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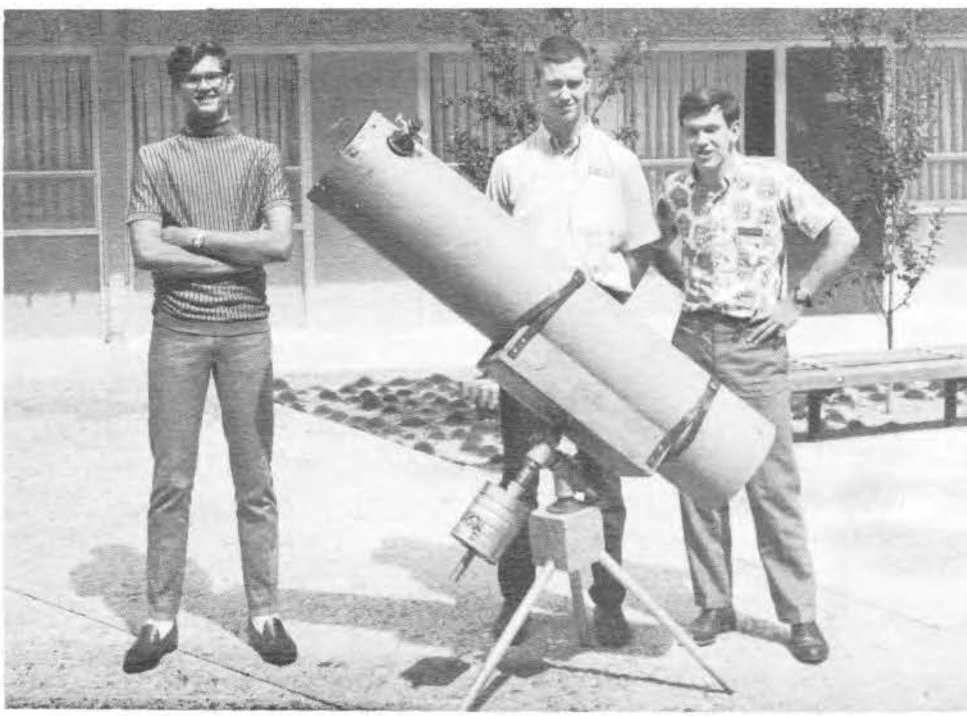

Comet discoverers at Southwestern Astronomical Conference '68 in Garcia Hall of New Mexico State University. On left is Mark Whitaker of Bishop, Texas, the youngest independent discoverer of a comet. Pat Clayton and John Bally-Urban stand behind Clayton's 10-inch reflector. A.L.P.O. members Bally and Clayton discovered Comet Bally-Clayton 1968d with this telescope during the Conference (see page 70). Photograph contributed by Jack Eastman. (Mr. Clayton in middle.)

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ASSOCIATION OF LUNAR & PLANETARY OBSERVERS ALPO

Founded In 1947

IN THIS ISSUE

COMETS SECTION NEWS

By: Dennis Milon, A.L.P.O. Comets Recorder

Several ALPO observers are noted in Brian Marsden's summary "Comets 1967," which is soon to appear in The Quarterly Journal of the Royal Astronomical Society. These roundups, published for 140 years, are now written by Dr. Marsden, who heads the International Astronomical Union's telegraph bureau at the Smithsonian Astrophysical Observatory. We are glad that the ALPO Comets Section files were of value for this article.

ALPO member Takeshi Sato, one of Japan's most active observers, has distributed our brochure and report forms to a number of Japanese astronomers. One of them, Ichiro Hasegawa, the editor of Yamamoto Observatory Circulars, is sending us reports.

Some very interesting notes on techniques of comet observing have been received from Dr. Max Beyer of Hamburg Observatory, West Germany. He writes:

"I am very glad to see that the visual survey of comets is a considerable part of the ALPO program. For research on the influence of solar activity on the brightness of comets very good and precise total magnitudes of the heads of comets are necessary.

"If our weather conditions at Bergedorf were better and the illumination of the streets and shops did not give so much trouble, I would have made photoelectric measurements of comets. With several instruments of very different focal lengths it must be possible to measure the whole head of a comet. Another reliable method would use different diaphragms; for example, 2', 4', and 6' could be used to determine the total magnitudes of comet heads of very different sizes. A friend of mine, Dr. Kurt Wenske, Hamburg-Rahlstedt, controls my visual estimates by photoelectric measurements with his 25-cm. reflector. However, this instrument is too small for comets fainter than 8th magnitude.

"Besides the development of total brightness, it appears to be desirable to measure the nucleus magnitude. We know that these nuclei are very small central condensations which do not merely reflect the light of the sun. The light curve of a nucleus resembles in some way that of the total magnitude, and in most cases they are four or five magnitudes fainter than the coma.

"The visual observations of the tails (whose appearance is less important than the position angles of their directions) may be supported by photographs. The difference between the visual and photographic observations gives data on whether gas or dust is present. Comparisons of the direction of the true motion of the comet or the direction of light pressure from the sun with those of the tails are very informative. And last, but not least, spectrographic objective prism plates give spectra of comets brighter than 7th magnitude with wonderful details for the coma and tails. A suitable combination is a 50° objective prism in connection with a 60-80-mm. camera of 30-40-cms. focal length. I have reported the results of such studies in 15 papers on 'Physische Beobachtungen von Kometen' in Astromomiche Nachrichten."

ALPO comet observations have appeared in Kiev Comet Circulars, distributed from the U.S.S.R. by Kiev Observatory director S. K. Vsekhsvyatsky. These are in Russian, but another source of current observations in English is the BAA Circulars, available by air mail from the British Astronomical Association, 303 Bath Road, Hounslow West, Middlesex, England, for an annual fee of $2.

Darrell Conger of Elizabeth, West Virginia, recounts the slowest known delivery of comet reports! On January 21, 1968 his Comet Rudnicki reports arrived in Cambridge, with the note, "They were originally mailed to you in January of 1967, but came back to me today. Apparently they have wandered all over the country, since there are postmarks on the envelope from Montana, Texas, Iowa, Georgia, Washington, D.C., and Arizona." He had the correct address, too!

A long series of Comet Tempel II and Comet 1967f observations were contributed by Albert Jones of Nelson, New Zealand. Both coma and nucleus magnitudes were estimated, using variable-star charts of the Royal Astronomical Society of New Zealand for faint stars. In January he wrote that "Comet 1967n is badly placed in the morning twilight to see with our short summer nights. From home I have a poor view to the east, being close to a 500-foot hill. But on it there is the Atkinson Observatory which I can use for comets too low in the east to see from home with my 12½-inch reflector. The observatory has a fine old 5-inch Cooke refractor made in about 1880 with a beautiful comet eyepiece having a 3° field."

At Leander McCormick Observatory, David Meisel is currently analysing ALPO magnitude estimates of Comet Tempel II and Comet Mitchell-Gerber-Jones 1967f. Meanwhile, at the University of Texas, Michael McCants has our Comet Kilston magnitudes well in hand.

Our mailing list has now grown to over 100; and in order to ease the Recorder's expenses in time and money, he asks observers to send stamped, self-addressed cards and envelopes.

JUPITER IN 1966-67: ROTATION PERIODS. AN ADDENDUM.

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

S. Component S. Equatorial Belt, System II

No.	Mark	Limiting Dates	Limiting L.	L.	Transits	Drift	Period
1	Dc	Jan. 9 - Jan. 31	135° - 235°	185°	6	+100°.9	9:57:59
2	Dc	Jan. 9 - Jan. 31	142 - 248	194	5	+106.0	9:58:06
3	Dc	Jan. 9 - Jan. 31	146 - 252	200	5	+106.0	9:58:06
4	Dc	Jan. 9 - Jan. 31	152 - 256	205	4	+104.8	9:58:05
5	Dc	Jan. 9 - Jan. 31	154 - 262	210	6	+108.0	9:58:09
6	Wc	Jan. 9 - Jan. 31	172 - 275	223	5	+103.9	9:58:04

Mean rotation period: (without No. 1) 9:58:06

Circulating Current in S. Tropical Zone, System II

No.	Mark	Limiting Dates	Limiting L.	L.	Transits	Drift	Period
1	Dc	Jan. 9 - Jan. 31	146° - 252°	200°	5	+106°.0	9:58:06
2	Dc	Jan. 9 - Jan. 31	152 - 256	205	4	+104.8	9:58:05
3	Dc	Jan.31 - Feb. 19	252 - 162	---	7	- 90.8	9:53:37
4	Dc	Jan.31 - Feb. 28	256 - 171	---	5	- 85.4	9:53:44

Nos. 1 and 2 - Dark condensations on the south edge of the SEB_s. The northern branch of the Circulating Current.

Nos. 3 and 4 - Small, very dark condensations on, or very near, the north edge of the STB. The southern branch of the Circulating Current.

The dark condensations on the south edge of the SEB_s were observed drifting rapidly in the direction of increasing longitude, or in retrograde motion. When the Nos. 1 and 2 condensations reached the vicinity of the sectional STrZ Disturbance, they crossed the STRZ from the south edge of the SEB_s to the north edge of the STB. Then they moved along the north edge of the STB in the direction of decreasing longitude. In previous years, the Circulating Current was a phenomenon apparently associated with, or at least influenced by, the great South Tropical Zone Disturbance of 1901 - 39. The circulating spots then were confined to that portion of the STRZ that was clear of the Disturbance. The spots moved very rapidly in increasing longitude along the south edge of the SEB_s until they reached the preceding end of the Disturbance. They then would become diffuse for a few days, during which time they apparently were swept across the STRZ along the concave leading edge, or preceding end, of the Disturbance. A few days later they would return to prominence as small dark spots along the north edge of the STB, moving very rapidly in decreasing longitude.

No. 1 was observed well by Farrell, Moore, and Budine. No. 2 was observed well by Farrell, Mackal, Moore, and Budine. No. 3 was observed by Moore, Farrell, and Budine. No. 4 was observed by Moore, Shartle, and Farrell.

A special "thank you" to Joanne Farrell and Patrick Moore for their fine observations of the SEB_s spots and the Circulating Current. Observation of the Circulating Current activity is not an easy task, and Mrs. Farrell should be congratulated for her excellent observations with a 4-inch refractor.

N. edge SEB_s, S. part SEB Z, System II

No.	Mark	Limiting Dates	Limiting L.	L.	Transits	Drift	Period
1	Wc	Nov. 20-Apr. 26	14° - 11°	12°	5	-0°.6	9:55:40
2	Wp	Nov. 13-May 1	36 - 30	34	14	-1.1	9:55:39
3	Wc	Mar. 2-May 1	43 - 32	--	8	-6.0	9:55:32
4	Wf	Mar. 2-Apr. 26	44 - 35	--	8	-4.7	9:55:34
5	Dc	Nov. 13-May 1	38 - 38	38	11	0.0	9:55:41
6	Dc	Nov. 20-Mar. 24	50 - 47	50	8	-0.7	9:55:40
7	Dp	Mar. 18-May 1	54 - 52	--	6	-1.3	9:55:39
8	Dc	Mar. 16-Apr. 12	53 - 52	--	4	-1.0	9:55:39
9	Df	Mar. 16-Apr. 12	56 - 56	--	4	0.0	9:55:41
10	Dp	Mar. 16-May 1	65 - 62	--	7	-1.9	9:55:38
11	Dc	Nov. 13-Apr. 29	63 - 65	64	9	+0.4	9:55:41
12	Df	Mar. 16-May 1	68 - 68	--	4	0.0	9:55:41
13	Dp	Mar. 24-Apr. 29	71 - 73	--	5	+1.5	9:55:43
14	Dc	Nov. 13-Apr. 30	78 - 77	77	8	-0.2	9:55:40
15	Df	Mar. 24-Apr. 29	75 - 80	--	5	+3.9	9:55:46
				Mean Rotation Period:			9:55:40

The highlight of the SEB Z region was a dark complex of disturbed material consisting of bright ovals and dark festoons in the SEB Z following the Red Spot area. The SEB Z activity was greatest between March 1 and May 1, 1967. Nos. 2-15 are all in the SEB Z disturbance region. Practically all the data included in the table for Nos. 2-15 is based upon the fine transit observations from Stanley Shartle, who observed this activity closely from March 1 to May 1, 1967. Other observers who contributed were Moore, Pollak, Farrell, and Budine.

No. 1 was a very bright oval observed on the north edge of the SEB_s. No. 5 was a very dark festoon observed transversing the SEB Z.

S. edge SEB_n, N. part SEB Z, System II

No.	Mark	Limiting Dates	Limiting L.	L.	Transits	Drift	Period
1	Dc	Oct. 24--Nov. 13	189° - 87°	--	8	-102°.7	9:53:21
2	Wc	Nov. 24--Dec. 13	289 - 184	--	5	-105.2	9:53:17
3	Wc	Nov. 24--Dec. 13	297 - 192	--	4	-105.2	9:53:17
4	Dc	Dec. 4--Dec. 16	273 - 180	--	3	- 93.0	9:53:34
5	Dc	Dec. 13--Jan. 21	330 - 212	212°	6	-118.0	9:53:00
6	Dc	Jan. 21--Feb. 9	282 - 181	--	4	-101.3	9:53:23
7	Wc	Jan. 29--Feb. 22	303 - 217	--	5	- 86.0	9:53:43
				Mean Rotation Period: (without No. 5)			9:53:26

A number of small very bright nodules and thin dark projections were observed along the south edge of the SEB_n. No. 1 was a very dark spot in the SEB_n observed best by Moore. No. 7 was a very bright white oval observed in the SEB Z mostly by Farrell, Moore, and Budine.

A REPORT AND ANALYSIS OF SEVENTEEN RECENT LUNAR TRANSIENT PHENOMENA. PART II

By: H. W. Kelsey and Charles L. Ricker, A.L.P.O. Lunar Recorders

In a previous article (Kelsey 1967), 17 Lunar Transient Phenomena (LTP) were listed and examined with respect to their possible correlation with gravity and tidal conditions at the moon's surface, and particularly at the local areas on the moon where they were observed. In this present article, the same 17 events will be examined in respect to possible correlations with solar activity.

Theoretical Considerations

Before examining the LTP's in detail, it would be well to look at some of the hypothetical relations which have been advanced to explain the possible relationship between solar activity and LTP. These possible causes are:

1. Solar flare emitted corpuscular radiation (Kopal 1965).

2. Influence of the Earth's Magnetic Tail (Speiser 1965).
3. Low angle incidence of light, up to three days after local lunar dawn, causing thermo-luminescence (Sidran 1967).

Examining these in some detail, we find:

1. Solar Flares. Kopal (1965) has strongly suggested that many color events can be luminescence triggered by corpuscular particles which are emitted by solar flares.

In laboratory experiments by Nash (1966), silicates displayed excitation in the red when the mineral is first bombarded by 5-kev protons. The luminescence intensity decreases with time. The supposed constitution and conditions at the lunar surface qualitatively favor the concept of solar-ion excitation; however, the luminescence effect was shown to be directly proportional to incident ion energy and flux, and the measurements indicate that insufficient energy is supplied by solar-ion excitation to produce the observed luminescence on the sunlit lunar surface. It is suggested by Nash, though, that some as yet undetermined energy concentration, such as magnetic focusing of charged particles, may yield the required energy.

The obvious lack of correlation of historical events with simultaneous solar events rather conclusively demonstrates that electromagnetic radiation cannot be the cause of observed LTP's, but particles which travel at velocities considerably less than c may cause LTP's at the delayed transit time of these solar flare emitted particles. There is an indicator of the effects of solar flare radiation at the earth-moon system. It is the geo-magnetic disturbance index (the Kp index). Some writers have argued that if a relationship exists between LTP and solar flares, a correlation should be found between the Kp index and the observed LTP (Cameron & Gilheany, 1967, and Matsushima, 1967). Since the lines of force in space, the solar wind, and the Earth's Magnetic Tail are so incompletely understood, this argument may not be entirely true.

2. Earth's Magnetic Tail. As suggested above, solar particles may be accelerated and focused by the Earth's Magnetic Tail (EMT). Speiser (1965) has suggested that this mechanism may impart sufficient energy to excite lunar gases or surface materials to observable luminescence. If this is true, it would be expected that events would occur within the EMT and its bow-shock front (Cameron & Gilheany, 1967), whose limits are approximated at 4.5 days before and after Full Moon (Ness 1966).

3. Thermo-luminescence. Thermal glow caused by sudden heating of lunar materials after a long period of cold has been suggested as a possible explanation of some LTP's (Sidran 1967). If this is true, a correlation should be found between LTP's and local lunar dawn, at which time the background illumination is low and the sudden heating conditions are present. Enhancement should also be observed during lunar eclipses when formations are leaving the umbra. It would be expected that a correlation should exist between LTP's and a period up to three days after local lunar dawn. Sun & Gonzales (1966) have conducted experiments with meteoritic materials and have found after bombardment with 2 Mev electrons, and suitable cooling and heating of the materials, that vivid red and blue glows are observed (thermoluminescence). It was concluded that the sunrise terminator should appear enhanced in these colors. Sunrise reddening is an observed phenomenon which is not completely understood at present.

The Observations

The observations are listed in Table I along with certain pertinent data which were chosen in view of the above theoretical considerations. The data are presented in graphic form (Fig. 1) with the LTP's and their associated discrete flares plotted as functions of associated Kp indices, and the number of days from Full Moon. Even without a rigorous analysis of this graph, it is evident from inspection that the majority of events occurred within the limits of 4.5 days from Full Moon (the Earth's Magnetic Tail, and its bow-shock front). It is also evident that the majority of events occurred at quiet geomagnetic levels as indicated by the Kp index. It is also seen that all of the LTP's were preceded by solar flares of importance 1 F or greater. The lead time of these flares varied between 21 and 52 hrs. In Table II, an attempt is made to demonstrate correlations (or lack of same) between the 17 events and all of the factors that have heretofore been discussed, including the tidal data which appeared in Part I of this paper. This correlation chart makes it apparent that all of the advocated causes of LTP's are in force. A definition of optimum conditions for having LTP would be at a time when the moon is in apogee or perigee, and when the formation in question is at gravity high or low as determined by the libration, and is within the Earth's Magnetic Tail. These conditions are further to be preceded by a solar flare at a lead time of 24 to 48 hrs.

It is evident that all of the observations are accompanied by one or more of the above criteria. The observations accompanied by flares of importance 1F, 1N, or 1B, which are rather weak and commonplace, are mostly reinforced by the other defined conditions. In only two cases (observations 8 and 15) is the EMT absent. In case 15, a very high Kp index was preceded by, and probably is an indicator of, a 3B flare at -25 hrs.; and this severe solar activity may have been sufficient for excitation without the help of the EMT. Additionally, observations 15 and 17 were not made at apogee or perigee, but were both accompanied by high Kp indices.

This remark leaves only observation 8 which was preceded by a weak (1N) flare with a low Kp index, and which had no help from the EMT. A very important conclusion can be drawn from this: observation 8 may not be a genuine LTP. It is evident that such a correlation chart can be used in reverse; that is, to judge the realty of LTP observations.

Number	Date UT	Time UT	Color Reported	Sun's Altitude °	Days From Full Moon	Kp Index	Flare Importance	Flare Lead Time
1	4-30-66	2130	Red	1.0	-4.0	3-	1N	32h
2	5-1-66	1930	Orange	7.9	-3.0	2-	1F	52
3	5-2-66	2005	Orange	12.6	-2.0	3+	1N	28
4	8-4-66	2240	Red	32.3	+3.6	3	1N	32
5	9-2-66	0450	Orange	67.2	+2.2	2+	2N	34
6	9-3-66	0127	Orange	71.6	+3.1	3	2N	28
7	1-21-67	1940	Orange	1.0	-4.5	3	1B	28
8	2-17-67	1800	None	4.5	-7.0	3	1N	20
9	2-19-67	2030	Red	29.3	-4.9	2	1N	49
10	3-22-67	1940	Red	9.7	-3.3	1-	1N	26
11	3-23-67	1840	None	20.7	-2.4	3-	2N	38
12	3-23-67	1945	Red	14.0	-2.4	3-	2N	39
13	4-21-67	2120	Red	8.8	-2.6	2-	2N	24
14	5-20-67	0504	Red	2.4	-3.6	1+	2N	21
15	5-29-67	0640	Red-Brn	61.4	+5.4	7-	3B	25
16	6-18-67	2110	Red	4.9	-3.3	0+	1B	24
17	9-17-67	0205	Red	18.2	-1.6	6	1N	44

Table I. Tabulation of selected data upon 17 recently reported Lunar Transient Phenomena. Table arranged by H. W. Kelsey and Charles L. Ricker and discussed in text of their accompanying article.

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Conclusions

It is realized that there are some authorities who deny the very existence of LTP's even though such disbelief is becoming more and more untenable. It may be argued that the above correlations are only coincidences; but without discussing the mathematical probabilities against such a chain of coincidences, it must be clear that it would be incredible if they were all coincidence.

Even though the sample is small, it is considered that strong evidence exists in these 17 observations that LTP may be caused by solar flare corpuscular radiation which has been accelerated and focused by the Earth's Magnetic Tail and is delivered to the moon's surface

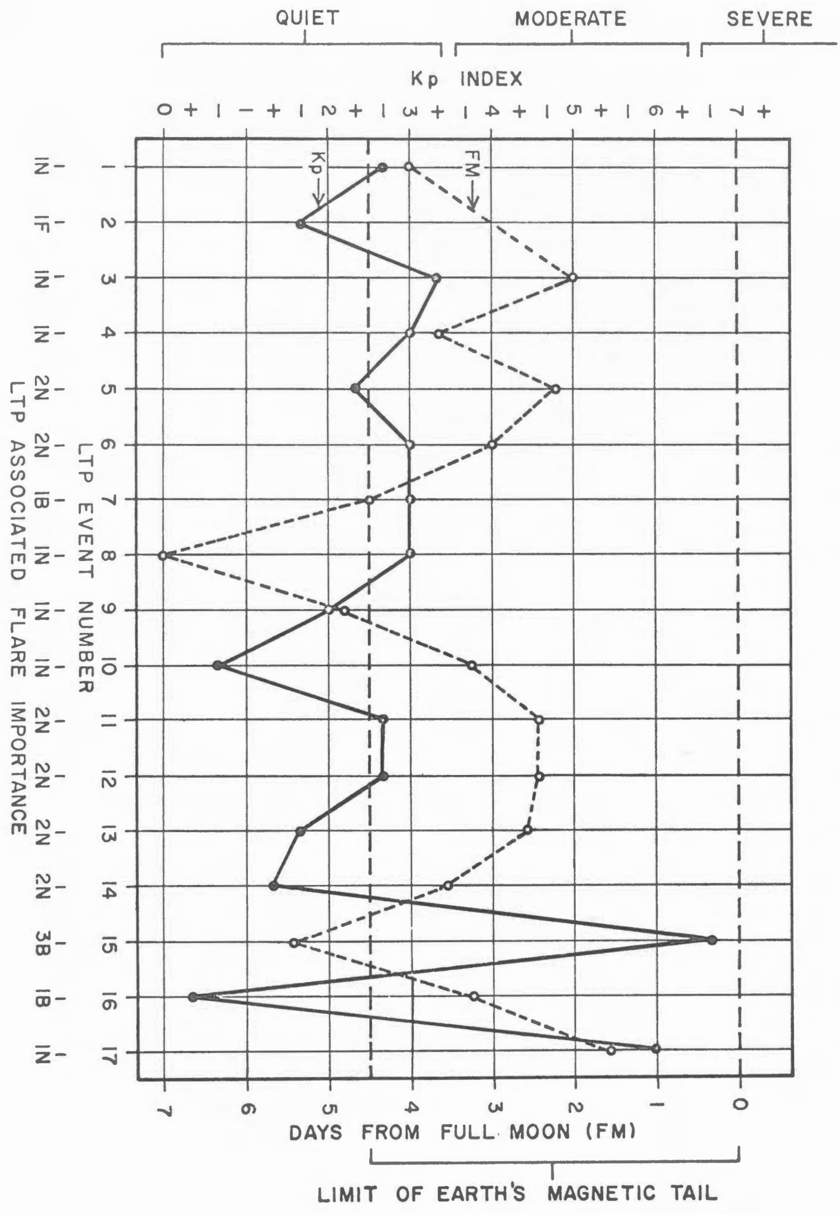

Figure 1. Graph prepared by H. W. Kelsey and Charles L. Ricker to show certain relationships among 17 recently reported Lunar Transient Phenomena and selected data on solar flares and the Earth's Magnetic Tail. See also discussion in text of their article in this issue.

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when its surface is receptive to excitation as a result of gravity conditions associated with apogee, perigee, and libration. The contribution made by conditions at a low angle of solar lighting up to three days after local lunar dawn is not yet clear, but cannot be disregarded. It may be that the only observable consequence of this influence is the much discussed sunrise reddening.

Number	Solar Flare	Electromagnetic Radiation X-ray - UV	Kp Index	Earth's Magnetic Tail	Local Dawn Plus 3 days	Apogee or Perigee	Libration Gravity High or Low
1	A			A	A	A	
2	B			A	A	A	
3	A		B	A	B	A	A
4	A			A		A	A
5	A			A		A	
6	A			A		A	
7	A			A	A	—	
8	B				A	—	
9	A			A	A	—	
10	A			A	A	—	A
11	A	A		A	A	A	A
12	A	A		A	B	A	
13	A			A	A	A	
14	A			A	A	A	A
15	A+		A				A
16	A			A	A	A	
17	A		A	A	A		

Table II. Tabulation of additional selected data upon 17 recently reported Lunar Transient Phenomena. Table arranged by H. W. Kelsey and Charles L. Ricker and discussed in text of their accompanying article.

A=Good Correlation
B=Borderline Correlation
Blank=No Correlation

The importance of reporting all cases of suspected LTP's to the proper individuals is herein demonstrated; for if such observations are not published, and thereby subjected to analysis, a very important part of the record will be lost. The writers believe that all reported LTP's should be subjected to this type of analysis, both for the purpose of determining possible causes and also for the purpose of establishing the reality of the suspected LTP.

References

Cameron, W. S. and Gilheany, J. J. (1967). "Observational Results of The First One and One-Half Years of The Moon Blink Projects." The Strolling Astronomer, Vol. 20, Nos. 9-10.

Delano, The Rev. K. W. (1967). "A Possible LTP Seen in the Southwest Rim Craterlet of Aristarchus." The Strolling Astronomer, Vol. 20, Nos. 9-10.

Kelsey, H. W. and Charles L. Ricker, (1968). "A Report and Analysis of Seventeen Recent Lunar Transient Phenomena, Part I." The Strolling Astronomer, Vol. 21, Nos. 1-2.

Kopal, Z. (1965). "Luminescence of The Moon and Solar Activity." Proceedings of The 1965 IAU-NASA Symposium.

Lunar Section Reports of LTP. (1966-1967). The Lunar Section Circular of The British Astronomical Association. Vol. 1, Nos. 10 and 11; Vol. 2, Nos. 3 through 11.

Matsushima, Satoshi (1967). "Transient Lunar Brightening." Nature, Feb. 4, 1967.

Nash, Douglas B. (1966). "Proton Excited Luminescence of Silicates, Experimental Results and Lunar Implications." Journal of Geophysical Research, Vol. 71, No. 10.

Ness, N. F. (1966). "Earth's Magnetic Field: A New Look." Science, 151, 1043.

Ricker, C. L. (1967). "An Apparent Observation of Color in the Aristarchus-Herodotus Region." The Strolling Astronomer, Vol. 20, Nos. 7-8.

Sartory, P. K. (1966). "Report on Transient Phenomena." Journal of The British Astronomical Association, Vol. 77, No. 1.

Sidran, M. (1967). "Thermoluminescence of The Moon." Grumman Research Department Report RE-294.

Solar-Geophysical Data. Published Monthly by The Institutes For Environmental Research and The Department of Commerce Environmental Science Services Administration.

Speiser, T. W. (1965). "Particle Trajectories in Model Current Sheets. 2. Analytical and Numerical Applications to Auroras Using a Geomagnetic Tail Model." NASA-GSFC X-Document 641-65-451, 31.

Sun, K. H. and Gonzales, J. L. (1966). "Thermoluminescence of The Moon." Nature, No. 5057.

OPTIMUM METHODS FOR OBSERVING MERCURY'S MARKINGS

By: Clark R. Chapman

Abstract: Conclusions are reached here which are important to all visual observers of Mercury concerning the best methods for observing surface details. Psychophysical studies of the contrast perception of the human eye show that detection of surface markings on Mercury depends significantly on many factors, including: telescope aperture, magnification, Mercury's phase and orbital distance from the sun, the brightness of the sky, scattered light in the telescope, transparency of the sky, absorption in the telescope and filters, seeing conditions, inherent contrast of surface markings, and size of surface markings. The results of the analysis are very important; if the proper methods suggested here are not followed, observers will not see surface detail. The conclusions are summarized succinctly in Parts III and IV and should be read even by beginners not interested in the detailed calculations in the middle of the article.

I. Introduction

A. The Importance of Mapping Mercury

One of the more interesting serious projects on which amateurs can work is the mapping of surface features on the planet Mercury. About three years ago, radar observations proved that Mercury's rotation period is about 60 days and invalidated all previous maps based on a synchronous rotation (88 days). Some of the early papers on the faster rotation period have been summarized by Hodgson in a recent article in this Journal[1]. The latest account of radar work is that of Dyce, Pettengill, and Shapiro[2], in which the rotation period is determined to be 59 ±3 days. Comprehensive analysis of past visual and photographic observations of Mercury[3] gives some support for the rotation period's being 58.63 ±0.03 days -- a range which includes the period of 58.6462 days which is exactly two-thirds of the orbital revolution period of 88 days and which is expected on theoretical grounds to be a dynamically stable period.

Two maps of Mercury have been made recently[4,5] assuming the 58.6462-day period. Both are based largely on observations made before the revision of the rotation period. The consistency of the old data with the maps lends support to the 58.6462-day period, but it is by no means conclusive. Therefore, in order to verify the rotation period, it is important for further visual and photographic observations to be made. Also, it will be particularly interesting to construct the first accurate, objective map of Mercury's surface features.

It is the purpose of this article to discuss the factors which affect visual observations of Mercury and to explain the best observing procedures. Observing Mercury is inherently difficult, and only by using optimum methods can amateur observers improve appreciably over earlier results. The discussion which I apply to Mercury in this article can be applied, with some modifications, to observations of other planets or the moon. The analysis is based largely on the theory-of-observation chapter in the forthcoming A.L.P.O. Observing Manual[6].

B. When to Observe During the Year

As observers familiar with Mercury know, the planet's elongations from the sun (of which there are about six per year -- three in the evening sky, three in the morning) are fairly brief and differ considerably in favorability. Apparitions usually considered to be favorable are thos during which Mercury is fairly high above the horizon during twilight (morning apparitions in the autumn, evening ones in the spring). However, Mercury is frequently farther from the sun (though low on the horizon during twilight) during so-called unfavorable apparitions, as seen from the northern hemisphere.

In our Sky and Telescope review article[4], Dale Cruikshank and I show how some coincidental periodicities make it difficult to get good coverage of the planet's surface if one observes just at favorable apparitions (one keeps seeing the same side of the planet each time). Indeed, in order to get good coverage of all the planet sufficient to make a complete map of the planet, one must attempt to observe during all apparitions -- both morning and evening, favorable and unfavorable. In addition, for best coverage, an observer should try to observe throughout each apparition, not just during the few days near greatest elongation when the planet is approximately half full. Observations are possible for at least two weeks centered around each elongation, and sometimes for as long as five weeks.

C. Finding Mercury in the Daylit Sky

Following the observing schedule suggested above is not easy. One common difficulty is finding Mercury in the daylit sky (only during favorable morning apparitions is it possible to find the planet easily against a reasonably dark sky). Setting circles on the telescope are virtually a necessity, though they need not be too exact and the telescope need not be permanently mounted. (If you do not have, and cannot make, setting circles, the only alternative is to set the telescope the night before on a star with the same declination as Mercury's. Mercury will be in the field of view the next day, at a time later in hours and minutes equivalent to the difference in right ascension between the star and Mercury.) If you have setting circles, and the telescope is reasonably aligned to north, first set the telescope on some bright object with a known position (such as the sun, the moon, or Venus). Then quickly turn the telescope about both axes by an amount equal to the difference in both right ascension and declination between the bright object and Mercury (use positions given in The American Ephemeris and Nautical Almanac). Focus is critical; the telescope should be pre-focussed on Venus, the moon, the edges of distant cumulus clouds, or on stars the night before.

II. Observing the Surface Features

The problem of seeing surface features on Mercury sufficiently reliably to map them involves four factors: (1) the effective resolution of the telescope (taking the effects of seeing into account), (2) the apparent size of Mercury and its features as seen through the eyepiece, (3) the apparent surface brightness of Mercury as seen through the eyepiece, and (4) the apparent contrast between the dark and light areas on Mercury's disk as seen through the eyepiece.

A. Resolution and Seeing

I will not dwell too long on the effective resolution of the telescope because there is not much that can be done about it. The effective resolution may be defined as a measure of the resolution of the telescope under the seeing conditions obtaining during the observation. The effective resolution is limited by (a), the finite aperture, and perhaps limited quality, of the telescope optical system, and (b), the seeing conditions. For observations of Mercury with a telescope aperture larger than six inches, factor (b) is almost always the limiting condition. The amateur observer should endeavor: (1) to determine a good site where the air is often reasonably still during daylight hours, and (2) to determine the time of day when the air is stillest. Convection caused by solar heating is frequently worst in the afternoon, in cities, and on south sides of hills, but depends on local conditions. The seeing conditions always vary strongly with the altitude of Mercury above the horizon. It is my opinion that Mercury should be 30° (certainly never less than 15°) above the horizon, in order to have usable resolution. But sometimes the resolution must be compromised to optimize some of the other factors discussed below.

The observer should make an estimate of the effective resolution R_{eff} in seconds of arc. This may be done by guessing at the apparent size of the smallest black dot which could be seen on Mercury during moments of better seeing. Base the guess on the sharpness of the image and estimate it as a fraction of Mercury's diameter; then convert to seconds of arc using the value for Mercury's diameter given in A.E.N.A. Such estimates should be checked and calibrated against the smallest size of lunar craters visible on the crescent moon when the moon is near Mercury in the sky (2 kms. on the crescent moon = 1 second of arc; get crater diameters from standard catalogs[7], but avoid using craters too near the terminator).

Given an image of Mercury, resolved to the degree determined above, the task is to optimize contrast perception, in order best to see the markings which may be present. The optimization of contrast perception depends on factors (2) and (3) mentioned above: the apparent size of the surface features subtended at the eye and the apparent surface brightness of Mercury.

B. Apparent Size of Markings

The apparent size of a surface feature is simply its true angular size, as seen from the earth, multiplied by the magnification*. On any occasion, the smallest apparent surface feature which can be seen on Mercury subtends an angle of approximately $A = (M)(R_{eff})$ where M is the magnification. If one is interested in a marking with a diameter one-third that of the planet, its apparent size A is given by Mercury's diameter (from the ephemeris) times 1/3 times M. It is important to remember in the discussion of contrast perception later in this article that the important factor is the apparent size of the features one wishes to observe, not the apparent diameter of Mercury and not necessarily the size of a feature at the limit of resolution.

C. Surface Brightness

The true surface brightness of Mercury has been determined quite accurately[8]. It is not constant, but varies considerably with Mercury's phase, and to a lesser extent with Mercury's distance from the sun as shown in Table 1. The phase variation has nothing to do with the fraction of the planet illuminated but is a property of the surface of Mercury. (For a similar reason, the full moon is twelve times brighter in magnitude than the half-illuminated "quarter" moon, not twice. The illuminated portion of the full moon is twice as large, but the surface brightness per unit area is six times greater.) The American Ephemeris and Nautical Almanac gives Mercury's radius vector (distance from the sun in astronomical units) in the heliocentric position tables, and the phase angle i in the table for the illuminated disk of Mercury.

Before reaching the observer's eye, Mercury's light is attenuated by absorption in the earth's atmosphere, in the telescope optics, and in any filter which is used. The percentage of light passed through some filters commonly used for reducing the brightness of the blue sky when observing Mercury is given in Table 2. Transmission of light through the telescope optical system is determined by the number of optical surfaces in the light's path, the reflectivity of the mirrors, the thickness of the lenses, and the general cleanliness of the optical components. Even for telescopes with freshly silvered or aluminized mirrors and oculars with few components, less than 0.8 of the light is transmitted. Usually, in practice the telescope transmission factor α_t is nearer 0.4, and it can be much less.

The observer can determine the transmission factor α_s for the earth's atmosphere by estimating the transparency of the atmosphere. For the night sky, the transparency estimate is simply the magnitude of the faintest star which can be seen (at the elevation above the horizon of interest) by an observer for whom the limiting magnitude is 6.0 on a clear night. (If you can occasionally see magnitude 7, you should revise your estimates of the transparency T_r downward by one magnitude.) Of course, during daylight the scattered blue light in the sky makes meaningless an estimate of stellar magnitude (stars can't be seen). It is sufficient to make an approximate guess, based on the blueness of the sky, or perhaps based on an estimate made before dawn or after twilight on the same day. Then use Table 3 to convert the transparency estimate to a total transmission factor α (multiply together the transmission factors for the telescope and filter, discussed above; and read under the appropriate column).

In addition to light loss by absorption, scattered light is added to Mercury's image,

*Actually a better value for the apparent size of a spot of diameter d smeared by the limited resolution is $(d + R_{eff})(M)$ where M is the magnification.

Table 1. True Surface Brightness of Mercury B (candles/sq. meter)

phase angle $\underline{i}$ =	50°	70°	90°	110°	130°
radius vector = 0.31 AU	11500	8700	6300	4500	2700
radius vector = 0.39 AU	7700	5800	4200	3000	1800
radius vector = 0.46 AU	5100	3900	2800	2000	1200

Table 2. Transmission of filters.

Wratten number	Color	Transmission Factor, α_f
23A	red	0.25
106	orange	0.34
21	orange	0.46
15	yellow	0.66
12	yellow	0.74

Table 3. Total Transmission Factor ($\alpha = \alpha_s \alpha_f \alpha_t$)

Transparency T_r	$\alpha_f\alpha_t = 0.8$	$\alpha_f\alpha_t = 0.6$	$\alpha_f\alpha_t = 0.4$	$\alpha_f\alpha_t = 0.2$	$\alpha_f\alpha_t = 0.08$
6.0	0.64	0.5	0.3	0.15	0.064
5.5	0.40	0.3	0.2	0.10	0.040
5.0	0.25	0.2	0.13	0.06	0.025
4.5	0.16	0.12	0.08	0.04	0.016
4.0	0.10	0.075	0.05	0.025	0.010
3.5	0.06	0.050	0.03	0.015	0.006
3.0	0.04	0.030	0.02	0.010	0.004
2.0	0.016	0.012	0.008	0.004	0.0016

both in the atmosphere and in the optical system. Provided that care is taken to insure that direct sunlight does not strike, or reflect into, the optical system of the telescope, scattered light in the telescope S_t is small compared with the sky brightness; and we ignore it here. The surface brightness S_s of the clear blue sky is about 8000 cd/m^2 (use 4000 cd/m^2 when employing a yellow, orange, or red filter). The sky can be several times brighter on a bright hazy day, and, of course, is much lower and rapidly varying during dawn and twilight. Use an exposure meter aimed at the sky, away from the sun and not through the telescope, and compare with a reading on a clear day. The inverse ratio of indicated exposures is equal to the ratio of 8000 cd/m^2 to the sky brightness S_s. The sky brightness is reduced by absorption in the optical system and in a filter by the same factors discussed earlier: α_t and α_f.

The final considerations involved in determining the apparent brightness of the image as seen through the eyepiece are the telescope aperture and the magnification. The image is brighter by the ratio of the area of the telescope aperture to the area of the pupil (taken to be 1/8 inch) and is fainter by the square of the magnification. The following equation summarizes the calculation of the apparent surface brightness $\underline{B'}$:

$$B' = (64\,D^2)(\alpha B + \alpha_t \alpha_f S_s)/(M^2) \quad , \tag{1}$$

where:

D is the telescope aperture in inches,
M is the magnification,
B is the true surface brightness of Mercury (given in Table 1),
α_f is the transmission factor of the filter (given in Table 2),
α_t is the transmission factor of the telescope,
α is the total transmission factor (given in Table 3), and
S_s is the surface brightness of the sky.

D. Optimizing Contrast Perception

In order to achieve good contrast perception (i.e., in order to see markings), an image should be large and bright in the eyepiece. Under most conditions in planetary observation, however, it is difficult to obtain contrast perception approaching the theoretical visual threshold. If the magnification is increased to the extent required to make the image sufficiently large, it will be far too dim, while if the magnification is lowered to brighten the image sufficiently, it will be far too small. Figure 2 summarizes the results of psychophysical tests of visual contrast perception[9] under ideal laboratory conditions. It is very useful for determining the optimum magnification to use. The figure also gives the contrast threshold obtained.

To use the graph, plot the point determined by: (1) the apparent surface brightness of the image as found by equation (1), and (2) the subtended angle of the surface features of interest (but no smaller than the effective resolution) as discussed in Part II-B. If the point falls below the clear region, contrast perception can be improved significantly by increasing the magnification. If the point falls above the region, a lower magnification is better. To determine the best magnification from your trial value, draw a line through your plotted point parallel to the set of straight lines sloping up to the left. At the point where this line intersects the slightly curved line in the middle of the clear region, read off the corresponding subtended angle. The intersection gives you the ideal contrast threshold when you increase your trial magnification by the ratio of the subtended angle at the intersection to the trial subtended angle.

Contrast C of a dark marking against a brighter background is defined as $C = (B_2 - B_1)/B_2$ where the B's are surface brightnesses and $B_2 > B_1$. The contrast perception threshold in practice is usually at least 4 times larger than the ideal thresholds given in Figure 2. While the ideal threshold is never better than 0.3%, the threshold is never less than 1½% in practice. (The contrast of the maria on the moon is about 30%, for comparison.) Whether or not an observer can see markings on Mercury depends on whether or not the optimized contrast threshold (determined from Figure 2 and multiplied by 4) is greater or less than the apparent contrast of Mercury's surface markings. For daytime observations, the apparent contrast is very different from the true contrast, as is shown in the next part.

E. Apparent Contrast

The true contrast C of planetary surface markings is determined by the reflectivities of the surface features (dark features appear dark because they reflect less sunlight). The brightness of a surface feature is, in general, an average of the brightness of its component parts below telescope resolving power. Of course, the "true" contrast may be different when viewed through various color filters, if the contrasting features have different colors. Only two factors alter the true contrast of surface markings: scattered light added to the image and smearing of the image by the finite resolution. Both effects always worsen contrast (only through photographic or electronic processes can contrast be enhanced).

For readers arithmetically inclined, I now give the derivation of the formula for apparent contrast; but really it is only the result which is important. Let the true brightness of the background surface be B_2, and of the darker spot B_1. The apparent brightnesses of B_2 and B_1 are, respectively, $(64\ D^2)(\alpha_f\alpha_t\alpha_s B_2 + \alpha_f\alpha_t S_s + \alpha_f S_t)/M^2$ and $(64\ D^2)(\alpha_f\alpha_t\alpha_s B_1 + \alpha_f\alpha_t S_s + \alpha_f S_t)/M^2$, where all the terms are as defined earlier. Therefore, from the definition of contrast and considering smearing by seeing*, the apparent contrast is given by:

$$C' = \frac{\{[(64\ D^2)(\alpha_f\alpha_t\alpha_s B_2 + \alpha_f\alpha_t S_s + \alpha_f S_t)/M^2] - [(64\ D^2)(\alpha_f\alpha_t\alpha_s B_1 + \alpha_f\alpha_t S_s + \alpha_f S_t)/M^2]\}\ d^2}{[(64\ D^2)(\alpha_f\alpha_t\alpha_s B_2 + \alpha_f\alpha_t S_s + \alpha_f S_t)/M^2]\ (d + R_{eff})^2} \quad (2)$$

This very long expression has many factors common to both the numerator and the denominator, and therefore reduces immediately to:

$$C' = \frac{\alpha_t\alpha_s\ (B_2 - B_1)[d^2/(d + R_{eff})^2]}{\alpha_t\alpha_s B_2 + \alpha_t S_s + S_t} \quad . \qquad (3)$$

If we consider scattered light in the telescope negligible (its value is difficult to measure), then:

$$C' = \alpha_s(B_2 - B_1)[d^2/(d + R_{eff})^2] \ / \ (\alpha_s B_2 + S_s) \quad . \qquad (4)$$

*For a round spot near or below the scale of resolution R_{eff}, its true contrast is reduced by the factor $(d^2)/(d+R_{eff})^2$, where d is the true (not apparent) diameter of the spot in seconds of arc. (For linear streaks of width w, the correct factor is $(w)/(w+R_{eff})$. The difference between these two factors, by the way, explains why narrow "canals" are much easier to see than round spots of the same size.)

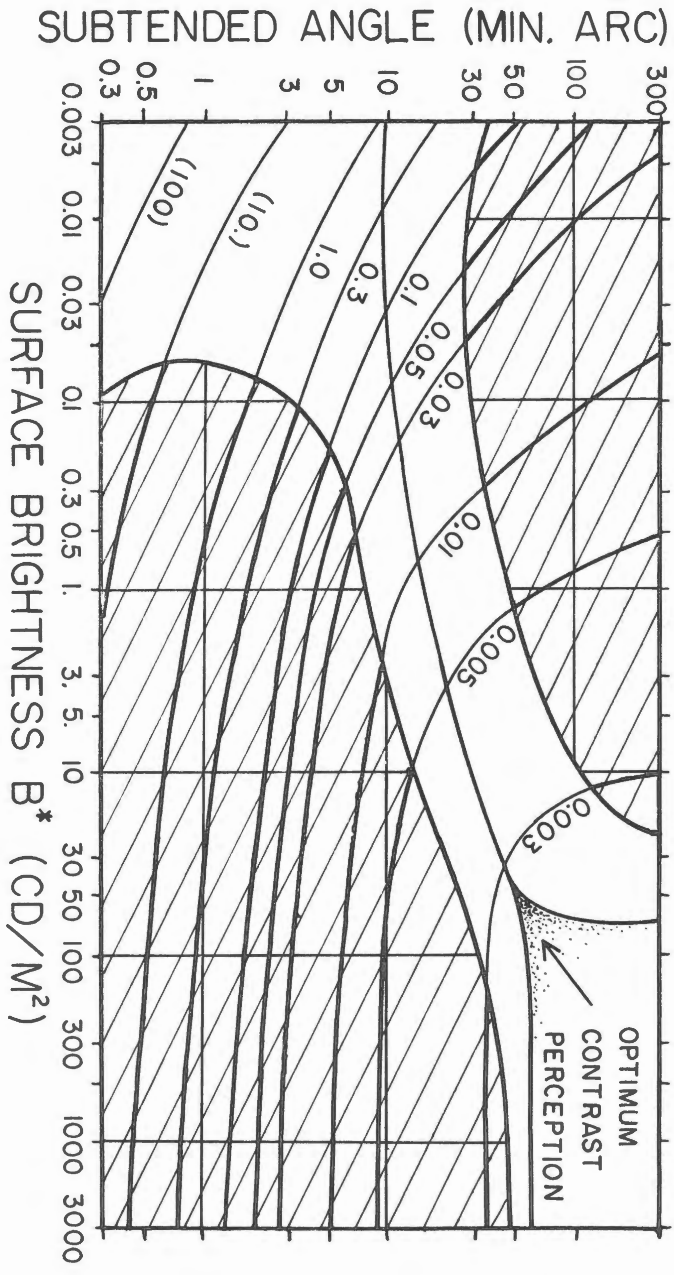

Figure 2. The ideal contrast thresholds for the human eye (under laboratory conditions) are plotted as functions of the apparent planetary surface brightness and the subtended angle of the contrasting feature. Changes in magnification alone will move parallel to the set of parallel straight lines. The best magnification is being used if the plot falls in the clear region around the gently curving "optimum contrast perception" line. Thresholds in excess of 1.0 can only be achieved for bright markings on dark backgrounds, in which case the contrast is defined as $C = (B_2 - B_1)/B_1$, for $B_2 > B_1$.

It is important to note the result that the apparent contrast is not dependent on telescope aperture or magnification. Nor is the apparent contrast dependent on (monochromatic) absorption if the scattered light is zero. Of course, as I showed earlier, the eye's ability to detect the contrast is strongly dependent on all these factors.

F. Sample Mercury Observation

Suppose you observed Mercury during the afternoon of January 16, 1964, with excellent seeing (R_{eff} = 0.7 seconds of arc). You hope to see large surface spots about 1/7 of Mercury's diameter in size. Since the ephemeris gives Mercury's apparent diameter on January 16, 1964, as 8".4, such a spot would be 1".2 in diameter. Suppose your telescope is a reasonably clean $12\frac{1}{2}$-inch reflector, well-shielded from direct sunlight, and that you used 300 power and a Wratten 21 filter to reduce the sky brightness ($D = 12\frac{1}{2}$, $M = 300$, $\alpha_t = 0.6$, $\alpha_f = 0.46$ from Table 2, $S_t = 0$, and $S_s = 4000$). Suppose that the sky was very blue, and the estimated transparency was limiting magnitude 5.5. Then the total transmission coefficient $\alpha = 0.14$ (from Table 3, recalling that $\alpha_f\alpha_t = (0.46)(0.6) = 0.28$). Since $\alpha_s = \alpha/(\alpha_f\alpha_t)$, $\alpha_s = (0.14)/(0.28) = 0.5$.

From the ephemeris, we find that on January 16, 1964, Mercury's radius vector from the sun was 0.36 and its phase angle i was 110°; hence, from Table 1, Mercury's true surface brightness was about 3500 cd/m^2. Suppose at that time Mercury's darkest spots had a surface brightness of only 2300 cd/m^2. The true contrast between the dark spots and Mercury's disk was:

$$C = \frac{3500 - 2300}{3500} = 0.34 \text{ or } 34\%. \qquad (5)$$

However, the apparent contrast, given by equation (4), was only:

$$C' = \frac{0.5\ (3500 - 2300)\left[(1.2)^2/(1.2 + 0.7)^2\right]}{(0.5)(3500) + 4000} = 0.04 \text{ or } 4\%. \qquad (6)$$

The apparent surface brightness of the image to the eye is given by equation (1):

$$B' = 64\ (12.5)^2\left[\ (0.14)(3500) + 0.28\ (4000)\right] / \ (300^2) = 180 \text{ cd/m}^2. \qquad (7)$$

The limiting resolution of 0".7 smears a spot of diameter 1".2 to 1".9. At 300x magnification such a spot subtends $9\frac{1}{2}$ minutes of arc at the eye.

When we plot $9\frac{1}{2}$ minutes of arc and 180 cd/m^2 on Figure 2, we see that we are attaining an ideal contrast threshold of about 0.005; but since the point falls below the clear region, the contrast threshold can be reduced somewhat further by using a higher magnification (up to 900x). The threshold in practice is about 4 times the ideal threshold, or 2% for 300x. Since the 2% threshold is less than the 4% apparent contrast, contrasty spots will be seen under the very favorable circumstances of this example; but even with optimum magnification spots with true contrast less than 15% will be invisible.

III. Summary of the Best Observing Methods

The Table 4 on pg. 51 should be very helpful for observers of Mercury. This table lists the optimum magnifications, as well as the prospects for seeing markings, under a great variety of observing conditions. It is based on the theory discussed in Part II. Persons wishing more precise information on optimum methods under particular circumstances, and willing to do some arithmetic calculation, may follow the procedures outlined earlier and exemplified in Part II-F. However, simple interpolation or approximation in Table 4 will provide rapid answers for anyone.

The following information is required in order to use Table 4:

(1) Telescope aperture (in inches).
(2) Total transmission factor α. This is obtained in Table 3, using a limiting-magnitude-type estimate of transparency (T_r), and the product of the filter transmission factor α_f (given in Table 2) and the telescope transmission factor α_t (also discussed in Part II-C).
(3) Mercury's true surface brightness. This is given in Table 1 in terms of two quantities tabulated in the ephemeris.
(4) Sky brightness. This is 8000 cd/m^2 for the clear blue daylit sky (or 4000 cd/m^2 if you use an orange filter). The relative diminished brightness in twilight can be measured with an exposure meter (see also Part II-C).
(5) The resolution limit (measured in seconds of arc) imposed by seeing conditions alone (see

Table 4.

Mercury's surface brightness	Sky brightness	R_{eff} (seeing)	Diam. of spot	5 inch aperture, R_{eff}(tel) = 1".1, α = 0.5*	5 inch, α = 0.1†	5 inch, α = 0.025‡	10 inch aperture, R_{eff}(tel) = 0".56, α = 0.5*	10 inch, α = 0.1†	10 inch, α = 0.025‡	16 inch aperture, R_{eff}(tel) = 0".35, α = 0.5*	16 inch, α = 0.1†	16 inch, α = 0.025‡
8000 cd/m^2	8000 cd/m^2	1"	2"	500x V. GOOD 6.4 1.2	500x FAIR 4.7 1.6	500x POOR 1.5 1.7	1000x V. GOOD 6.8 1.2	800x GOOD 5.1 1.2	760x POOR 1.6 1.3	1150x V. GOOD 6.8 1.2	990x GOOD 5.1 1.2	930x POOR 1.6 1.2
8000 cd/m^2	8000 cd/m^2	1/3"	2/3"	500x POOR 2.1 1.8	500x POOR 1.6 1.9	(500x) HOPELESS 0.5 2.0	1000x GOOD 4.6 1.5	1000x FAIR 3.3 1.6	(1000x) HOPELESS 1.1 1.8	1600x V. GOOD 6.9 1.3	1600x GOOD 4.9 1.6	1600x POOR 1.6 1.6
8000 cd/m^2	800 cd/m^2	1"	2"	500x V. GOOD 12.5 1.4	490x V. GOOD 11.7 1.8	390x GOOD 7.6 2.0	920x V. GOOD 13.3 1.2	640x V. GOOD 12.5 1.5	540x GOOD 8.1 1.8	980x V. GOOD 13.3 1.2	830x V. GOOD 12.5 1.2	640x V. GOOD 8.1 1.5
8000 cd/m^2	800 cd/m^2	1/3"	2/3"	500x FAIR 4.2 1.8	500x FAIR 4.0 2.1	500x POOR 2.6 3.0	1000x V. GOOD 8.6 1.6	1000x GOOD 8.2 2.0	880x FAIR 5.3 2.7	1600x V. GOOD 12.6 1.5	1430x V. GOOD 12.0 1.9	1140x GOOD 7.8 2.2
2000 cd/m^2	8000 cd/m^2	1"	2"	500x FAIR 2.4 1.2	500x POOR 1.6 1.7	(500x) HOPELESS 0.42 2.0	1000x FAIR 2.6 1.2	760x POOR 1.7 1.3	(740x) HOPELESS 0.45 1.3	1180x FAIR 2.6 1.2	930x POOR 1.7 1.2	(870x) HOPELESS 0.45 1.2
2000 cd/m^2	8000 cd/m^2	1/3"	2/3"	(500x) HOPELESS 0.81 1.8	(500x) HOPELESS 0.53 2.0	(500x) HOPELESS 0.14 2.0	1000x POOR 1.7 1.5	(1000x) HOPELESS 1.1 1.8	(1000x) HOPELESS 0.29 1.8	1600x FAIR 2.4 1.4	1600x POOR 1.6 1.6	(1600x) HOPELESS 0.42 1.7
2000 cd/m^2	800 cd/m^2	1"	2"	500x V. GOOD 9.4 1.6	390x GOOD 7.9 2.0	340x POOR 3.3 2.4	740x V. GOOD 10.0 1.3	540x GOOD 8.4 1.8	500x FAIR 3.5 1.9	890x V. GOOD 10.0 1.2	640x V. GOOD 8.4 1.5	600x FAIR 3.5 1.6
2000 cd/m^2	800 cd/m^2	1/3"	2/3"	500x FAIR 3.2 2.0	500x POOR 2.7 3.0	(500x) HOPELESS 1.1 3.3	1000x GOOD 6.7 1.8	880x FAIR 5.7 2.7	800x POOR 2.3 2.9	1600x V. GOOD 9.6 1.7	1140x GOOD 8.1 2.2	1080x POOR 3.3 2.4

* T_r=6.0, α_t=0.8, α_f=1.0 † T_r=5.5, α_t=0.5, α_f= 0.4 ‡ T_r=4.0, α_t=0.4, α_f=0.5

BEST MAGNIFICATION (never use less than ½ this power)	
PROSPECTS for seeing very contrasty markings	
% APPARENT CONTRAST of spots with true contrast of 34%	% CONTRAST THRESHOLD (four times ideal threshold)

Figure 3. This block illustrates the information listed in each box of Table 4. See also text of Mr. Chapman's article.

Part II-A). In Table 4, two cases are considered where the apparent dimensions of the Mercurian spots are taken to be twice the resolution limit (spots similar to, or smaller than, the resolution limit are badly smeared out and can be seen only in exceptional circumstances).

Figure 3 illustrates the information given in each box of Table 4. The best magnification is given at the top. Results in excess of 100 times per inch of aperture have been arbitrarily reduced to exactly 100 times per inch of aperture (image quality is poor for larger powers). Because of the disrupting effect of seeing patterns, it may be more pleasing to reduce the suggested magnifications somewhat; this can be done without too seriously impairing contrast perception down to about half the suggested power.

At the lower righthand corner of each box is listed the practical contrast threshold when the suggested magnification is used. It is given as a percentage and is 4 times the ideal values shown in Figure 2. At the lower left is given the apparent contrast (percent) of a hypothetical spot with a true contrast of 34% (somewhat more contrasty than the lunar maria). When the threshold is greater than the apparent contrast, such a spot will, of course, be invisible. When the threshold is appreciably less than the apparent contrast, the prospects for seeing spots are better. These prospects are given in the middle of the box and have been determined from the ratio of the apparent contrast to the threshold: very good (ratio more than 5), good (3 to 5), fair ($1\frac{1}{2}$ to 3), poor 3/4 to $1\frac{1}{2}$), and hopeless (less than 3/4). The doubly outlined boxes are cases for which the prospects are good or very good. Of course, prospects for seeing surface markings on Mercury are reduced if the intrinsic contrast of spots is less than 34%.

IV. Conclusions

Examination of Table 4 leads to some important general conclusions regarding visual observation of Mercury's surface markings. Most important, excellent seeing conditions are required. The two cases considered in the table (R_{eff} = 1" or 1/3") represent unusually good daytime seeing, particularly exceptional if Mercury is low near the horizon. During inferior seeing, Mercury's features are obliterated; and attempts to observe them are useless.

Even with good seeing, the prospect for seeing markings is often marginal. Nevertheless, observers with telescopes only 4 to 6 inches in aperture can see large Mercurian markings under some circumstances (particularly if Mercury is near its perihelion and relatively bright, and if the sky brightness is reduced such as during late dawn or early twilight). In order to do this, however, it is essential that the telescope optics be clean, that oculars with few optical surfaces are used, and that the transparency be excellent. Slightly hazy or smoggy skies, scattered light in the telescope, or dirty optics destroys all possibility of mapping Mercury with a small telescope.

Use of a large telescope (say about 16 inches in aperture) does not appreciably improve the contrast perception for relatively large markings on Mercury. However, much smaller markings can be seen as well if other conditions are excellent. Here again daytime observations when Mercury is inherently dim (at crescent phases and when near aphelion) are virtually impossible. But if the transparency and telescope transmission are good, twilight observations (or even daytime observations when Mercury is inherently bright) should show a wide range of markings on Mercury's surface.

Under all circumstances, relatively high magnifications are necessary to maximize contrast perception. Amateurs interested in mapping Mercury's surface should find a good country observing site, clean their telescope optics and reduce all sources of scattered light, and endeavor to observe the planet whenever Table 4 suggests that useful observations are possible. If they are blessed with good daytime seeing, such observers can make detailed and accurate maps of Mercury's surface, even with relatively modest telescopes.

References

1. Hodgson, R. G., "Recent Studies of the Rotation of Mercury," Jour. A.L.P.O., 20, 73-75 (1967).

2. Dyce, R. B., Pettengill, G. H., and Shapiro, I. I., "Radar Observations of Mercury and Venus," Astron. J., 72, 351-360 (1967).

3. Chapman, C. R., "The Rotation of Mercury and a Map of Its Surface," in press.

4. Cruikshank, D. P. and Chapman, C. R., "Mercury's Rotation and Visual Observations," Sky and Tel., 34, 24-26 (1967).

5. The unpublished map was presented by A. Dollfus to the I.A.U. meeting in Prague, August, 1967, and is mentioned in: Camichel, H. and Dollfus, A., "La Rotation et la Cartographie de la Planète Mercure," C. R. Acad. Sc. Paris, 264, 1765-1767, Ser. B (1967).

6. Giffen, C. H. and Chapman, C. R., "The Theory of Visual Lunar and Planetary Observation," in Observing the Moon, Planets, and Comets (edited by C. R. Chapman and D. P. Cruikshank), to be published.

7. Arthur, D. W. G., Pellicori, R. H., Wood, C. A., et al, "The System of Lunar Craters," Comm. Lunar Planet. Lab., 2 (30), 3 (40), 3 (50), and 5 (70), (1963-1966).

8. Harris, D. L., "Photometry and Colorimetry of Planets and Satellites," chap. 8 in Planets and Satellites (edited by G. P. Kuiper and B. M. Middlehurst), Chicago: Univ. of Chicago Press, 276-278 (1961).

9. Blackwell, H. R., "Contrast Thresholds of the Human Eye," J. Opt. Soc. Am., 36, 624-643 (1946).

COMET WHITAKER-THOMAS 1968b

By: Dennis Milon, A.L.P.O. Comets Recorder

On his third night of searching for comets, 16-year-old Mark Whitaker of Bishop, Texas, discovered Comet 1968b. ALPO observers commented on Mr. Whitaker's alertness and keen sight, for some could barely see it at 10th magnitude! The procedure he followed is an example for other beginning comet hunters. He writes: "I did not have any plan to my comet hunting. I just swept on or near the ecliptic as recommended by New Handbook of the Heavens as a likely place for a comet to appear. After I found the comet, it proved difficult to get positions because I have neither a finder on my 4-inch reflector nor star charts to obtain the comet's exact position. It would have been almost impossible for me if the globular cluster M5 had not been in the vicinity to guide me.

"On June 14th, 11:20 to 2:00 CDT, I watched the comet's movement. When I first saw it, I noted a bright 'spot' in the center of the coma. I thought that this was a foreground star in front of a galaxy. As it moved, I knew it was a comet, and that the bright spot was its nucleus."

Before making an announcement, Mr. Whitaker waited until the next evening to verify once more its motion. He says: "On June 15th, 10:30 to 1:30 CDT, the nucleus appeared larger and brighter, but the coma was less discernible, and the comet appeared dimmer than on June 14th. Positive the object was a comet, I relayed a message to the Smithsonian Astrophysical Observatory, giving the magnitude and two positions. I was called by Dr. Brian Marsden of the Smithsonian who said my report was confirmed by Norman G. Thomas of Lowell Observatory, who had independently found the comet on a plate exposed for Icarus."

During June and July, 1968 reports were received from:

Frank De Courten
Albert F. Jones
V. L. Matchett
Michael McCants
Tom Middlebrook
Martin Miller
Dennis Milon
R. B. Minton
Walter D. Pacholka
Karl Simmons
Don Simmons
Eric Thiede
James Young

The Whitaker observations gave the magnitude as 9. On June 19th Mike McCants and Don Wells saw it with a 10" telescope at about 10th magnitude, almost completely diffuse, with the large size of 12'-15' of arc. Later reports gave a smaller diameter of 3' to 6', the latter size being reported by Tom Middlebrook on June 27th. The Recorder found on June 21, UT that the comet was fainter than any star in the Atlas Eclipticalis; therefore, no magnitude from the SAO catalog would suffice.

Martin Miller saw the comet on five nights in June, estimating it from 8.5 to 9.0 by comparison with SAO catalog stars. In Australia V. L. Matchett of North Brisbane commented on June 24th: "It was too faint and diffuse for either a micrometer measure or a magnitude estimate -- close to the limit of the 12-inch Newtonian at 40X." On June 25th Albert Jones of Tahunanni, Nelson, New Zealand, estimated it at 11.0 in his 12½-inch with an R CrB variable star chart.

Figure 4. High School student Mark Whitaker of Bishop, Texas, was the first to see the new 9th-magnitude comet, 1968b. Here he uses the 4-inch assembled from a Criterion kit that rides on an Edmund equatorial mounting. He also has an 8-inch with a mounting built during an industrial arts course.

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A nucleus of 13th or 14th magnitude was seen by Jim Young in Table Mountain Observatory's 24" reflector and by Frank De Courten with a 10" on June 21st and 23rd, respectively.

During July, unsuccessful searches were reported by Walter Pacholka (21st, 26th), Dennis Milon (21st), and Eric Thiede (16th). Mr. Thiede used the 15-inch refractor at the University of Wisconsin's Washburn Observatory. However, 1968b was reported throughout July by Karl Simmons, who last saw it on August 3rd when it was magnitude 12.8 in his 8-inch.

An orbit computed by Brian Marsden (distributed to the A.L.P.O. Comets Section on July 3rd) gives perihelion on June 4th, 1968 at 1.2 astronomical units from the sun. The absolute magnitude is 11 in the formula $11.0 + 5X \log \Delta + 10X \log r$, used by Marsden. At the beginning of August, 1968b was predicted to be 13th magnitude, fading to 16 in October.

THE 1965-66 APPARITION OF SATURN

By: Thomas A. Cragg and Larry C. Bornhurst, A.L.P.O. Saturn Recorders

Introductory Remarks

The following report on the 1965-66 apparition of Saturn is based on the work of the contributing observers listed below, along with their stations of observation and telescopes. The planet came to opposition on September 6, 1965, when it was at declination -8° and had a polar semi-diameter of 17". The majority of the observations were made within a few months of opposition.

James C. Bartlett, Jr.	Baltimore, Md.	3" refr., $4\frac{1}{4}$ refl.
Larry C. Bornhurst	Monterey Park, Calif.	18" refl., 24" Cassegrain
Phillip W. Budine	Binghamton, N. Y.	4" refr., 10" refl.
Thomas A. Cragg	Mt. Wilson, Calif.	18" refl., 24" Cassegrain
Kenneth J. Delano	New Bedford, Mass.	12.5" refl.
Walter H. Haas	Las Cruces, New Mexico	12.5" refl., $3\frac{1}{4}$" refr., 6" refl.
Alan W. Heath	Nottingham, England	12" refl.
Craig L. Johnson	Boulder, Colorado	10.5" refr.
H. W. Kelsey	Riverside, Calif.	8" refl.
Robert Monske	Mercer, Pa.	8" refl.
José Olivarez	Mission, Texas	8" refl., 17" refl.
Kenneth Schneller	Cleveland, Ohio	8" refl.
Nick Weis	Galena, Ill.	6" refl.

The Globe

Equatorial Zone. Brightness estimates indicated a definite fading towards the last half of the apparition when the zone was consistently estimated as equal to the outer part of Ring B by Bartlett, Delano, and Heath, who made most of the intensity estimates. Since the ring was narrowing rapidly and getting fainter, this conclusion is indeed the only one possible. Consistently the northern part of the EZ was observed to be brighter than the southern part. With standard filters (Wratten 25, 57, and 47, which are red, green, and blue respectively) the EZ was obviously red; for it was much brighter in red than in blue. This result is a continuation of the predominant red color of the EZ observed during the 1964-65 apparition. As the 1965-66 apparition neared its end, Cragg observed the E Z equal in blue and red with a 24" reflector. Without filters the EZ was called yellow-white consistently. No long-enduring white clouds were observed for a sufficient interval of time to derive a significant rotation period for this latitude.

Equatorial Band. This very elusive belt was perceived occasionally by Bartlett, Budine, and Haas. Most of the observations were within a month of opposition, further indicating how marginal the feature was. Its proximity to the shadow of the rings and nearness to the projection of the ring-ellipse on the ball surely must have influenced the visibility of the EB.

North Equatorial Belt. This belt was observed consistently by all observers and was deemed the most conspicuous belt by all. The only exception was Bartlett, who claimed the South Equatorial Belt to be the stronger during the last half of the apparition. Although the NEB was observed double a number of times in 1964-65, it was almost always single in 1965-66. The color was always called reddish brown to brown by those making color estimates with filters. Evidence is good that the belt darkened considerably during September and October, 1965, then returned to its previous intensity afterwards. Again, transitory darker sections and bulges were observed in the NEB, chiefly by Bartlett and Budine; but none lasted a sufficient time for significant rotation rates to be derived.

North Tropical Zone. This feature, although observed often by Bartlett and occasionally by others, was not seen on many dates during the apparition. In fact, Bartlett claimed it to be as bright as the EZ several times. Although not observed all the time, evidence indicates that this feature continued to increase in prominence since it went essentially unobserved in 1963, was recorded more often in 1964-65, and was now fairly frequently seen in 1965-66. It is therefore rather surprising to have the NTrZ reported so often and yet to be depicted on drawings so seldom. When seen, its color was reported as quite similar to that in the EZ.

North Temperate Belt. Although most observers failed to perceive this belt, it was seen frequently by Bartlett, about a third of the time by Budine, and occasionally by Haas. All agree that it was a difficult and basically very narrow belt, in fairly good agreement with the 1964-65 apparition.

North Temperate Zone. In 1964-65 this zone showed evidence of increasing intensity but did not this time. It was seldom seen by any observer; and when seen, it was very weak indeed.
*

North Polar Region. Most of the observers recorded this area, but it was never as dark as the NEB or SEB. Color estimates by Bartlett and Haas were consistently gray. During the 1965-66 apparition no significant trend was observed in intensity. In his many observations Delano surprisingly never showed the NPR.

Northern Part Of The Ball. In general all observers agreed that the northern part of the ball was consistently darker than the southern part; and no general intensity trend could be established, aside from the loss of the NTrZ and NNTB, which usually faded into the background.

South Equatorial Belt. During the entire apparition this belt was always the second most obvious dark belt on the planet. However, during the last half of the apparition Bartlett claimed consistently that it was even stronger than the NEB and was a vivid chocolate brown. This contention, however, was unconfirmed by other observers making intensity estimates. Surprisingly, Heath never showed the SEB on any of his drawings! Occasional darker sections and humps in the SEB were observed, but again none could be followed for a sufficient period of time to allow any significant rotation rates to be derived. The SEB was always depicted as single during the entire apparition, except that Haas sometimes found it double.

South Tropical Zone. This zone was recorded fairly often but is seldom shown on drawings. One wonders if this zone for the most part is nothing more than a contrast effect between SEB and STB. Bartlett, however, claimed the STrZ to be as bright as the EZ just prior to opposition.

South Temperate Belt. After this belt's first recovery in 1963 it was unobserved during the following apparition (1964-65). It continued to be unobserved in 1965-66 until August 4, but after that date its darkness continued to increase so that it was depicted by more and more observers. However, by October, 1965 it was definitely fading; and by December only a few scattered observations showed it.

*North North Temperate Belt. Unreported by any observers during this apparition, indicating a further lessening of activity in this region since 1964-65.

South South Temperate Belt. Only twice during the entire apparition was this very elusive belt recorded, both times (Nov. 25 and Dec. 2) by Budine when conditions were clearly superb.

South Polar Region. Although not reported prior to opposition, the SPR was frequently observed afterwards. The evidence for which shaded area (SPR or NPR) extended closer to the equator was not very conclusive in 1965-66 because of the very large discrepancies in the observed southern extent of the NPR. Intensity estimates frequently made the SPR darker than the NPR. The color of the SPR was most often described as gray although Bartlett reported it as green occasionally. If past presentations of the SPR can be taken as a criterion, it would be expected that as the southern part of the ball is presented more towards the Earth, the SPR will become one of the prominent features of the planet. Small white caps and many small faint belts and zones have appeared in the SPR in the past. These features should be looked for in future apparitions as the southern hemisphere becomes presented to us more advantageously.

Belt Latitudes

A program of measuring the latitudes of Saturn's belts was continued during the 1965-66 apparition. Although most of the measures are visual estimates by Haas (described in our last report, Str. A., 19, 5-6, pp. 98-104), several latitude observations were micrometer runs by Schneller and Cragg. Table I lists the individual measures of belt latitudes determined by ALPO observations during the 1965-66 apparition. Several comments regarding the measured latitudes of belts and zones are in order.

1. Note that somewhere between December 6 and December 20 a large, sudden change was found in the south edge of the SEB. This sudden change appears to be real because of the internal consistency of the measures both before and after the event.

2. Schneller's measures of the south edge of the NEB must have been erroneously labelled and are really measures of the north edge of the NEB.

3. The large scatter in measures of the southern border of the NPR must represent real changes in this feature. The random distribution of longitudes at the time of the individual measures precludes this variation's being attributed to an NPR asymmetrically located with respect to Saturn's north pole.

4. Although only two measures of the EB were made, it should be pointed out that the ring shadow and projected Crape Ring during this apparition were extremely close to, if not actually covering, the region normally occupied by the EB. Therefore, measures of the EB may represent the belt only during brief excursions from its normal position. Mean latitudes of features, where a mean appears reasonable, for the 1965-66 apparition follow:

S Hemisphere		N Hemisphere	
N border SPR	-48°.7	NTB	+27°.1
S edge SEB	-19.4*	NTrZ	+29.4**
N edge SEB	-12.4	N edge NEB	+16.6
		S edge NEB	+ 9.7

The NEB latitudes compare remarkably well indeed with previous measures, especially when it is considered how most of them were made. As an example, the north and south edges of the NEB over three recent apparitions are as follows:

Apparition	South Edge NEB	North Edge NEB
1963	+ 9°.2	+16°.0
1964-65	+10.7	+18.6
1965-66	+ 9.7	+16.6

Rings

As the rings were closing up during this apparition, the finer details naturally became more difficult. The tilt B was +4° on the date of opposition. Glimpses of a few of

*Before December 6 the mean latitude was -23.5°; after December 20 it was -15.7°.
**Only two measures of the NTrZ were made and at a time when the NTB was at +31°.

DATE	NPR	NTB	NTrZ	NEB N	NEB S	N CRAPE BAND	S CRAPE BAND	S RING EDGE	S RING SHADOW	EB	SEB N	SEB S	SPR	METHOD	OBSERVER
6/6	+35.9°			+10.8°	+6.2°			0.0°	-3.3°		-19.2°			V	Haas
6/19					+20.2									M	Schneller
8/6					+19.2									M	"
8/19					+12.2									M	"
9/18	+64.5			+13.7	+8.3			-0.4			-13.6°	-22.3°		V	Haas
9/29				+17.1	+10.8						-16.1	-23.7		V	"
10/10		+25.6°		+14.6	+8.4	+1.2°	-1.2°				-15.8	-24.8		V	"
10/23				+24.9	+10.3	+2.2	-2.0			+3.0°	-12.3			M	Cragg
11/20	+68.5			+17.5	+10.9						-15.3	-22.4		V	Haas
12/5		+24.8		+17.0	+10.7	+4.0	+0.4			+6.5	-10.1	-22.7		V	"
12/6				+16.0	+10.7	+4.5	-0.6				-11.4	-25.1		V	"
12/20	+42.4			+15.5	+9.3	+4.2	+0.1				-9.8	-13.2		V	"
12/21	+62.7			+16.2	+9.0	+3.7	+0.2				-11.5	-14.8	-44.2°	V	"
12/26	+57.8			+12.6	+7.6	+4.5	+0.4				-10.7	-15.0	-46.3	V	"
1/5	+38.9	+31.0	+29.0	+16.8	+10.3	+3.7	+0.1				-11.1	-15.3	-52.2	V	"
1/8				+16.3	+10.2	+3.0	-0.5				-12.7	-15.9		V	"
1/30	+59.3		+29.8	+17.5	+9.6	+2.5	-1.1				-11.5	-18.3	-52.1	V	"
2/17				+20.5	+12.1	+2.9	-0.6				-11.5	-18.6		V	"

Table I. Tabulation of latitudes observed on Saturn by A.L.P.O. members from June 6, 1965 to February 17, 1966, inclusive. See also discussion in text of article by Messrs. Thomas Cragg and Larry Bornhurst. The letter "S" in Table I denotes the south edge of a belt, or other feature; and the letter "N" denotes the north edge. All latitudes in Table I and elsewhere in this Saturn Report are Saturnicentric latitudes. In the "Method" column "v" is a direct visual estimate, and "m" is a micrometer measure.

the intensity minima were obtained:

Cassini's Division was recorded by most of the observers but not every time Saturn was observed.

B 3 was observed once by both Budine and Haas.

BO was observed once by Budine.

Encke's was suspected once by Cragg.

Most of the intensity estimates of the Ring System were made on the modified Goodman scale, which holds Ring B constant but at 7.0 instead of the normal 8.0.* With this limitation in mind, little real change in the relative brightness of each ring with respect to the others was observed. With the rapidly decreasing ring angle during this apparition, the basic brightness of the system steadily decreased. The Crape Ring was observed consistently, however. Also, no mention of Ring D was made by any observer during this apparition. These estimates were not made with filters. The following mean intensities were derived (number in parentheses indicates number of estimates in the mean):

Ring A	Ring B	Ring C
6.54 (30)	7.00	2.75 (16)

One is forced to think seriously about the great similarity of Ring A and Ring B since at higher inclination angles no such similarity is even suggested. Also, one must be very careful about attaching much weight to the Ring C measures since the estimates are divided nearly equally into two groups, suggesting the actual employment of two different intensity systems. The mean of the nine high estimates was 4.25 compared to 0.83 for the seven low estimates!

Bicolored Aspect of Rings. This effect was generally much less evident during 1965-66 than in 1964-65. Mostly in February, 1966, however, it became consistently evident to Haas. When seen well, the east arm of the rings was bluish; and the west arm, reddish. It should be noted here that the bicolored aspect is certainly not something very new as Maraldi in 1714 recorded it, as did Wray also in 1862.

Ring-Arm Lengths. Several observations were received in which an observer claimed ring-arms of unequal length. Clearly, the physics of the rings prohibits such large asymmetries so that the effect must be largely optical or psychological. Bartlett has an interesting explanation from which we quote: "This particular phenomenon appears to be a special case of the mysterious bicolored aspect, manifesting in this way due to the present, nearly edge-on presentation of the rings; when the rings are widely open the occasional reddening of Ring A on one side of the ball does not result in so great an apparent darkening and so the affected ring arm does not appear shorter." Earlier in the same letter he states, "Since red light is of longer wavelength this is interpreted by the eye as a darkening, and with sufficiently small aperture the darker ring, blending into the dark sky background, has the effect of shortening the ring arm."

Satellites

Phenomena of Saturn and its satellites were occurring in 1965-66 as the ring-plane came closer to being in line with the Sun. Several of these phenomena were looked for with the following results:

1. On June 20, 1965 at 09:56 U.T. a shadow transit of Rhea was predicted to begin, lasting some two hours. Craig Johnson observed with a $10\frac{1}{2}$" refractor and saw no sign of any transit until 10:40 U.T., when it was suspected in the best seeing moments. By 10:50 he felt rather confident of the shadow although it was quite difficult. (See Figure 5).

2. On October 24 Heath looked unsuccessfully for the shadow of Tethys with a 12" reflector.

3. On December 9 Craig Johnson again observed, this time realizing that shadows of both Tethys and Rhea should be on the disk but not knowing their exact positions, with a 4" reflector. Two dusky patches were suspected (see Figure 6), although they were clearly at the extreme limit of the telescope and were visible only in the best seeing moments.

*More exactly, it is the brighter, outer one-third or so of Ring B which is the reference area.

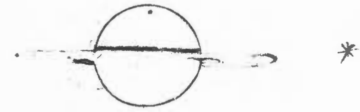

Figure 5. Sketch of Saturn by Craig L. Johnson showing shadow of Rhea. Belts deleted. June 20, 1965. 10^h50^m, U.T. 10.5" refr. 225X, 300X. Seeing 2-5 (Tombaugh-Smith). Transparency 6.5 (limiting magnitude). Wratten 12 Filter. In Figures 5,6, and 8 south is at the top, and west in the Earth's sky is at the left.

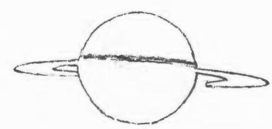

Figure 6. Sketch of Saturn by Craig L. Johnson showing apparent shadows of Tethys and Rhea. Belts again deleted. December 9, 1965. 4^h5^m, U.T. 4-inch refl., 135X. Seeing 3 to 4+ (Tombaugh-Smith). Transparency 5.5 (limiting magnitude). No filters. Suspected shadows totally invisible with higher and lower powers.

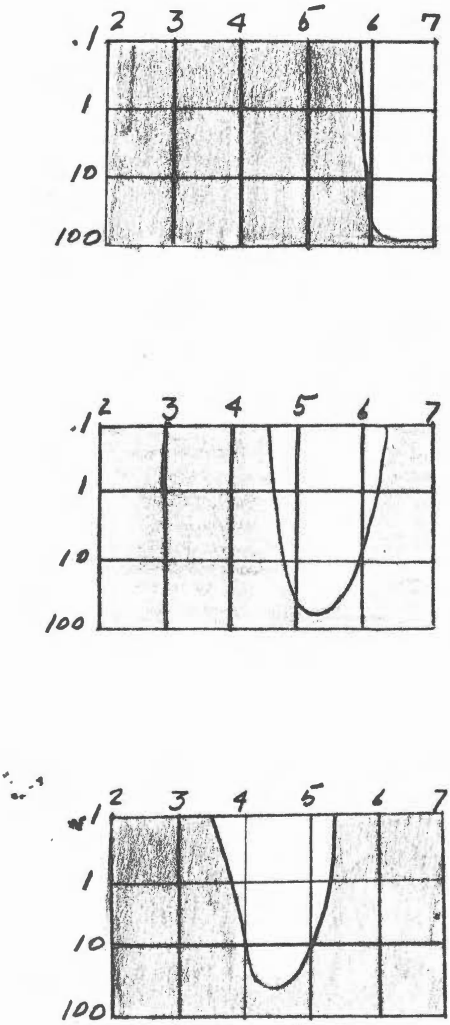

Figure 7. Transmission curves of Wratten Filters 25 (top), 57 (middle), and 47 (bottom). The transmission in percent (left scale) is plotted against the wave-length in thousands of angstroms (top scale). Light visible to the human eye extends from about 4,000 to 7,000 angstroms. See also text of Saturn Report by Messrs. Cragg and Bornhurst.

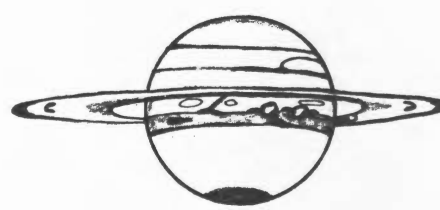

Figure 8. Drawing of Saturn by Phillip W. Budine on November 25, 1965 at 0^h14^m, U.T. 10-inch reflector at 250X. Seeing 9, transparency 4. Note complex detail in Equatorial Zone and North Equatorial Belt, duskiness of northern hemisphere, belt and bright oval area in high southern latitudes, and Terby White Spot adjacent to shadow of ball on rings. Saturnicentric latitude of Earth +5°7, of Sun +3°0.

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4. On November 20 Haas tried unsuccessfully for the shadow of Tethys with a 12" reflector.

5. Haas tried unsuccessfully on December 4, 1965 for the shadow of Dione with a 12" reflector.

Conclusions and Future Projects

We are always interested in C. M. transits of any globe detail at any latitude. However, unless spots are recovered for subsequent transits they can yield no rotation rates. A good plan is to try to recover an object after seven rotations of Saturn. If the spot is in or between the SEB and the NEB, a 10^h15^m period will repeat exactly three days minus 15 minutes later by Earth-time. Poleward from the NEB or the SEB, a preliminary period of 10^h40^m is much better for a start. This value repeats exactly three days plus 2^h40^m later by Earth-time for seven Saturnian rotations. Unless a spot lasts at least seven rotations, it is most unlikely to improve our present knowledge of rotation rates significantly. One should always be ready for a spot to transit as much as thirty minutes earlier than predicted since clearly these assumed rates are only provisional. For example, I (Cragg) observed a dark spot in the SEB to transit on October 17, 1967 at 3^h17^m U.T. My best guess for its return was October 20, 1967 at 3^h02^m U.T. A good observer realizes that it may be back early and so commences his recovery observations near 2^h30^m U.T. on October 20. This plan paid off, for a dark spot in the SEB was observed on October 20 but at 2^h55^m! Was it the same spot? Almost certainly, yes, since the "error" was -7^m during seven rotations of Saturn. Dividing the error in time by the number of intervening rotations: $-7^m/7 = -1^m$. This result means that the true rotation rate of my spot was my original assumption plus my correction; hence, we have $10^h15^m - 1^m = 10^h14^m$ for the actual period of my spot. This period is certainly acceptable in that latitude. Now it should be obvious that further transits can further refine the period. However, it's a little dangerous to go much longer than 1½ or 2 weeks without making the proper light-time correction. Similar examples could be shown for the longer rate, but beware rotation rates for regions N. of the NEB and S. of the SEB since they are far less accurately known so that an alert observer should expect a large error in his first assumption.

It is also hoped that we shall receive many more estimates of belt and zone intensities from observers using Wratten 47 (blue), 57 (green), and 25 (red) filters. This program is certainly the most fruitful contribution which owners of small telescopes can make to our studies of Saturn. Figure 7 gives the transmission curves for those filters. Note each is basically a 1000 Å bandpass. Although Wratten 25 transmits radiation redward of 7000 Å, the human eye cannot see beyond 7000 A so that it too for this purpose is a 1000 Å bandpass filter.

BOOK REVIEWS

Planets, Stars, and Galaxies. An Introduction to Astronomy, by Stuart J. Inglis. Second Edition, 1967. New York: John Wiley and Sons. 482 pages. Price $7.95.

Reviewed by Richard G. Hodgson

This book is intended as a college text for a one-semester introductory astronomy course designed for liberal arts students, and constitutes the sort of work which should be in every astronomer's library. Whether this is the best of such books is debatable; some parts of it, however, must be rated excellent. Among these are the portions dealing with meteors, comets, stellar structure, stellar evolution, galaxies, and the theory of relativity. Other portions of this book may be rated fair to good, and are similar to the presentations which can be found in many other works. The weakest chapter in the opinion of this reviewer is the first, which deals with astronomical instruments. The impression is given that pyrex is the only mirror material available for use in the modern reflecting telescope (p. 23). The discussion of the astronomical refractor (p. 25) fails to mention development of three lens apochromatic optics. Even more unfortunate is the absence of any reference about Cassegrainian or catadioptric telescopes, except for the Schmidt.

Several errors can be found elsewhere in the book. On page 69 carbon dioxide is said to be the third most plentiful gas in the Earth's atmosphere. For Inglis argon apparently does not exist! On page 100 he says that the principle of relativity was introduced 300 years after Newton; in truth it was 228 years. The discussion of apparent solar color (p. 206) neglects the yellow-red light sensitivity of the human eye as being a factor. Another curious mistake consistently refers to Barnard's star as "Bernard's star" (p. 246, p. 349 twice, p. 364, p. 472).

If one desires a good book on stellar and galactic astronomy, this work by Stuart J. Inglis should be considered; as an introduction to the whole subject of astronomy, however, it is not without weaknesses.

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All About Telescopes, by Sam Brown. Published by Edmund Scientific Co., Barrington, N. J., 1967. 192 pages. $8\frac{1}{2}$"x11", paper bound. Price $3.00.

Reviewed by Rodger W. Gordon

All About Telescopes is the result of a combination of several previous smaller booklets published by the Edmund Scientific Co., with the addition of much new material. Successive chapters on familiarization with the telescope, on observing and observing conditions, mirror grinding, building telescopes, astro-photography, telescope mounts, collimation techniques, and optical arithmetic are some of the many topics covered in this excellent book for amateurs in any stage of astronomy. It is a good reference for the professional too.

The author is a well-known instrument maker and observer who has written several small booklets in the past dealing with all types of optical projects and problems encountered in their development.

There are many tables of data, hundreds of illustrations, photographs, and much valuable information on almost every conceivable astronomical topic, most of which is seldom found in one book. The author has covered an amazing number of topics, yet gives detailed treatment and instructions on almost all problems an amateur is likely to run into. Yet, the coverage is not seeded with a lot of little used facts, which is a common characteristic of books in this category.

Some criticism can be directed to the chapters on optics and observing. The author states, for instance, on page 5 that the "usual tolerance for high-precision optics is $\frac{1}{4}\lambda$". This was true 20-30 years ago, but today's standards usually call for 1/10-1/20 λ accuracy and even 1/60 λ is not uncommon. He further states that $\frac{1}{4}\lambda$ optics result in a $\frac{1}{2}\lambda$ image error, which is "almost perfect imagery". Actually, a good observer can easily see the difference among $\frac{1}{4}$, $\frac{1}{2}$, and 1/8 λ errors. It is only when optics approach 1/20-1/30 λ that the difference in image quality becomes practically unnoticeable to the eye. Another statement is the one that serious observing requires an equatorial mount, also on page 5. A comet hunter would definitely have reservations about this; and Mr. Leslie Peltier, who has made such a notable contribution to new comet discoveries, gets along admirably with an alt-azimuth, as do other well-known observers in both the U.S. and foreign countries. There are a few other criticisms to make about the book, but they are minor faults which do not detract from its overall worth.

The physical size of the book ($8\frac{1}{2}$"x11"), the large print, clear illustrations, and diagrams make for easy reading. However, this is one of the most comprehensive books on amateur astronomy available today, and the low cost of $3.00 makes it a worthwhile addition to any library.

THE SOUTHWESTERN ASTRONOMICAL CONFERENCE '68

By: Ken Thomson

The 1968 Southwestern Astronomical Conference will long be remembered as one of the most momentous and enjoyable conventions of the decade. The Western Amateur Astronomers, the Southwestern Region of the Astronomical League, and the A.L.P.O. were the major societies represented, with numerous other amateur and professional astronomers also in attendance. The Astronomical Society of Las Cruces sponsored the gathering.

The excellent facilities of New Mexico State University played an important role in the success of the Conference. Most of the proceedings took place in Garcia Hall, which also provided our excellent dormitory facilities. The availability of several meeting rooms for informal get-togethers was exploited throughout the conference.

Mr. E. R. Casey chaired the Conference Committee, whose careful foresight minimized registration difficulties for the approximately 300 attendees who began arriving on Tuesday, August 20. After the hard-working ladies behind the desk handed out the registration packets and forms, guests quickly obtained their rooms and fell to renewing old friendships, making new ones, and discussing numerous diverse topics.

The Conference officially started Wednesday morning at the Little Theatre, about five minute's walk from Garcia Hall. Most of the participants ate their meals at the Cafeteria in Milton Student Center nearby; a $10 meal ticket provided excellent food for the four-day period.

Featured at the opening session were Dr. R. B. Corbett, President of New Mexico State University; General H. G. Davisson, Commander of White Sands Missile Range, which we were later to visit; Dr. Richard H. Duncan, Vice President for Research at N.M.S.U.; and Dr. Clyde Tombaugh, who presented some interesting conjectures on Martian topography.

After lunch, the paper sessions began in a lecture room in Garcia Hall. All remaining papers were presented there, grouped together as logically as possible. Each half-day session was provided with a midpoint coffee break. The early afternoon session on Wednesday featured Bradford A. Smith, Director of NMSU Observatory, who discussed their planetary astronomy programs. After coffee, we heard from Mrs. Winifred Cameron, who spoke on evidence for lunar vulcanism.

Wednesday evening's schedule called for meetings of the boards of the Astronomical League and the Western Amateur Astronomers, and a Star Party on the NMSU campus. Unfortunately for the latter, an impressive storm darkened the usually impeccably transparent New Mexico skies; and a somewhat anticlimactic pattering rain cancelled our observations.

On Thursday morning, August 22, the primary speakers were J. R. Dunlap, Larry Chuipek, and J. R. Gallivan, all of Corralitos Observatory, who briefed us on our upcoming tour of their facilities. The late morning session concerned lunar transient phenomena and Mars, with the principal address given by William B. Chapman of NASA.

A group photograph was taken during the lunch break; then we reconvened to hear several papers on Mercury and Jupiter. The final paper session that day was highlighted by a talk by Raymond F. Barbera on "Astrophotography for the Amateur".

Inclement weather again prevailed as we made ready for the Observatory field trips on Thursday night. Two different tours were offered; unfortunately both were in the same time period. One group visited the 24" NMSU Observatory reflector on Tortugas Mountain. Buses conveyed the visitors to the base of the mountain; jeeps were then used to take them up the muddy switchback road to the summit ridge. The Boller and Chivens instrument has a fused silica f/5 primary, with a supplemental Cassegrain system operating from f/40 to f/75 for planetary studies. "Armchair Astronomy" might be an apt phrase to use to describe the Corralitos Observatory facility. Operated by Northwestern University under grants from NASA and NSF, this Observatory carries out a continuous surveillance for lunar transient phenomena, and a search for supernovae in galaxies. The 12" and 24" reflectors use image orthicon television systems and project their images upon monitor screens in remote viewing rooms. The lunar program involves "blink" studies of the moon with a two-orthicon pickup; infrared observation to 1040 nanometers is possible with the apparatus connected to the 24" instrument. The same telescope is also used to scan over 1300 galaxies for possible supernovae. A Digital Equipment Corp. PDP-8/S computer automatically points the telescope to the desired galaxy, whereupon a 2-second integration within the orthicon tube records stars to magnitude 16.5. The 12" instrument operates at f/16, as compared to f/10 for its larger companion, is manually controlled, and requires a 4-second integration to reach the same magnitude - still a very impressive feat! (It makes the fastest photographic plates look like Daguerreotypes by comparison.)

Friday morning began with a speech by Dr. George W. Rippen of Anchorage, Alaska. He spoke on upper atmospheric phenomena. The rest of the morning's papers covered solar flares, color photography of the planets, artificial satellites, and the plans of the Astronomical League to organize an expedition to observe the total solar eclipse of March 7, 1970.

On Friday afternoon we set out for a bus tour of White Sands Missile Range and White Sands National Monument. The buses took us first to the Missile Range, where General Davisson and other officers described the optical tracking facilities with the aid of movies and slides. We were then permitted to examine some of these ultra-precision optical instruments at several buildings. Optical tracking is highly important here, and the domes of many large fixed installations can be seen as one drives past the Range. White Sands National Monument preserves an ocean-like expanse of almost pure gypsum. On these dunes we wandered in ant-like insignificance until we clustered about a picnic supper and awaited a dramatic sunset - for the bad weather had relented at last.

When the buses unloaded at Garcia Hall, it was unanimously decided to recoup the lost Star Party - and it was then that John Bally-Urban and Patrick Clayton discovered Comet 1968d. Using a 10" Newtonian set up near the campus, they spotted the fuzzy object during a search for the Ring Nebula in Lyra.

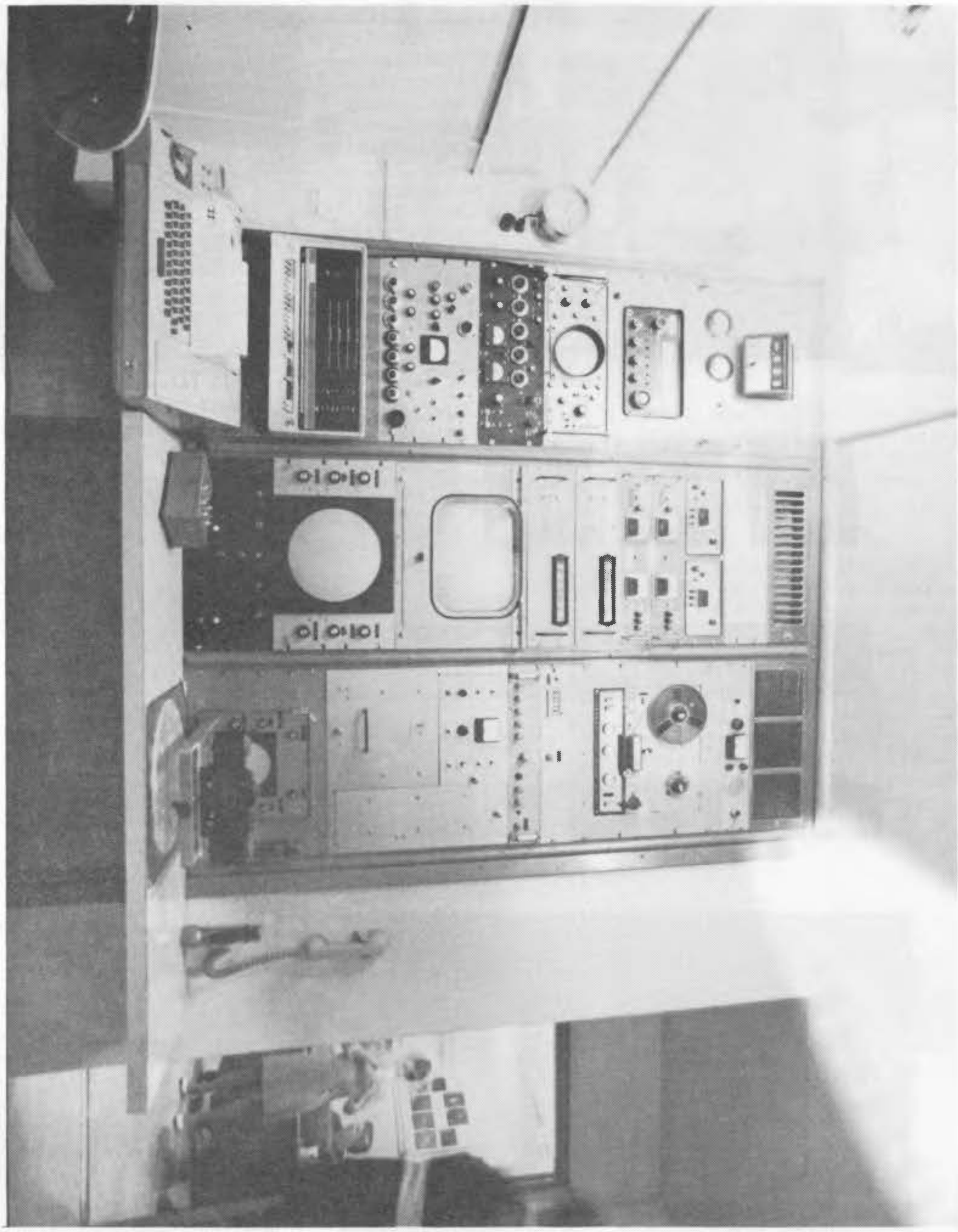

Figure 9. Console of 24-inch reflector at Corralitos Observatory. Photograph taken by Jack Eastman during Southwestern Astronomy Conference '68. The Observatory is operated by Northwestern University and is located about 20 miles northwest of Las Cruces, New Mexico. Note that the up direction is actually on the right side of the page. The principal programs of the 24-inch telescope are patrols for lunar transient phenomena and surveys for supernovae in galaxies. See also text of Ken Thomson's article about the S.A.C.'68 in this issue.

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Several of us accepted an invitation by the staff of Corralitos Observatory to revisit the installation, this time to see the 12" orthicon telescope at work on supernovae.
(text continued on page 70)

Figure 10 (left). C. F. ("Chick") Capen speaking on multi-color planetary photography during Southwestern Astronomical Conference '68. All photographs on this page taken and contributed by Mr. Frederick W. Jaeger.

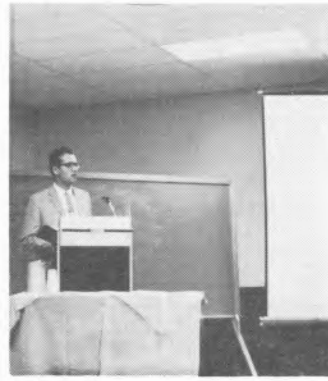

Figure 11 (above). Reverend Richard Hodgson speaking about the planet Mercury during S.A.C.'68.

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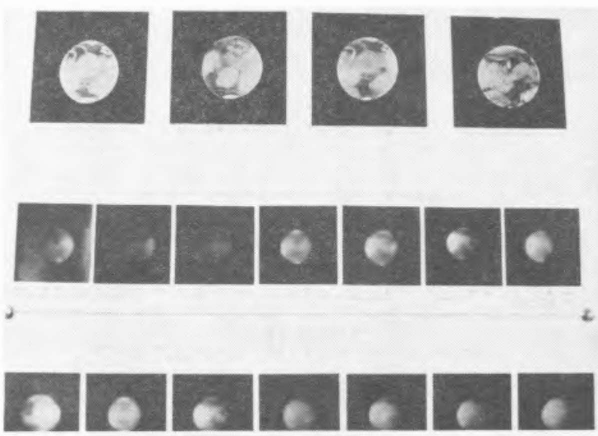

Figure 12 (left). Mars drawings and photographs in Exhibit Area during S.A.C.'68. Amateur and commercial exhibits were coördinated and arranged by Mr. R. B. Minton.

Figure 13 (above). Sunset over the gypsum dunes of the White Sands National Monument.

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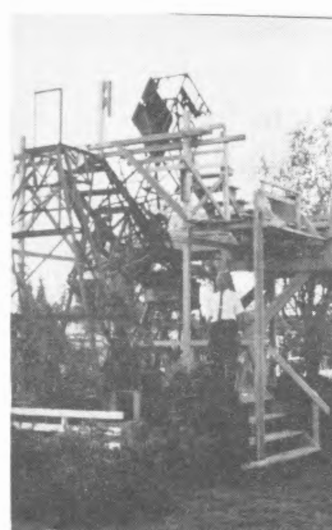

Figure 14 (right). Dr. Clyde W. Tombaugh's home-built 16-inch reflector at Las Cruces, New Mexico.

Figure 15 (above). Discussion between Tom Cave (left) and Kenneth Delano in Exhibit Area during S.A.C.'68. All photographs on this page by Frederick W. Jaeger.

Figure 16 (above). Mr. Byron Barry of Phoenix Observatory Association at rostrum. Mrs. Natalie Leonard, Session Chairman, to right.

Figure 17 (left). Stage of Little Theatre of New Mexico State University during Opening Session of S.A.C.'68. Left to right: Richard Hodgson, Kenneth Delano, Dr. Roger Corbett at rostrum, General H. G. Davisson, Dr. Richard Duncan, Dr. Clyde Tombaugh, Walter Haas, and Ed Casey, General Convention Chairman. Arthur Leonard barely visible behind speaker.

Figure 18. Buses and S.A.C.'68 delegates at White Sands National Monument.

Figure 19. Mrs. Winifred Cameron, NASA, Goddard Space Flight Center, speaking on evidence for lunar vulcanism.

Figure 20 (left). Jack Fondren (left), featured speaker, and Mrs. Margaret Dickson of Astronomical Society of Las Cruces (Session Chairman). All photographs on this page by Frederick W. Jaeger.

Figure 21 (above). Phil Budine talking about Jupiter during S.A. C.'68.

Figure 22 (left). A popular feature of the Southwestern Astronomical Conference '68! One of the mid-morning or mid-afternoon coffee breaks.

Figure 23. Convention Banquet in Milton Hall Student Center, New Mexico State University. It was here on Saturday evening, August 24, that the discovery of Comet Bally-Clayton 1968d was announced.

Figure 24. Portion of audience during one of the paper sessions of the S.A.C.'68. In lower right is Mr. Charles Frazier, Chairman of the Southwest Region of the As-rtonomical League. Mrs. Frazier to his left.

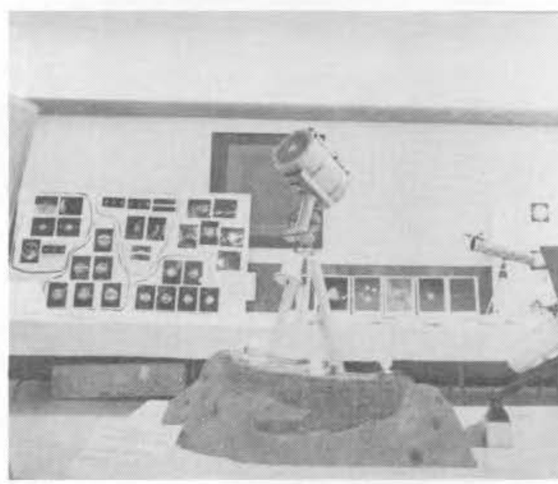

Figure 25 (above). Mr. E. R. Casey, General Chairman of the Southwestern Astronomical Conference '68. It was Ed Casey who conceived of the Conference, who contacted the three major participating organizations and promoted the idea at their meetings, who supervised the work of preparing for the meeting by the Astronomical Society of Las Cruces, and who himself made many of the necessary arrangements.

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Figure 26. Portion of Exhibit Area during the S.A.C.'68. Photograph by Jack Eastman. Model of future observatory of N.M.S.U. on Magdalena Peak in foreground.

Figure 27 (right). Miss Grace Fox of Ft. Dodge, Iowa, speaking about her adult evening classes in astronomy during S.A.C.'68. Photo by Frederick W. Jaeger.

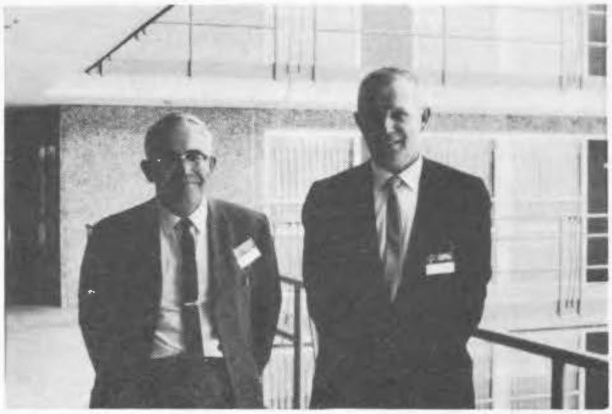

Figure 28. Dr. Clyde W. Tombaugh (left) and Mr. Frederick W. Jaeger in Garcia Hall of New Mexico State University during S.A.C.'68.

Figure 29. Mr. Ray G. Coutchie giving paper "Techniques of Guiding for Long Exposure Photography" during S.A.C.'68.

Figure 30 (above). Mr. Richard Henke of Boulder, Colo., presenting paper. His subject was "Current Research on Solar Flares". Figures 29 and 30 are photographs by Jack Eastman.

Figure 31 (left). View of Organ Mountains to east of Las Cruces from bus on tour to White Sands Missile Range and White Sands National Monument. Photograph by Frederick W. Jaeger.

Figure 32. Group photograph of the Southwestern Astronomical Conference '68. Taken by Mr. Leonard Jefferson of Las Cruces, New Mexico. Site the southeastern side of Garcia Hall at New Mexico State University.

We were permitted to use the combination 12" Cassegrain/10" Maksutov visual telescope system which was installed as an adjunct to the Argus-Astronet program.

The final paper sessions were held on Saturday, August 24. The featured speaker, Jack K. Fondren of Winnipeg, spoke on auroral studies in Canada. The rest of the day's sessions, which ended at 3:00 P.M., were a potpourri of miscellanea ranging from comet discovering to telescope controls.

The three principal participants - WAA, AL, and ALPO - held their business meetings Saturday afternoon.

The Banquet was the last official event of the Conference. It was held in Milton Student Center and was a masterpiece of elegance. Dr. Thomas O. Nevison, Jr. of the Lovelace Foundation was the main speaker; he described his mountain-climbing adventures in the Himalayas and his attempts to prove or disprove the existence of the Abominable Snowman - which were without conclusive results. The G. Bruce Blair Medal of the WAA was awarded to David W. Dunham in an impressive ceremony. Door prizes were then drawn for: these had been donated by several of the firms who were displaying their wares near our meeting room. The 1968 Southwestern Astronomical Conference now set a precedent - official confirmation of the discovery of Comet Bally-Clayton from a contingent of our observers in Truth or Consequences, New Mexico made this the first comet found during such a convention by members therof. On this jubilant note the official festivities ended.

After a final night in Garcia Hall, the guests departed the City of the Crosses sharing an elation which is certain to sustain us until we meet again next year in San Diego.

Further Notes by Editor on Discovery of Comet Bally-Clayton 1968d. All S.A.C. '68 people may take justifiable pride in what is, to my knowledge, the only astronomical discovery of this kind ever made during an astronomical convention!

The discovery was an accident - so was Herschel's discovery of Uranus and some other famous achievements in science. On the night of August 23, 1968 a number of observers held a star party in the desert several miles east of the New Mexico State University campus. John Bally-Urban of Richmond, California and Patrick Clayton of Springfield, Missouri attempted to find the Ring Nebula in Lyra with Clayton's 10-inch reflector. A fuzzy eleventh or twelfth magnitude object sighted instead in the telescope field turned out to be missing from a Vehrenberg star atlas. Surely many observers, both amateur and professional, would not have taken the time and the care to learn this much. If the mystery object were indeed a comet, it would move with respect to the star background. Such motion was suspected that night. Others in the observing group included Jim Young of the Table Mountain Observatory, Len and Carol Farrar, Douglas Penrod, Tom Middlebrook, Steve Hall, John Wulf, Jimmy Mitchell, Tony Preslar, Dennis Milon, and Neil Adams.

The next evening, August 24, was cloudy and raining at Las Cruces. Bally, Clayton, Young, and others drove about 75 miles north to near Truth or Consequences, New Mexico. They soon found the suspect, and there was now no question that it had moved among the stars. A telephone call to report the discovery to the Smithsonian Astrophysical Observatory quickly followed.

Comet Recorder Milon's paper at the Conference was called "Discovering Comets." Surely few authors have illustrated their subject so well!

OBJECTIONS TO COMPOUND REFLECTING TELESCOPES

By: Eugene W. Cross, Jr.

Observational astronomers, both amateur and professional, who plan to acquire or construct a Cassegrainian, or other compound reflecting telescope, should carefully consider some facts on optical tolerances which recently came to my attention in the course of investigating the differences between spherical and paraboloidal reflecting mirrors of varying focal lengths.

A reflecting objective is considered to be "aperture limited" when the optical surface is of sufficient accuracy that no appreciable improvement in the image definition will result by improvement of the optical surface. For a stellar image, Lord Rayleigh showed that if a reflecting objective's optical surface was perfectly smooth, and its center and optical axis coincided with the theoretically desired curve, the edge of the two surfaces could deviate by not more than $\lambda/8$, where λ is the wavelength of electromagnetic energy employed in observation or detection. If the deviation between the actual curve and theoretically perfect curve was less than $\lambda/8$, then there would be no deviation of the wavefront at the focus by more than $\lambda/4$. According to Rayleigh's criterion, a reflecting objective whose optical surface curve differs by more than $\lambda/8$ will produce stellar images (and point source resolution) noticeably degraded from the ideal.

In practice, the formation of a stellar image is more complicated than Rayleigh's model, since optical surfaces are usually not without irregularities along the surface of the concave surface curve. Such irregularities, even if much smaller than $\lambda/8$ in amplitude, are quite harmful to image formation, especially if such irregularities occur in the 80-100 percent zone.

In compound reflecting telescopes, the focal length of the reflecting objective is multiplied by the hyperbolic convex secondary mirror in the case of the Cassegrainian, the ellipsoidal concave secondary in the case of the Gregorian, or the Barlow Lens in the case of the "compound" Newtonian. Not only is the focal length of the reflecting objective surface multiplied by a secondary imaging device, but all optical errors present on the reflecting objective's surface are multiplied in significance for the final wavefront at the focus. It is assumed that the amplifying agent (secondary mirror or Barlow Lens) is perfect and introduces no new aberrations into the final wavefront at the focus. The reflecting objective in a compound reflecting telescope must then have a smooth surface whose surface curve is within ΔW of the ideal curve, where $\Delta W = (\lambda/8)x(1/A)$, and A is equal to the amplifying power of the amplifying agent; this tolerance will satisfy Rayleigh's criterion. As an example, a Cassegrainian objective used in conjunction with a 4X secondary mirror must have a smooth surface whose surface curve is within $\lambda/32$ of the ideal (perfect) surface curve (parabola in this case)! An optical surface of the accuracy desired in the foregoing example is far beyond the capability of all but the most skilled and experienced optical workers. It becomes obvious, then, why compound telescopes generally have reputations for yielding definition inferior to the simple Newtonian design.

Up to this point, Rayleigh's criterion has been discussed as an end unto itself, although Rayleigh's criterion refers only to the formation of stellar images. However, as pages 490 and 491 of ATM, Book I, state, there is no real lower limit to the optical accuracy to be achieved where the observation of detail in extended objects (non-resolvable star clusters, nebulae, the moon, and planets) is concerned. Since detail in extended objects is due to the observability of differing contrasts, tolerances far finer than Rayleigh's criterion must be recognized as a goal to be sought. At Rayleigh's criterion, a reflecting objective operates at 64 percent of maximum contrast efficiency, while at an optical tolerance six times finer than that dictated by Rayleigh's criterion, the contrast efficiency increases to better than 98 percent. A skilled lunar and planetary observer will find a telescope noticeably improved, even in poor seeing, if the wavefront deviation at the focus is two to four to even six times smaller than that required by Rayleigh's criterion. Thus, a reflecting objective made as poorly as Rayleigh's criterion will give disappointing results on extended objects.

It has already been established that it is difficult to construct a compound reflecting telescope which will perform to Rayleigh's criterion. It is unrealistic to expect a compound reflecting telescope to perform significantly better than Rayleigh's criterion. Hence, such a telescope is optically grossly inferior to a medium to long focus simple Newtonian with an equally perfect objective for the observation of detail in extended objects.

Acknowledgement

The author wishes to acknowledge Mr. Jack Eastman, Jr.'s kind and thoughtful suggestions and criticism during the preparation of the foregoing paper.

ANNOUNCEMENTS

Additions to A.L.P.O. Library. Mrs. Walter H. Haas announces the recent acquisition of two pamphlets, Institute of Astrophysics and Kwasan Observatory, University of Kyoto, Nos. 169 and 170, "Meteorological Observations of Mars during the 1967 Opposition" and "Mantle Convection and Selenological Histories". Both were authored by Dr. S. Miyamoto.

New Address for Patrick Moore. Coorespondents of our British colleague will want to know that in June, 1968 he moved from Armagh, Northern Ireland to Farthings, 39 West St., Selsey, Sussex, England.

New Address for Phillip Budine. Mr. Phillip W. Budine, one of our Assistant Jupiter Recorders, now receives his mail at: The Fels Planetarium, The Franklin Institute, 20th St. and Benjamin Franklin Parkway, Philadelphia, Penn. 19103. Mr. Budine is now Observatory Director and Lecturer at the Fels Planetarium. We wish him every success in his new work and locale.

Sustaining Members and Sponsors. As of October 23, 1968, we have in these special classes of membership:

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Sponsors pay $25 per year; Sustaining Members, $10. The excess above the regular rate goes to support the work and activities of the A.L.P.O.

Partial Report of A.L.P.O. Business Meeting in August, 1968. We were invited to hold our 1969 Convention with the W.A.A. in San Diego, California. We were also invited to make our meeting part of the 1969 Convention of the National Amateur Astronomers in Denver. After considerable discussion, it was decided to accept the invitation from San Diego in a close vote. The host will be the San Diego Astronomy Association. Efforts to find a publisher for the A.L.P.O. Observing Manual continue. Miss Grace Fox kindly offered back copies of The Strolling Astronomer to those who may lack a particular issue. It was voted that future issues of this journal should carry only the actual month and year of publication.

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