kilometers, unselectively crossing all geologic structures in their path.

Upon close examination of terrestrial craters, it will also be noted that rock strata in the crater rim dip strongly away from the central axis of the crater (dip is eighty degrees at Canyon Diablo[1]); evidence of volcanism in the area is conspicuous by its absence;[2] nickel-iron alloy will often be found in the crater and nearby, often as microscopic droplets;[3] breccia and powdery rock dust (rock flour) may be found if the crater is located in an arid region and is geologically young;[4] and the surrounding strata often contain explosion shatter cones from compressional wave fracture of the surrounding rocks (the points of the cones point toward the center of impact), and high pressure polymorphs of silica such as coesite and stishovite.[5,6]

Perusal of the literature of volcanism will reveal that the features described above are evidently not volcanic craters.

Of course, terrestrial erosion processes are continuously modifying all geologic structures, blurring outlines and adding minor details such as gullies. Thus, old crater outlines will become increasingly rounded with time, covered with vegetation, and inconspicuous to the casual traveler, as opposed to the lunar case where changes in temperature and the solar wind are the chief agents of erosion, leaving crater identities very obvious even after millions of years. Also, there are some volcanic processes that produce craters bearing a surprising resemblance to those described above; for example, Elegante Crater in Mexico at the edge of the Cerro del Pinacante volcanic field and Kilbourne Hole west of Las Cruces, New Mexico bear a striking superficial resemblance.[7,8] These, however, show marked evidence of volcanic origin when closely examined, such as proximity to lava fields, small side vents, and location over fissures.[9]

It would appear, then, that lunar craters and some terrestrial examples are not volcanic in origin. How did they originate? It is beyond the scope of this paper to investigate all possible causes, but from empirical observations and energy requirements it would appear that they are the result of the impact of solid objects moving at high speeds, sometimes with a final explosion; these objects will hereafter be referred to by the general term <u>meteorite</u>. It is also beyond the scope of this paper to describe thoroughly the characteristics of meteorites per se, or their differentiation from native rocks; this paper is mainly concerned with meteoritic craters of at least local geologic significance, i.e., a kilometer or more in diameter.

Due to the rarity of falls of this magnitude and the effects of erosion on terrestrial features, some of these craters on the Earth have been eroded beyond recognizability with regard to gross features, and are evident only by their residual effects on terrain. These effects include circular lakes[10] in areas where, geologically, they would not be expected; arcuate coastlines (both of these may be accompanied by fragmented island chains near the shore and matching its arc),[11] and/or circular faulting with zigzagging rivers where they cross these impact-produced faults;[12] or less obvious effects such as anomalous salt beds and lava beds.[13] These features and the possible origin of their causative meteorites will be discussed later in this paper.

It was mentioned previously that the visible lunar surface is covered with a multitude of craters of all sizes, in a random pattern. This holds true at any telescopic magnification; and indeed the smaller ones pile upon the larger ones, on the rims, floors, and upon other small craters. Though much of the visible lunar surface is covered by the <u>maria</u> (lava plains) which are comparatively devoid of craters, the number of craters on the lunar near side in the size range from 1.5 to 16 kilometers approximates 3,395.[14] The photographs taken by the Lunar Orbiter series and the later ones from the manned Apollo missions show[15] that the lunar far side not only has a matching multitude of craters but that there are no major <u>maria</u> present; therefore, the number of craters present in the 1.5 to 16 kilometer range could be double the 3,400 present on the near side, despite the fact that the term "near side" refers to fifty-nine per cent of the lunar surface area and "far side" to the remaining forty-one per cent. Early in the writing of this paper the author made an attempt to add up the area of the lunar surface covered by craters of various sizes; but it soon became apparent that, quite apart from the magnitude of the task, the resultant figure would probably exceed the total available surface area, due to the tremendous mutual overlapping. Though it has not been absolutely proven that the lunar craters are all impact-derived (and there is evidence for a limited amount of volcanic action, to be described later), the available observational evidence fits this hypothesis best at the present time, in the opinion of this author.

The number of near side lunar craters in the size range from sixteen to eighty kilometers approximates seven hundred and four,[16] in the eighty to one hundred and sixty kilometer range thirty-one,[17] and those whose diameter exceeds one hundred and sixty kilometers number five.[18,19]

The lunar near side also includes a type of feature whose appearance is that of a lava plain, ranging from very approximately to quite closely circular in shape, and collectively termed maria (after their rough resemblance to oceans in the first telescopes). It has long been realized that these resemble the smaller craters (including raised rims, sunken floors, and circularity), though observers have been at a loss to explain how the small (rapidly cooling) and obviously tectonically and volcanically inactive world of Luna could support an asthenosphere or fluid core (to account for the flow of lava). The author intends to show later in this paper that magma chambers of any type are unnecessary and that lava flows could occur on a totally cold and inert ball of rock (planetary body) under certain conditions, to be described.

Regardless of mode of formation, these maria range in diameter from the twelve hundred kilometers of the Imbrium basin down to approximately one hundred and fifty kilometers. Oceanus Procellarum is not considered to be a single feature, but rather a fusion or overlapping of smaller maria. There are also several craters which appear to have maria-like floors (dark), in contrast to their relatively bright wall material (Grimaldi, Plato, Schickard, Billy, and others); but since these occur at the edges of maria rather than separately (on the lunar near side), they would appear to be connected with maria formation as side effects.

And what of the lunar far side? For most of human history its appearance has been an unknown and unknowable quantity (aside from plotting the convergent points of ray systems seen near the lunar limb), and astronomers could say only that it probably resembled the lunar near side. With the advent of the first crude far side photographs in 1959 and the first good ones in 1966 and 1967, however, it became apparent that the near and far sides of the moon did not resemble each other. As was previously mentioned, both sides of the moon have craters, but the large maria formations are on the Earth-facing side only; and in the place of far side maria are features of previously unknown types. These include isolated dark-floored craters (Tsiolkovsky, Lomonosov, and Joliot-Curie),[20] ultra-large ghost craters (smaller, later craters have almost destroyed them) without lava floors,[21,22] and a unique transitional feature between craters and maria. The latter, termed the Orientale basin, takes the form of a single, well-preserved crater (diameter fully one thousand kilometers) with concentric inner rings from circular slumping; between the concentric ridges lie patches of lava, and the central section (diameter approximately two hundred and ninety kilometers) is lava-floored. One must see this feature to believe it,[23,24] and it is bound to be a topic of discussion for decades to come.

Having briefly surveyed the lunar surface, we turn now to the Earth. Here, of course, the processes of erosion modify and erase geologic features continuously, and in addition the atmosphere acts as a protective shield. While very large meteorites may reach the surface virtually unhindered, smaller ones are slowed appreciably in speed; and very small ones are vaporized from friction, as one may see demonstrated by observing the sky on a dark night.

That any sort of stones could "fall from heaven" was, of course, very doubtful to the scientific community for a considerable length of time, as has been recounted numerous times in the literature.[25,26,27] The best-known impact crater in the world today and a near-classic textbook example due to its comparative youth and excellent state of preservation in an arid climate, the Canyon Diablo crater in Arizona, was considered to be either a maar or an unexplainable curiosity of erosion until about 1930.[28,29] Once the idea became respectable, however, a casual search was begun for more impact craters, and since World War Two the Canadian government has paid some specific attention to the matter; Canada is an excellent hunting ground for ancient impact sites, due to the large area of ancient rocks exposed (the Canadian Shield). Indeed, the greatest number and largest size of impact craters in the world are found in Canadian territory.[30,31]

In the small size range of one to fifteen kilometers, the terrestrial craters found to date that have been confirmed by detailed on-site sampling, or remain highly probable, are as follows: Pilot Lake, Keeley Lake, Deep Bay, Lake Couture, West Hawk Lake, Chubb Crater, Merewether, Lake St. John, Brent, and Holleford in Canada; Canyon Diablo in the United States; Talemzane (Algeria), Aouelloul (West Sahara) and Bosomtwe (Ghana) in Africa; and Mt. Doreen and Wolf Creek in Australia, a total of sixteen.

The size range from fifteen to eighty kilometers includes Carswell Lake (32 km), Clearwater Lake East (21 km), Clearwater Lake West (32 km), and Manicouagan Lakes (60 km) in Canada (all discovered by aerial photography and undergoing investigation, the Clearwater Lakes are confirmed and the others are classed as good probables);[32] Vredefort Ring, Johannesburg (40 km, confirmed by shatter cone findings)[33]; Tibesti Ring, Chad (18 km, probable);[34] and the Richat structure in Mauretania (35 km[35], probable[36]). These seven structures are capable of good documentation; and if all are confirmed as meteoritic by on-site investigation, no serious or unified protest is likely from the scientific community at large.

The last three structures to be listed here, however, are somewhat more controversial, due to their great size and to the associated presence of some volcanic action. As will be explained shortly in this paper, however, consideration of impact energies shows that, as with the lunar <u>maria</u>, very large impacts can and do produce their own volcanism.

The first of the possible very large terrestrial impact craters is the Gulf of St. Lawrence, approximately two hundred and ninety kilometers in diameter. No direct evidence of explosive formation (such as shatter cones or coesite) has been found, and there is little evidence of a crater rim, hardly surprising in view of the aqueous environment and high erosion rates. However, in this granitic-surrounded basin, basement rock does not begin until a depth of six thousand, seven hundred meters is reached (near Prince Edward Island); and below a surface layer of sediment the material all appears to be rock salt.[37] Can this be due to the slow, even accumulation of salt from evaporation and subsidence, extending over hundreds of millions of years, in the same era when tectonic revolutions were taking place in the nearby Appalachian Mountain Belt? No positive evidence is forthcoming, but the salt beds also could have been formed by the inflow of huge quantities of sea water into a crater basin on top of molten magma, which were flushed off, leaving the salt precipitate.[38]

The next structure is the Witwatersrand basin, surrounding the Vreedefort structure, at Johannesburg; and it has a diameter of three hundred and twenty-two kilometers. The city of Johannesburg is located on the north rim of the basin; and from there may be seen a line of mine dumps extending away in both directions along the kilometer-wide basin rim, which rises about one hundred and seventy meters, since this rim of metamorphic rocks bears gold. Near the center of the basin is the Vreedefort Ring structure, which is at the top of a granite plug and slightly resembles a (greatly eroded) central mountain of a lunar crater. Aside from the circularity of both structures and the presence of shatter cones throughout the area, the gold deposits previously mentioned occur in placer form, as thin beds between metamorphic and sedimentary rocks and not as material intrusive into quartz. This fact would appear to suggest that the gold had been vaporized before deposition. At this point the structural-historical picture is somewhat confused due to lack of sampling data, but the footnoted work makes a case for the idea that the whole Witwatersrand-Vreedefort structure resulted from impact with melting plus stretching from the known rifting of the continent.[39]

The final, and largest, possible impact structure is the arcuate eastern coastline of Hudson Bay, with Belcher and Nastapoka island clusters. The projected diameter of this shoreline to a full circle is approximately four hundred and sixty kilometers. The extreme age of the structures in this area, plus the Arctic location, makes investigation very difficult, particularly with regard to finding direct evidence. However, perusal of a combined (mosaic) topographic map of the area shows that circular faulting occurs at the surface east of the arc (and rivers zigzag to cross this), and that the Nastapoka, Hopewell, Castle, Merry, and Long islands form an arcuate chain matching the curve of the eastern shore. The Belcher Islands farther out in the bay also show curving linearity. While the impact formation of this feature cannot be established until field work supplements the scanty and somewhat contradictory data available to date, the probability remains good.[40]

Thus far we have surveyed the surfaces of Earth and Luna, and have found a number of evidently impact-caused structures. That meteorites caused these structures looks fairly certain in many cases, but a few questions remain at this point, not the least of which is that of available impact energy. Can a ball of rock drifting through space, even if over a kilometer in diameter, cause the formation of large craters and even bring forth the flow of magma upon striking the surface of Earth or Luna? The author believes that the answer is in the affirmative and hopes to demonstrate this conclusion in the following pages.

First, there is the matter of the velocities of meteorites. It has been found, first from triangulation among two or more visual observers and later from radar data, that meteorites initially strike the Earth's atmosphere at speeds of from ten to seventy kilometers per second.[41,42] The velocity depends on the individual body, and whether the atmospheric encounter is head-on or overtaking; these speeds are those that would be expected of bodies orbiting within the Solar System. While there are a few cases on record with speeds exceeding one hundred and fifty kilometers per second, these are a tiny fraction of the total; and the reliability of the tracking data for them is not fully established. Also, of course, the smaller stones will be slowed appreciably from atmospheric friction before reaching the ground when the Earth is involved.

Many small meteorites are observed to explode before reaching the ground; and when the gravel so produced strikes the ground, the impact is relatively gentle. For instance, in the fall of 6 July, 1924 at Johnstown, Colorado, residents of nearby Mead reported that their roofs rattled as if someone had thrown pea gravel from nearby. Gravel was found, and it was meteoritic.[43] Larger discrete stones carry more impact energy, but are still rather ineffectual. While one case is known where the meteorite penetrated the roof of a garage and the roof of an automobile below, then rebounded from the latter's muffler, and finally came to rest in the seat cushions (a two kilogram stone),[44] it is well known that meteorites falling in plowed fields seldom bury themselves. In a recent case a ground search was being made for a meteorite observed photographically, and it was found in the middle of a snow-covered road. The ten kilogram stone had made a dent in the snow of approximately its own size, bounced once, and then came to rest.[45]

Larger falls are more spectacular, such as the Sikhote-Alin fall of 12 February, 1947. In this event a ball of fire was seen to travel across the sky trailing a long cloud of dust (which persisted in the air for several hours); and minutes later powerful sonic booms were heard, resembling the firing of heavy cannon. Some two hundred craters of varying sizes were found at the impact site, ranging up to twenty-seven meters in diameter; and calculations showed that the pyrotechnics and cratering had been caused by a sixty-five ton mass which struck the atmosphere at 14.5 kilometers per second.[46] As will be noted, however, this value is far from the meteoritic mass that would produce a one kilometer crater, let alone a crater of over four hundred kilometers, such as has been postulated for Earth, and one of a thousand kilometers for Luna.

What amount of mass would be required to form these larger craters? It is well known that $e = \frac{1}{2}mv^2$ (the kinetic energy of a moving body equals half its mass times the square of its velocity), also that when a moving body is involved in a collision, the energy of movement is partially converted into heat. The exchange into heat is at known rates for various materials.[47] From this fact, it should become apparent that at meteoritic velocities, where relatively large bodies are involved, meteoritic cratering involves a bit more than the bouncing observed when a small boy throws a rock at a stone wall. As early as 1929, F. R. Moulton demonstrated mathematically that if a single meteorite formed the Canyon Diablo crater, it must have exploded upon impact. He showed that if its space velocity had been forty-one kilometers per second and it had impacted at twelve to twenty kilometers per second, for a mass of one million tons or less the impact alone would raise the temperature of the mass above the boiling point of iron;[48] and a million-ton mass of iron-rich rock, or even plain rock, would be considerably smaller than the one kilometer diameter of the resultant crater. Modern estimates of the mass necessary to form this crater are much less than the above.[49]

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[30]J. E. Enever, "Giant Meteor Impact," Analog, LXXVII (March, 1966), pp. 66-68-71.
[31]Allan O. Kelly, Continental Drift (Carlsbad: Allan Kelly, 1966).
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[33]Allan O. Kelly, Continental Drift (Carlsbad: Allan Kelly, 1966).
[34]"New Giant Crater in Africa?," Sky and Telescope, Vol. 34 (July, 1967), p. 12.
[35]National Aeronautics and Space Administration, Earth Photographs from Gemini III, IV, and V (Washington: United States Government Printing Office, 1967), p. 29. N.A.S.A. photograph S-65-34670.
[36]See footnote 34.
[37]Allan O. Kelly, Continental Drift (Carlsbad: Allan Kelly, 1966), p. 40.
[38]Ibid.
[39]Allan O. Kelly, Continental Drift (Carlsbad: Allan Kelly, 1966), pp. 43-49.
[40]Allan O. Kelly, Continental Drift (Carlsbad: Allan Kelly, 1966), pp. 51-70.
[41]H. H. Nininger, Out of the Sky (New York: Dover Publications, Inc., 1959), p. 39.
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[43]H. H. Nininger, Out of the Sky (New York: Dover Publications, Inc., 1959), pp. 16-18.
[44]Ibid., p. 25.
[45]Richard E. McCrosky, "The Lost City Meteorite Fall," Sky and Telescope, Vol. 39 (March, 1970), pp. 154-158.
[46]E. Krinov, "The Siberian Meteorite Fall of February, 1947," Sky and Telescope, XV (May, 1956), pp. 300-301.
[47]J. E. Enever, "Giant Meteor Impact," Analog, LXXVII (March, 1966), p. 66.
[48]H. H. Nininger, Out of the Sky (New York: Dover Publications, Inc., 1959), pp. 142-236.
[49]See footnote 47, p. 67.

(to be concluded)

ANNOUNCEMENTS

Lunar Section Staff Changes and a Lunar and Planetary Training Program. Because of the gratifying response to the announcement in the last issue concerning the appointment of Charles L. Ricker as the Lunar Training Program Director and because of severe limitations on his time, Mr. Ricker has felt it to be necessary that he resign as a Lunar Recorder so that he can devote all his available time to the ALPO training programs.

The Lunar Selected Areas Program will be taken over by Mr. H. W. Kelsey, who is already fully familiar with the program. Any members who desire to participate in this program are urged to contact Mr. Kelsey. Present participants are asked to begin sending their observations to him at once.

The Lunar Training Program is being expanded to include planets and will be known as the Lunar and Planetary Training Program. The goal of this expanded program will be to provide necessary elementary knowledge and skills to beginning observers who desire to start submitting their observations to the various Observing Sections of the ALPO. For the present, this training will be offered on an individual basis, providing assistance to prospective observers as required according to their individual degree of proficiency. It is felt by Mr. Ricker and others that there are a very large number of ALPO members who would like to participate in our programs but who hesitate to submit observations simply because they are afraid that they lack the necessary experience. We hope to correct this situation by providing the necessary guidance and training to anyone who desires to participate in our programs. Interested members may begin by writing to Mr. Charles Ricker at 403 W. Park St., Marquette, Michigan 49855.

Some changes are in progress in the programs being offered by the ALPO Lunar Section, and it is hoped that these can be described under "Lunar Notes" in the next issue.

Telescope Makers Conference at Riverside, California. The third annual event of this kind will be held on April 24 and 25, 1971. The location is Riverside City College, 3500 Fairfax, Riverside, Calif. The sponsors are the Riverside Astronomical Society and the Riverside City College. Plans are being made to visit the Big Bear Solar Observatory and other places of interest to astronomers. Any communications about this meeting should be mailed to Mr. Clifford Holmes, 8642 Wells Avenue, Riverside, California 92503.

Correction to Vol. 22, Nos. 9-10 of The Strolling Astronomer. Mr. Paul Mackal advises us that the first sentence under "Addendum" near the top of pg. 154 should have read: "The following observers also sent full disc drawings to the Jupiter Recorder for the 1968-69 apparition." The qualitative report on the 1968-69 apparition was prepared before the qualitative report on the 1967-68 apparition, the latter appearing in Vol. 22, Nos. 9-10.

Site of 1971 ALPO Convention. Contrary to some statements in recent months in Sky and Telescope and elsewhere, we are not meeting this year with WAA in Hawaii. Our next Convention will be held as part of the Astronomical League National Convention on August 18-22 at Southwestern College in Memphis, Tennessee. More details will appear in future issues. Readers are again cordially invited to consider giving suitable papers and bringing astronomical exhibits. In fact, a few "early birds" have already promised appealing papers. May we see you in Memphis?

Sustaining Members and Sponsors. There follows a listing of our Sponsors and Sustaining Members as of January 23, 1971. Sponsors pay $25 per year; Sustaining Members, $10 per year. We are greatly indebted to all these colleagues for their generous and most meaningful financial support. The surplus which they pay above the normal dues is used to help meet the general expenses of the ALPO.

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First Annual Apollo Rendezvous and Telescope Fair. The Miami Valley Astronomical Society is hosting this event on Saturday, June 19, 1971 in the Apollo Observatory at the Dayton (Ohio) Museum of Natural History. The attendance and participation of amateur astronomers, astronomical societies, and telescope makers are heartily invited. Interested persons should write to Apollo Rendezvous Committee, Mr. Robert Wetz, Chairman, Apollo Observatory, 2629 Ridge Ave., Dayton, Ohio 45414. There will be a key-note speaker with a world-wide reputation in his field. An extensive exhibit of telescopes and related instruments is planned, with commercial, educational and amateur displays all represented. It is hoped to receive amateur papers, including ones from juniors, on a wide variety of subjects. Individuals and representatives of astronomical societies are invited to bring slides and photographs with them.

JOHN EDWARD MELLISH: TELESCOPE MAKER, ASTRONOMER, AND NATURALIST

By: Eugene W. Cross, Jr.

John Edward Mellish, internationally renowned telescope maker and astronomer, died quietly at the home of his daughter on July 13, 1970 in Medford, Oregon. Born January 12, 1886, near Madison, Wisconsin, John Mellish spent his boyhood in the semi-agricultural community of College Grove, the city of his birth. Later he moved to Ohio; and later still he moved to Escondido, California, where he lived from 1933 to 1959. From 1959 to 1970, he resided at Cave Junction, Oregon.

Mr. Mellish's interest in astronomy and telescopes began at age 14; at age 15 he obtained a small telescope. In the summer of 1903, young John Mellish independently discovered the dark marking on Saturn later reported by Barnard. In 1904 Mr. Mellish made his first telescope. He authored (in 1905) an article on telescope making in Popular Mechanics. As a result of his article, he began to receive orders for telescopes. His career in telescope making was launched! Scientific American published several papers by Mr. Mellish instructing the novice on how to make astronomical telescopes. These instructive papers did much in popularizing telescope making and astronomy in America at a pre-Ingalls-ATM period.

Mr. Mellish was quite successful as an amateur comet hunter, and is credited with the discovery of five new comets. Among these were 1907V, 1915II, 1915IV, and 1917I; he co-discovered Comet Grigg-Mellish, 1907II. The Astronomical Society of Mexico awarded him a gold medal commemorating his feat of discovering two comets in 1907. Besides those comets noted, he independently discovered three others that were reported by other observers before his reports reached authorities at Harvard.

Few astronomers knew of another discovery he made, and few of those who knew believed in it. John E. Mellish discovered, in November of 1915, craters on the planet Mars. In the morning sky, with Mars near the observer's meridian, under conditions of "superseeing", with the world's largest refractor at 1,100X, John Mellish saw what no other man has ever seen directly from the Earth: CRATERS ON THE SURFACE OF MARS. He saw craters on Mars in the same sense that the average person sees craters on the gibbous moon with low power binoculars. He had to wait fifty years, until Mariner IV, to see his discovery of Martian craters accepted by the astronomical world.

John Mellish engaged in telescope making for more than fifty years, and in the course of time made more than a thousand astronomical telescopes. While he made both reflecting telescopes and refracting telescopes, his achromatic refracting telescope objectives are probably the most outstanding examples of his work, being capable of remarkably fine definition by even modern standards. In his own words: "In my life I made and sold over one hundred refractors from three inches to twelve and one-half inches; I worked several twenty-four inch mirrors and six thirty-six inch mirrors and quite a number of other mirrors from eighteen inches to thirty-two inches in diameter." In his later years, Mr. Mellish gave up his career in optics because of failing eyesight.

Optical manufacture of the desired quality often put a strain on his patience, and he frequently closed his shop to get close to nature in the wilderness. With unusually keen powers of observation, he perceived many previously unknown phenomena. Among these was the aestivation of the Poorwill in cliffs near the Colorado River about fifteen years before the fact was published in The National Geographic. He once saw a family of three black cats, like "black leopards or jaguars" near a pool of water on the south face of the Santa Rosa Mountains (California). He knew of the mud volcanoes at the south end of the Salton Sea (California), now flooded. He knew Fish Creek (California) when it had fish in it. He used to point out the double-headed eagle carving on the large boulder near the road leading to Mt. Palomar, as being the work of some early Aztecs.

Among his many interests was gem collecting, and he was once told by a noted authority that he had one of the best gem collections west of the Mississippi. To the great misfortune of Mr. Mellish, however, that collection was lost when his home in Oregon was destroyed in a fire. All of the observational notes of a life-time, as well as the optical work then in progress, were casualties of that fire.

Mr. Mellish is survived by his eight children, and by the memory of all who knew him .... and loved him.

NOTE ON MARTIAN CRATERS: Readers who wish to pursue the matter of the observability of Martian craters are urged to consult the following:

(1) Mellish, John E., Sky and Telescope, 31, 339, 1966.
(2) Harris, Daniel H., "Martian Relief and the Coming Opposition", Science, 155, 1100-1101, 1967.
(3) Private communications from Mr. Mellish which are in the possession of Mr. Eugene Cross.

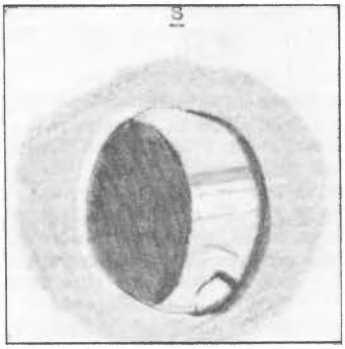

Figure 20. Lunar crater Milichius as drawn by Harry D. Jamieson on June 14, 1962 at 2^h21^m - 2^h30^m, U.T. 5.5-inch Clark refractor, 271X. Seeing 6-8. Transparency 4. Colongitude 46°.4. Note the dark wall band and the very bright wall band just north of it. Both were very conspicuous objects.

****

OBSERVATIONS AND COMMENTS

Bright and Banded Craters Program. Lunar Recorder Harry Jamieson calls attention to Figure 20 as a sample observation in this project. He will welcome correspondence with all interested lunar observers.

In Memoriam: M. de la Rosa. Though his name will be known to very few of our readers and though he was in no sense an astronomer, it is proper that we here express appreciation to the deceased owner of the Commercial Printing & Stamp Company, who produced this journal from about 1964 to 1970. His death in late Nov., 1970 brought a deep feeling of personal loss to the Editor and his family. The regular trips to the office in downtown El Paso had become a personal pleasure as well as a business convenience. We owe to the efforts of Mr. de la Rosa and his staff the good technical quality of the reproduction of this magazine.

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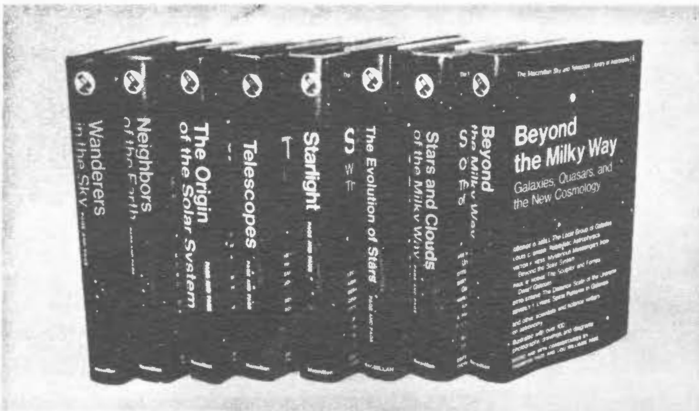

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