See pg. 222

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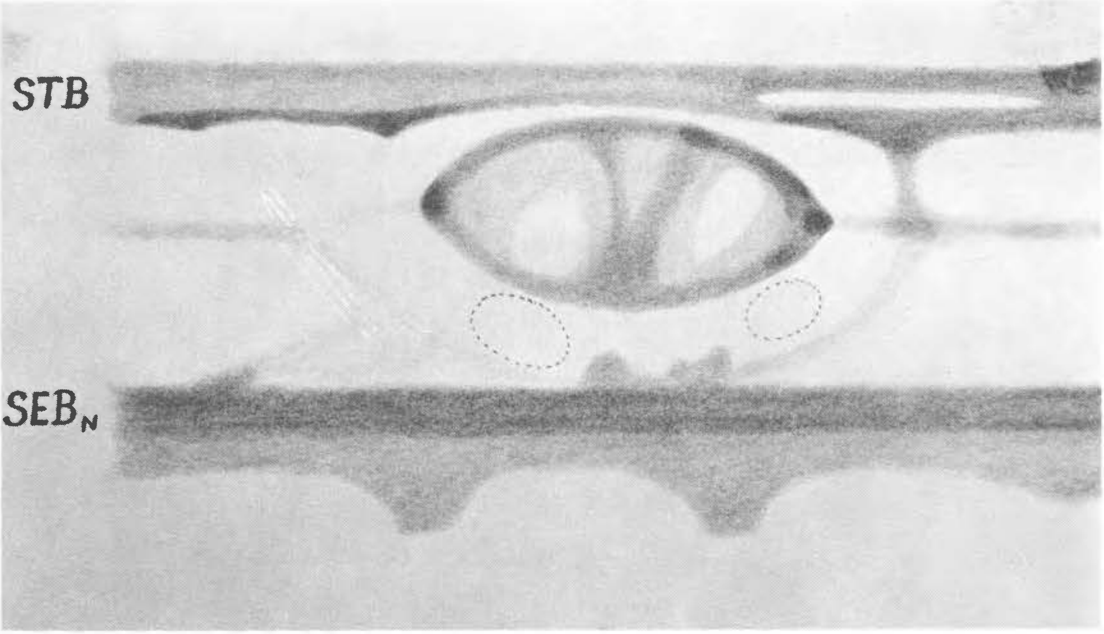

Drawing of Red Spot and vicinity by Elmer J. Reese with an 8-inch reflector at 250X on July 7, 1962. Seeing 6 (fairly good), transparency 5 (clear). Longitude (II) of center of Red Spot 8 degrees. Mr. Richard E. Wend's report on A. L. P. O. studies of the 1962-3 apparition of Jupiter begins on page 209 of this issue.

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ASSOCIATION OF LUNAR & PLANETARY OBSERVERS
ALPO
Founded In 1947

IN THIS ISSUE

THE 1962-3 APPARITION OF JUPITER

By: Richard E. Wend, A.L.P.O. Assistant Jupiter Recorder

Introduction

The rotation periods, and some excellent descriptive material, for this eventful apparition have already been published in The Strolling Astronomer,[1] along with mean latitudes of Jupiter's belts. Also, Elmer Reese wrote "A New Disturbance and an 'Old' Theory"[2] discussing the historical background of SEB Disturbances and the major SEB Disturbance of 1962.

This was a well observed apparition; a list of ALPO observers and their telescopes appears below (Table I). Figure 1 shows how many observations were made during each month of the apparition. The lesser observed morning appearance of Jupiter after conjunction and the corresponding twilight observations soon before conjunction are crucially important foundations for theorizing about what happens while Jupiter is lost in the glare of the sun. These observations also help provide continuity of identifiable features on the ALPO drift charts.

Elmer Reese says: "The most significant development in the Jupiter Section in 1962 has been the outstanding improvement in the quality of photographs being taken." When these photographs are studied at a distance sufficient to make the image size comparable to what is seen at the eyepiece, detail not otherwise noticed is visible. Such photographs are valuable in measuring belt latitudes and in providing a check on drawings. Unfortunately, much fine detail is lost in reproducing for publication.

Table I. The Contributing Observers

Anthenien, Larry	San Jose, Calif.	6" Refl.	13 Observations
Bartlett, Dr. James C., Jr.	Baltimore, Md.	4" Refl.	62
Binder, Alan	Tucson, Arizona	4" Refl.	83
Bornhurst, Larry	Monterey Pk., Calif.	10" Refl.	12
Bradbury, David Paul	Texas U.	9½" Refr.	1
Bradbury, Charles	Texas U.	9½" Refr.	3
Brasch, Klaus R.	Rosemere, Que.	8" Refl.	215
Budine, Phillip W.	Binghamton, N.Y.	4" & 6" Refrs.	26
Cahill, William J., Jr.	Princeton, N.J.	9½" Refr.	7
Capen, Chas. F.	Wrightwood, Calif.	16" Refl.	22
Chapman, Clark	Buffalo, N.Y.	10" Refl.	635
Cooke, Douglas	San Diego, Calif.	6" Refl.	12
Cruikshank, Dale	Tucson, Arizona	36" Refl.	3
Cyrus, Charles M.	Baltimore, Md.	10" Refl.	34
Delano, K. J.	New Bedford, Mass.	8" Refl.	21
Doucet, René	Quebec, Canada	3" Refr.	22
Dragesco, J.	Gabon, Africa	7" Refl.	103
Eastman, J.	Manhattan Beach, Calif.	12½" Refl.	75
Epstein, E. E.	Hollywood, Calif.	10" Refl.	1
Fallon, F.	Silver Spring, Md.	8" Refl.	14
Farrell, Mrs. D. J.	Binghamton, N. Y.	3" Refr.	4
Gaherty, Geoffrey, Jr.	Montreal, Canada	8" Refl.	111
Giffen, Charles	Princeton University	9½" Refr.	707
Glaser, Philip R.	Menomonee Falls, Wisc.	8" Refl.	337
Goodman, Joel W.	San Francisco, Calif.	6" Refl.	26
Gordon, Rodger W.	Pen Argyl, Penna.	6" Refl.	98
Grasdalen, G.	Albert Lea, Minn.	6" Refl.	37
Haas, Walter H.	Edinburg, Texas, and Las Cruces, N.M.	12½" Refl. and 6" Refl.	926
Hartmann, W. K.	Tucson, Ariz.	8" Refl.	16
Heillegger, G. A. T.	Willemstad, Curacao	8" Refl.	2
Herring, Alika K.	Tucson, Arizona	12½" Refl.	54
Hills, Jack G.	Lawrence, Kansas	6" Refl.	138
Hirabayashi, Isamu	Tokyo, Japan	4" Refl.	104
Hodgson, Richard	Gloucester, Mass.	4" Refr.	4
Jamieson, Harry D.	Rock Island, Ill.	10" Refl.	96
Johnson, Craig L.	Boulder, Colo.	10½" Refr.	10
Kidwell, Gary	Los Gatos, Calif.	8" Refl.	1

Leary, Colleen	Hartford, Conn.	4" Refl.	7 Observations
Louderback, Dan	South Bend, Wash.	8" Refl.	2
Lovi, George	Lakewood, N. J.	7" Refr.	1
Mackal, Paul	Mequon, Wisc.	6" Refl.	82
Martellaro, John	South Bend, Ind.	4¼" Refl.	3
Matsuoka, Takashi	Aichi-ken, Japan	6" Refl.	7
Matter, Eleanor	Arlington, Va.	6" Refl.	6
Matthies, Dennis	Milwaukee, Wisc.	12½" Refl.	1
Mc Intosh, Patrick	Sunspot, N. M.	4" Refr.	103
Meeus, Jean	Belgium	6" Refr.	10
Melsness, John	Wenatchee, Wash.	6" Refl.	1
Milne, John	Schenectady, N. Y.	2.4" Refr.	11
Milon, Dennis	Houston, Texas	8" Refl.	79
Moore, Patrick	E. Grimstead, England	8½" Refl.	4
Nicolini, Jean	São Paulo, Brazil	30 cm. Refl.	25
Olivarez, José	Edinburg, Texas	17" Refl.	7
Osypowski, Thos.	Milwaukee, Wisc.	12½" Refl.	22
Pazmino, John	Brooklyn, N. Y.	7" Refr.	2
Pope, Thomas	Milwaukee, Wisc.	12½" Refl.	14
Reese, Elmer	Uniontown, Pa.	6" & 8" Refls.	1801
Ricker, Charles	Marquette, Michigan	6" Refl.	87
Rippen, George	Madison, Wisconsin	6" Refl.	41
Roberts, William O.	Alameda, Calif.	4" Refr.	14
Roberts, J. A.	" "	" "	7
Rost, Carlos E.	Santurce, Puerto Rico	6" Refl.	232
Sato, Takeshi	Hiroshima, Japan	10" Refl.	5
Schultz, Martin	Bergenfield, N. J.	8" Refl.	3
Smith, J. Russell	Eagle Pass, Texas	16" Refl.	52
Smith, Turner	La Mesa, Calif.	10" Refl.	3
Starbird, James	Topeka, Kansas	6" Refl.	20
Tanaka, Wataru	Univ. of Tokyo, Japan	16" Refl.	2
Tronfi, A.	La Spezia, Italy	12" Refl.	101
Vitous, J. P.	Riverside, Ill.	8" Refl.	67
Wedge, G. E.	Montreal, Que.	8" Refl.	87
Wegner, Gary	Bothell, Wash.	10" Refl.	1
Wend, Richard	Milwaukee, Wisc.	12½" Refl.	2
Wyburn, Fred	Red Bluff, Calif.	4" Refr.	12
Williams, David B.	Normal, Ill.	6" Refl.	7
Young, J.	Table Mt., Calif.	16" Refl.	4
Zit, Raymond	Wauwatosa, Wisc.	6" Refl.	1
Zuzze, Stephen	Fresh Meadows, N. Y.	8" Refl.	49
78 Observers			7020 Observs.

General Appearance

Alika Herring commented: "In all the years I have been observing Jupiter, I do not believe the planet has ever been as colorful as it is this year".

The Equatorial Zone was churned by tremendous turbulence; Clark Chapman noted on July 15, 1962 that changes could be noted in intervals as short as 15 or 30 minutes. Reese commented: "If the region becomes much more confused, I am afraid we will lose track of the long enduring features" (August 16).

The NEB, EZ, and SEB_n appeared as one huge, almost solid belt across the middle of the disk, the EZ being even darker than in 1961 (Reese on March 28, 1962). Described variously as a rich yellow or warm brown, the EZ was narrowed as James Bartlett, Jr. observed (August 26), because the NEB and SEB_n had greatly expanded.

A photograph taken by Tom Pope on August 2 in red light with a 12½" telescope shows long (east to west) ovals in the EZ, brighter than they appear visually, while an unfiltered photo shows no ovals at all. Elmer Reese noted on July 12: "In blue light, the EZ just isn't there."

The whole NEB-EZ-SEB_n complex was compared to a loosely woven blanket held to the light (Joel Goodman) and also to an emulsion of oil and milk (Douglas Cooke).

Clark Chapman, in a detailed analysis of the EZ, believes that the principal features are white spots. With 12½" aperture and excellent seeing, he writes (July 15): "I had the very strong impression that all the NEB-EZ detail was composed of dozens of tiny white spots, most too tiny to represent well. For instance, an oval in the NEB was clearly seen as three white spots. Jupiter's appearance under such conditions is radically different from its appearance with poorer conditions and equipment." He feels that relatively permanent features that undergo slow changes are covered by a layer of white spots, which are deflected by some mechanism (such as magnetism) away from the large dark areas.

Outside the EZ, also on July 15, Chapman continues: "The major zones (particularly the NTrZ-NTeZ) were all covered with larger cellular brighter zones of faint contrast. Some of the brighter of these were seen as 'ovals'."

In the matter of the tiny white spots, it is interesting to note that during superb seeing (also with a 12½"refl.), Alika Herring made the following observation of the Red Spot: "I get the impression that the interior is covered with minute white flecks - perhaps like a layer of cumulus clouds seen from above." (see Figure 9).

Late in the apparition, the equatorial regions showed signs of becoming more "normal" in appearance (Chapman on January 9, 1963). Festoon activity was either markedly decreased or masked by complexity (Giffen on January 31). The whole region also appeared lighter than earlier.

The Equatorial Band was only occasionally seen during most of the apparation, dark and thin when it was observed (Chapman on August 6). Walter Haas reported it broken and close to the SEB$_n$, well south of the center of the EZ (May 7 and 22). Festoons connected the EB sections with the south edge of the NEB. On June 11 Haas noted that the EB bent northward, and following Longitude (I) 260° was near the middle of the disk. McIntosh reported an EB in evidence on November 9 (Figure 10), forming the tops of the EZ loops.

The South Equatorial Belt North was an orange brown or orange red - sometimes strikingly so (Reese on July 17). Usually it was the most prominent belt on the disk. The south edge returned to a near-normal position (Reese on July 12) compared to its near-equator position in 1961. Haas on March 26, 1962 found the north edge very close to the center of the disk in latitude, within an estimated 1% of the polar diameter. Reese commented on July 12 that the north edge blended in with a very dark EZ$_s$. He speculated that the dark projections along the S edge of the EZ$_s$ in 1961 had actually been portions of the true SEB$_n$. Dark belt material subsequently expanded southward from the EZ$_s$ to fill completely the normal latitudes of the SEB$_n$, engulfing the 1961 projections. No conspicuous projections were noted along the south edge of the SEB$_n$-EZ$_s$ during the 1962-3 apparition (Reese on July 1).

By August 3 Reese found the SEB$_n$ getting narrower as a result of the forming of numerous light ovals along the north edge. Bartlett on August 26 noted that the SEB$_n$ appeared to be composed of a number of dark, parallel, closely-spaced stripes - giving it a multiple structure. Late in the apparition Chapman (November 30) found the SEB$_n$ dark, but broken and knotted. Rodger Gordon on November 31 (sic) found both the SEB$_n$ and NEB not so dark as earlier.

The South Equatorial Belt South was usually thin. Chapman found it dark following the Red Spot (July 31) and doubling in places (August 5). Figure 2 shows the SEB$_s$ touching the Red Spot on both ends, and in Figure 14 the belt even crosses the Spot. Figure 4 shows the SEB$_s$ disjointed by the first recorded observation of the SEB Disturbance (see below). Hirabayashi found two belts in the zone between the SEB$_n$ and the STB, starting in mid-November. These were the SEB$_s$ and what he called the SEBZB (see Figure 12).

The South Equatorial Belt Zone was white with a pale bluish tinge. Chapman found the combined SEBZ and STrZ the most prominent zones on Jupiter (April 16); the two zones were differentiated only by the bluish tint of the SEBZ and the yellowish tinge of the STrZ.

On July 29 Giffen wrote to Reese: "The SEB$_s$ seems to be gaining in prominence, and the Red Spot Hollow is quite easy now. These [developments] may be pointing to a change in the RS, SEB, and STrZ."

The Major SEB Disturbance of 1962 was first noted by Bornhurst on Sept. 24 (see Figure 4). The reader is again referred to references 1 and 2 below for a description of the

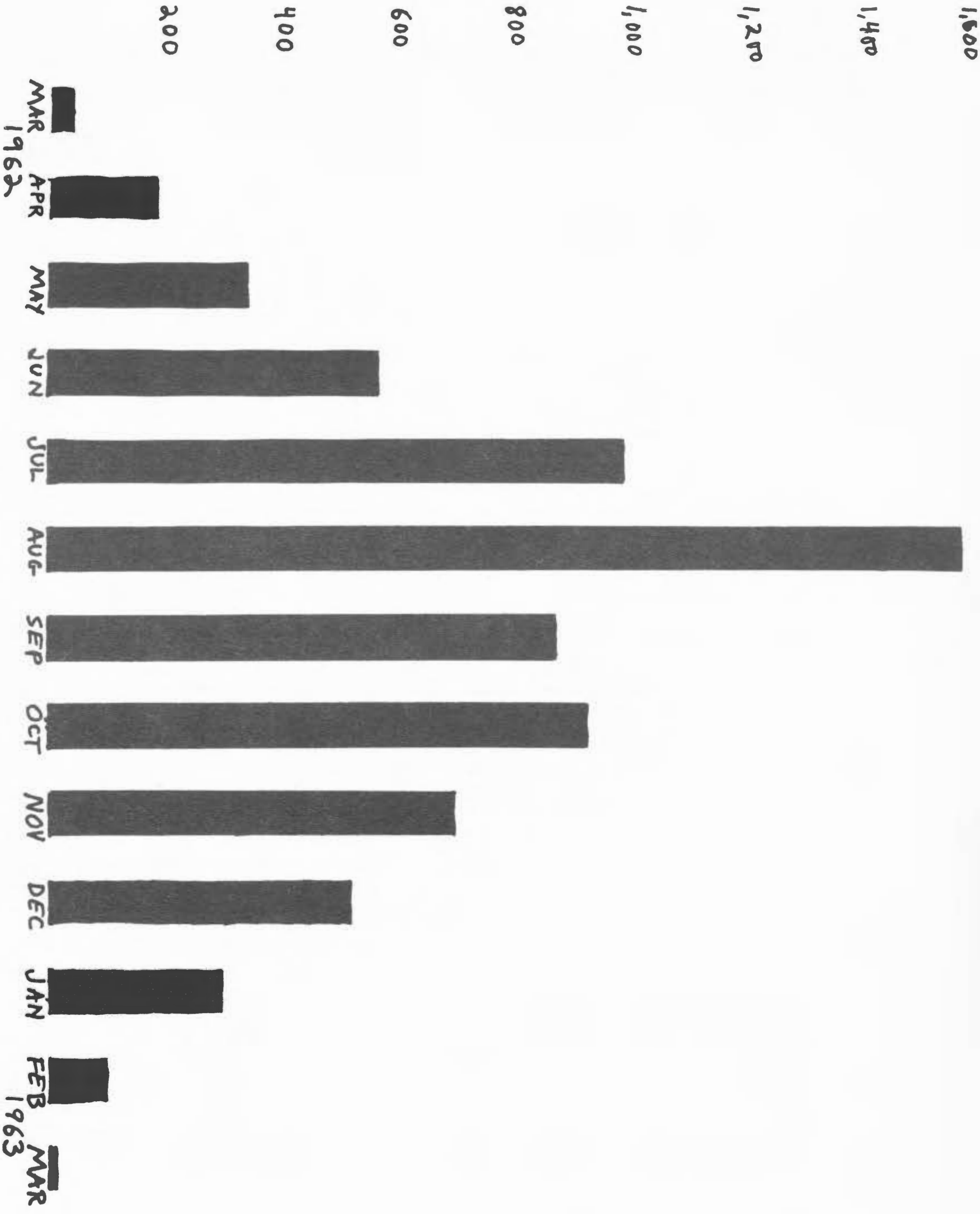

Figure 1. Histogram to show frequency of A.L.P.O. observations of Jupiter during the 1962-3 apparrition. The bars indicate the number of observations during each month. Graph prepared and contributed by Richard E. Wend.

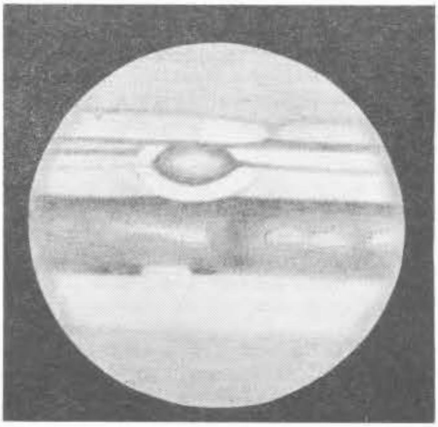

Figure 2. Drawing of Jupiter on Aug. 1, 1962 at 14^h42^m, U.T. C.M.$_1$=163°;C.M.$_2$=17°. Other data not available. Note Red Spot and Hollow. All illustrations of Jupiter in this article are simply inverted views with south at the top.

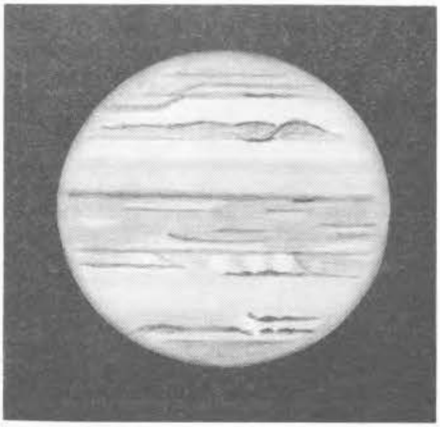

Figure 3. Drawing of Jupiter by Alika K. Herring. Aug. 31, 1962. 4^h22^m, U.T. 12.5-inch reflector. 208X. Seeing 4-6. Transparency 6 .C.M.$_1$=206°;C.M.$_2$=195°.

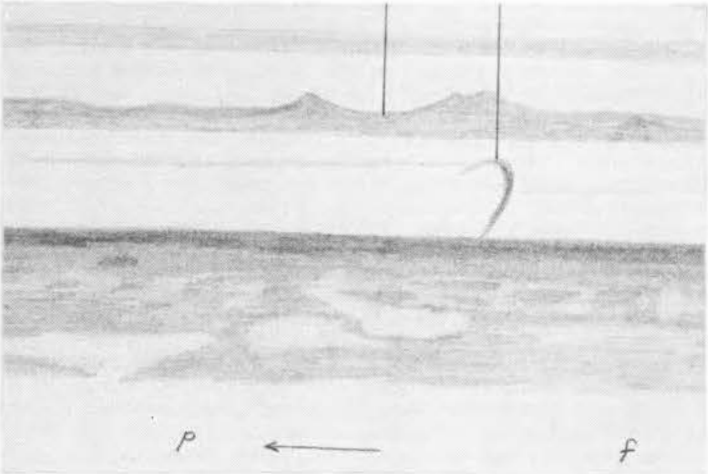

Figure 4. Sketch of South Equatorial Belt and vicinity by Larry Bornhurst on Sept. 24, 1962. 10-inch refl. at 240X. Seeing bad. The loop festoon in the SEBZ is the initial outbreak of the 1962 major SEB Disturbance and is in fact the first known observation of the Disturbance.

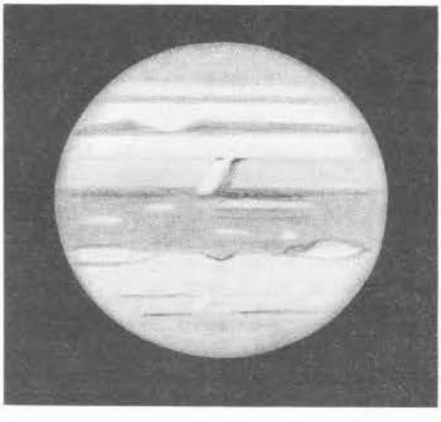

Figure 5. Drawing of Jupiter by Alika K. Herring. September 27, 1962. 2^h47^m, U.T. 12.5-inch reflector. 208X. Seeing 2-3. Transparency 6 .C.M.$_1$= 94°. C.M.$_2$=237°. Another very early view of the SEB Disturbance.

rotational periods of the elements of the Disturbance, as well as a general description. Compare Figures 5 and 6, drawn two weeks apart. Figure 7 shows the dark portion of the SEB$_s$ to be constructed of a close series of black spots.

Reese and Glaser noted instances where festoons in the EZ were in perfect alignment with festoons in the SEB Disturbance (October 4 and 7). This tendency has been noted in several previous Disturbances.

McIntosh wrote that on November 14 the Disturbance still consisted of well defined black spots on the SEB$_s$ near the initial outbreak. The spots and columns became broadened and more diffuse the further from the point of eruption.

On December 8 Chapman observed that the SEB$_s$ shifted south between the following end of the SEB Disturbance and the preceeding end of the STrZ Disturbance, and was quite southerly bordering the STrZ Disturbance.

Figure 11 shows the spectacularly bright bay in the SEB$_n$ first seen by Glaser on November 23. Its appearance was very sudden; until this bay formed, there was not much disturbance in the SEB$_n$. Figure 14 shows the subsequent development of the bay.

Note how the SEB Disturbance filled the STrZ right up to the Red Spot, with no apparent separation (Figures 14 and 15).

By January 9 Chapman and Giffen confirmed that the Disturbance surrounded Jupiter completely in both the SEBZ and the STrZ.

The South Tropical Zone was often found to be the most prominent zone during the first part of the apparition, seldom varying much in intensity compared to the SEBZ. After the spread of the Disturbance, the STrZ was of variable prominence. Chapman reported it brilliant (Jan. 16) following the Red Spot, but the combined STrZ-SEBZ was much less prominent than the NTrZ-NTeZ.

Reese found (November 25) that activity in the STrZ in those longitudes affected by the SEB$_s$ branch of the Disturbance appeared to be stealing the show from the SEBZ branch of the Disturbance. He didn't feel that a separate STrZ Disturbance was involved, however. See Figure 14, the area preceding the Red Spot.

The Red Spot began the apparition dark and conspicuous, a dull brick red with a slight orange cast according to many observers. The lighter interior oval noted the previous year remained present. The tendency of the RS to drift in a series of discrete little jerks, holding stationary in the STrZ between these motions, was noted by Reese.

In the first part of the apparition, Haas (May 20) found the Red Spot Hollow much brighter than the STrZ following the Spot, with a conspicuous festoon connecting the RS to the SEB$_n$. He noted (May 22) that the RS ends were sharply pointed, and the long axis of the Spot tilted slightly, southward at the preceding end and northward at the following end. Johnson thought that this tilt was not so much as in '61 (June 3).

By August 2 Haas found the RSH surprisingly dim and inconspicuous. Chapman noted that the dusky preceding border of the RSH was unusually dark, thick, and quite close to the RS (August 10). McIntosh observed (November 2) that the RSH was becoming more obvious again, with a separation between the RS and the last dusky STrZ column preceding it. Then, a week later, he noted a fading of the RS and no separation between the RS and the SEB Disturbance preceding it.

Many observers reported the RS to be fading near the end of the apparition, losing its dark border and elliptical shape (Smith on November 18). Chapman (Jan. 9, 1963) thought it was disintegrating and was mainly recognizable by its remaining light orange tint. Also, at the end of the apparition the RS did not appear to extend so far north as a few months before (Haas on February 5).

At the conjunction of the RS with the long enduring white oval FA, on December 5, Reese commented on a tendency of these ovals to be slightly retarded as they pass the RS.

The South Temperate Belt was a cool gray in most longitudes, with some brown (Reese on July 17). It was easily split into two components by Chapman with a 12½" reflector (July 23), both components darker in intensity preceding and following STeZ oval BC. The two components connected just preceding and following the oval. The STB was sometimes deflected slightly into the STrZ by the long enduring white ovals (Chapman on August 24). On January 12 Bartlett thought that the STB appeared to be fading rather rapidly.

The South Temperate Zone was usually reported white, with a few indications of bluish or lavender color. Giffen (June 25) found several white spots that appeared to be stable, lying between the long enduring white ovals. Chapman (August 11) noted a white spot, quite large, bright, and distinct, following oval FA. He found the STeZ dark and festooned in this area, though at 90° following it was second only to the STrZ in brightness.

All three long enduring white ovals (FA, BC, and DE) were clearly observed during the apparition.

The South South Temperate Belt was generally fourth or fifth in relative prominence estimates. Chapman (August 6 and 10) found the north edge much darker than the rest of the belt, and also darker preceding the RS and following STeZ oval BC. He considered the belt reddish. From time to time bright ovals would appear in this belt. On July 7 a photograph taken by Osypowski with a 12½" reflector showed one of these ovals.

The South South Temperate Zone was one of the faintest zones on Jupiter. Giffen noted a little subtle detail (August 13), and Chapman found it quite bright on December 8 preceding 290° in System II.

The South South South Temperate Belt was very faint and inconspicuous, according to Haas and Chapman.

The Polar Regions were most often described as a neutral gray, though some observers thought the NPR bluish gray and the SPR greenish or brownish gray. When they were not reported of equal duskiness, the NPR was considered slightly the darker.

Haas (April 10, 1962) noted brighter "caps" at each pole, at 5.2 on the usual Jupiter intensity scale versus 4.0 for the Polar Regions themselves (0 for shadows to 10 for most brilliant marks).

The North North North Temperate Belt received little comment during the 1962-3 apparition. Chapman's comprehensive "Belt Relative Prominence Estimates" lists this belt in late July as ranking 8th out of 9 belts observed, the NTB alone being fainter. See Figure 3 for a good drawing of the far northern belts.

The North North Temperate Zone, according to Chapman, was usually darker than the adjacent NTeZ, and was undistinguished by any detail. On August 4 and 10 he found the NNTeZ and NTez equal.

The North North Temperate Belt was variable and was disconnected at times. Chapman called it comparatively strong on April 2, with prominent spots on June 30. Haas saw it double on May 9 and brown in color on May 25. On July 23 Chapman found it practically invisible, except for two very narrow, dark sections. By August 13 Giffen reported it much more prominent than previously. Haas and Chapman usually found it to be the fourth most prominent belt, after the NEB, SEB_n, and STB. However, near the end of the apparition the NNTB darkened; on January 1 Haas ranked it the equal of the NEB and SEB_n. Giffen reported it double and wide on January 31, and on February 4 Haas described it as unusually dark and conspicuous.

The North Temperate Zone was a creamy white, compared to a pale bluish tinge in the NTrZ at times, and a yellow-orange NNTeZ. These reported colors changed from time to time, and also from observer to observer. With a red Wratten 25 filter, Chapman (May 28) found the NTeZ-NTrZ the most prominent (merged) zone on Jupiter, indicating a warm color.

The North Temperate Belt was usually a difficult belt to see, often just a darkening and not really a belt (Chapman on June 3). On June 30 Haas saw it very plainly in sections, and on August 13 Giffen called it only slightly more difficult than the SEB_s.

The North Tropical Zone was bright, a creamy color early in the apparition but later called a lavender gray. On February 24, 1963 Haas called the NTrZ-NTeZ extremely bright. With the NTB so faint between these two zones, they were often described as a single zone.

Giffen described a "new belt" (August 13), extremely difficult to see but a distinct

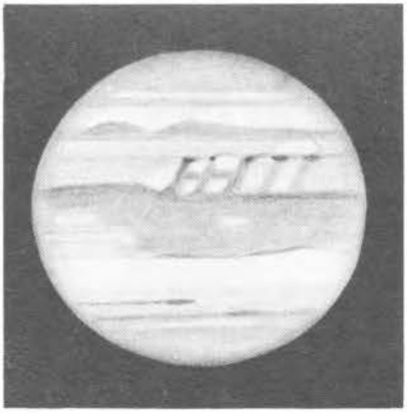

Figure 6. Drawing of Jupiter by Alika K. Herring. October 11, 1962. 4^h4^m, U.T. 12.5-inch reflector. 208X. Seeing 2-4 Transparency 6 .C.M.$_1$= 192°.C.M.$_2$=228°. Note developing SEB Disturbance.

Figure 8. Photograph of Jupiter by Wataru Tanaka, Astronomy Institute, University of Tokyo. 16-inch reflector used at 8.3 meters direct Cassegrain focus. Minicopy film, 1 second exposure. October 24, 1962. 9^h56^m, U.T. C.M.$_1$ = 298°.C.M.$_2$= 234°.

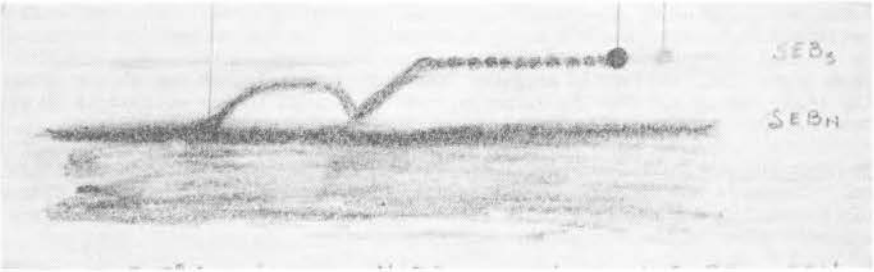

Figure 7. Sketch of general appearance of SEB Disturbance by Philip R. Glaser on October 12 and 14, 1962. 12.5-inch reflector.

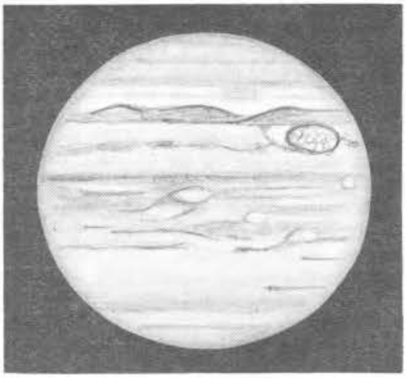

Figure 9. Drawing of Jupiter by Alika K. Herring. October 28, 1962. 5^h48^m, U.T. 12.5-inch reflector. 208X. Seeing 9. Transparency 6 .C.M.$_1$= 59°.C.M.$_2$= 325°. Red Spot flecked with minute white spots.

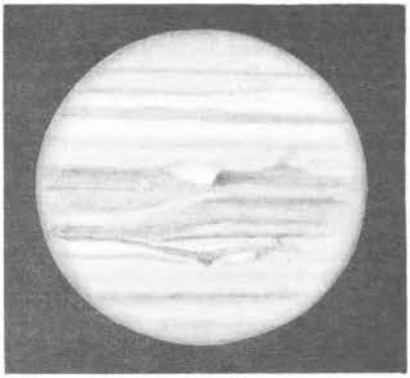

Figure 11. Drawing of Jupiter by Alika K. Herring. November 29, 1962. 6^h17^m, U.T. 12.5-inch reflector. 208X. Seeing 6-7. Transparency 6 .C.M.$_1$= 85°.C.M.$_2$= 107°.

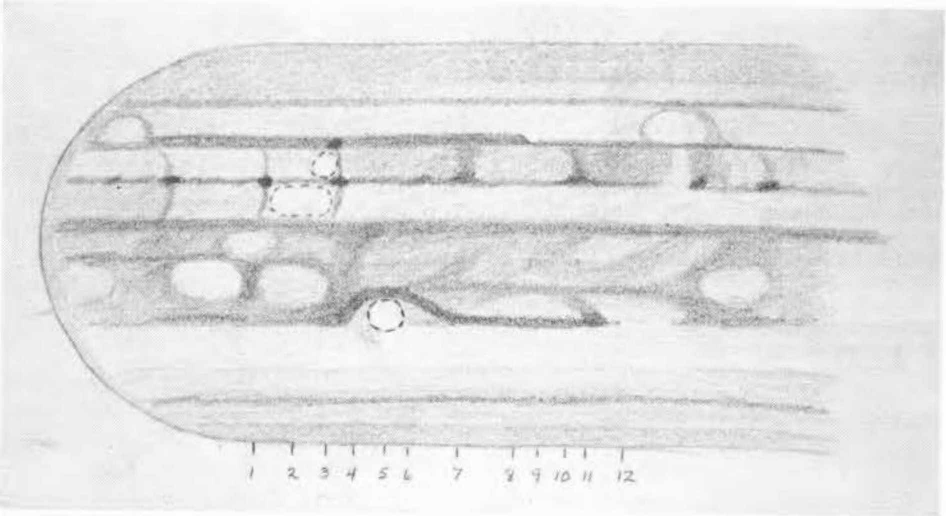

Figure 10. Continuous drawing of Jupiter by Patrick S. McIntosh, November 9, 1962. 3^h26^m–5^h28^m, U.T. 4-inch Unitron refractor. 167X. Seeing 1-5, usually 2-3. Transparency 6½. C.M.$_1$ =66° to 140°.C.M.$_2$= 241° to 315°. The figures at the bottom refer to objects of which C.M. transits were observed.

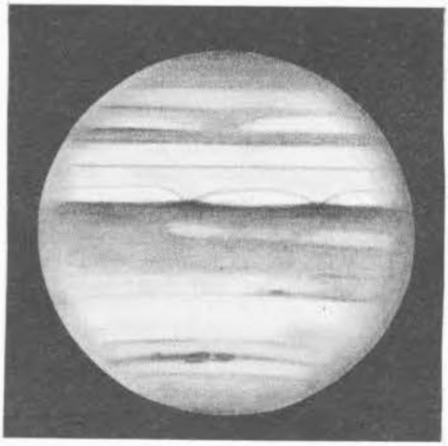

Figure 12. Drawing of Jupiter on December 1, 1962 at 8^h20^m, U.T. C.M.$_1$= 116°.C.M.$_2$= 121°. Other data not available.

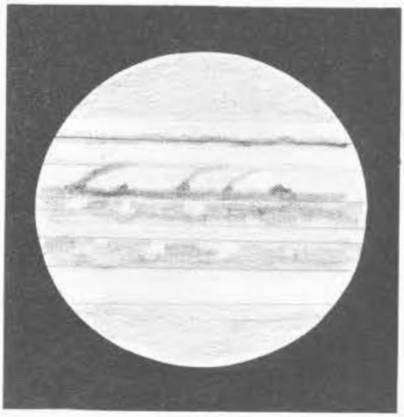

Figure 13. Drawing of Jupiter by James C. Bartlett, Jr. December 1, 1962. 23^h 22^m,U.T. 4¼-inch reflector. 50X, 120X, 240X. Seeing 5. Transparency 5.C.M.$_1$= 305°. C.M.$_2$= 306°.

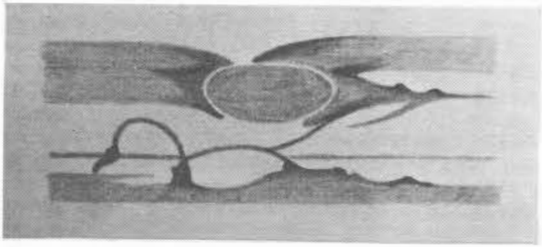

Figure 15. Drawing of Red Spot and environs by Charles F. Capen (?) at Table Mountain Observatory. December 14, 1962. 1^h30^m - 1^h40^m, U.T. 16-inch Cassegrain. 600X. Seeing 3-5. Transparency 6.C.M.$_2$ = 28°.

belt in the NTrZ for over 240° in longitude. He placed it at 40%of the way from the center of the NEB_n to the NTB. Most of the NTrZ_s light ovals were between this belt (named NTrZB) and the NEB_n.

The North Equatorial Belt, often double, was as dark as the SEB_n during much of the apparition. Chapman found the north component of the NEB fainter and thin (June 3). Giffen found dark strips in the NEB_n-NEB_s along with light ovals (June 25), and on August 13 he reported the NEB_n itself double in certain parts. Haas (June 13) described the NEB as slightly tilted, widening the EZ where it bent north, and narrowing the EZ where it bent south. After opposition, Chapman (November 30) thought the NEB more complex than before, adding "but then, it has been strange all along."

Figure 12 shows how a large segment of the NEB seemed obscured by a large cloud. Sato and Hirabayashi called the fading of the NEB "most striking", noting (July 31) a faintness in the south component also.

Figure 10 shows a bright oval on the NEB_n, with a very dark belt looped over it. This feature was the most conspicuous object visible on Jupiter at that time.

The Jovian Satellites

Clark Chapman observed an occultation of J. II by J. III on December 8, 1962. He noticed an elongated satellite appearance, realized that an occultation was taking place, and timed last contact at 23^h36^m, U.T. (predicted last contact 23^h32^m). By 23^h53^m the satellites were separated by one diameter of the smaller satellite.

Charles Giffen observed J. II in transit on June 14 with a 15.6-inch Clark refractor, using a Wratten 15 (yellow) filter. He noted: "Thru V filter (Wratten 15, yellow) satellite J. II many times brighter than any part of Jupiter - roughly as much brighter as Ring B is over Saturn's NPR this year (nearly four intensity units.)" He also noted considerable limb darkening of J. II.

On June 27, 1962, with a 9.5-inch Clark refractor, Giffen reported J. III in transit, almost black, intensity about 1.0.

A table of observed satellite phenomena follows:

Date	Predicted (U.T.)	Observed (U.T.)	Observer
1962, April 2	III Tr E 10:24	Seen definitely 10:28	Chapman
April 10	I Ec D 9:52	9:52	Chapman
May 4	III Ec D 9:17	9:20	Chapman
May 11	I Sh.E 11:29	11:26.6	Haas
May 13	II Tr E 10:41	10:39.0	Haas
May 20	II Tr I 10:35	10:31.1	Haas
May 20	IV Ec R 10:52	10:50	Haas
May 22	III Sh E 10:51	10:51.8	Haas
May 26	I Ec D 10:14	10:13.7	Haas
June 3	I Sh I 9:21	9:25 3/4	Chapman
June 18	I Ec D 10:25	10:25.8	Haas
June 19	I Tr I 8:55	8:52.8	Haas
June 19	I Sh E 9:52	9:51.5	Haas
June 19	I Tr E 11:10	11:07.6	Haas
June 21	II Tr I 10:17	10:14.7	Haas
June 21	II Sh E 10:25	10:25.5	Haas
June 23	IV Ec R 10:57	10:57.7	Haas
July 1	IV Sh E 8:21	8:20.1	Haas
July 4	III Sh E 10:48	10:50.4	Haas
July 12	I Tr I 8:51	8:47.5	Haas
July 12	I Sh E 10:02	9:58.6	Haas
		9:58 1/2 - 10:02 1/4	Chapman
July 12	I Tr E 11:06	11:03.6	Haas
		11:02	Chapman
July 16	II Tr E 9:34	9:31.7	Haas
July 20	I Oc.R 10:15	10:13.4	Haas
July 23	II Tr I 9:12	9:11 1/4 - 9:13 1/2	Chapman

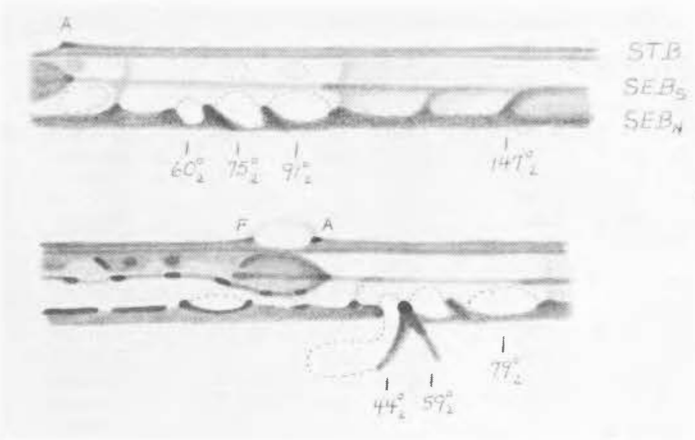

Figure 14. Strip sketches of selected latitudes of Jupiter by Elmer J. Reese on Dec. 2-3 and Dec. 4-5, 1962. (U.T. date changed during observation.) 8-inch reflector, 310X and 225X. Seeing 3-5, transparency 4-5. Longitudes (II) of some features marked. Red Spot and STeZ oval FA in conjunction on Dec. 5.

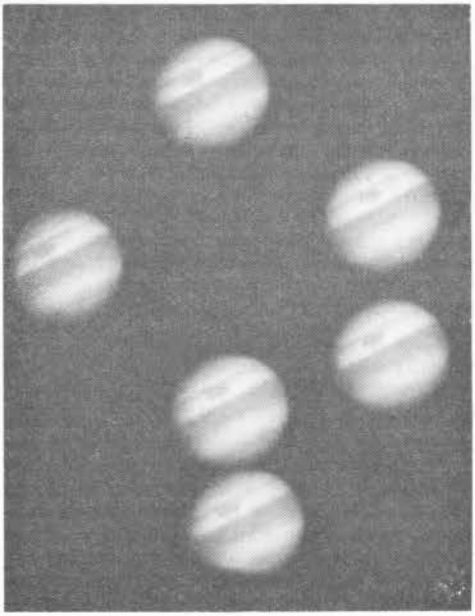

Figure 16. Photographs of Jupiter by Dennis Milon on July 2, 1962, 9^h57^m to 10^h9^m, U.T. 8-inch reflector at F:170. Seeing 4, transparency 5. Royal Pan sheet film developed in Dk60a, all exposures 1 second. At 9^h57^mC.M.$_1$= 289°, C.M.$_2$= 14°. Measures of top image by Elmer J. Reese place Red Spot at 9°5 (II), with a length of 23°1.

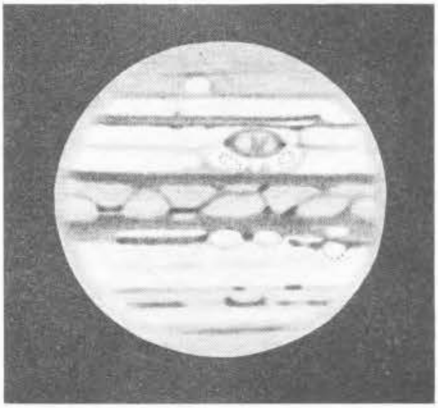

Figure 17. Drawing of Jupiter by Elmer J. Reese on July 7, 1962 at 8^h35^m, U.T. 8-inch reflector, 280X. Seeing 5-6, transparency 5. C.M.$_1$= 309°C.M.$_2$= 356° Note detail in Red Spot.

Figure 18 (left). Photograph of Jupiter by J. Russell Smith with a 16-inch reflector on September 29, 1962. Other data not available. Note oval, conspicuous Red Spot. EZ so dusky as to simulate a single "belt" with bordering NEB and SEB$_n$. Some white ovals faintly present in EZ on original print.

Date	Predicted (U.T.)	Observed (U.T.)	Observer
1962, July 23	II Tr E 11:55	11:51	McIntosh
July 30	II Sh I 9:56	9:58	Haas
July 30	II Tr I 11:32	11:30.5	Haas
August 4	I Tr I 8:36	8:33 1/2 - 8:37 0/4	Chapman
August 4	I Sh E 10:13	10:12 3/4	Chapman
August 4	I Tr E 10:52	10:47 0/4 - 10:50 3/4	Chapman
August 6	I Tr E 5:18	5:13 0/4 - 5:17 0/4	Chapman
August 10	II Tr E 5:40	5:34 - 5:39	Chapman
August 24	II Tr I 7:26	7:28	Chapman
September 6	I Oc D 1:43	1:40 3/4 - 1:44 1/2	Chapman
September 6	IV Tr I 3:39	3:34 1/4 - 3:41 3/4	Chapman
September 6	IV Sh I 4:51	4:52	Chapman
September 11	II Sh E 4:19	4:15 0/4 - 4:18 0/4	Chapman
November 30	I Sh I 22:08	22:06 1/2	Chapman
November 30	I Tr E 23:04	23:01 1/4 - 23:05 0/4	Chapman
December 1	III Sh E 23:08	23:00 1/4 - 23:08 0/4	Chapman
December 8	I Ec R 23:34	23:31 3/4 Quite faint	Chapman
December 8	III Sh I 23:52	23:54 3/4	Chapman
1963, January 28	III Tr I 0:49	0:48.0	Haas
February 7	I Oc D 0:58	0:56.6	Haas

When nothing else is indicated, the observed times refer to the observed middle of a phenomenon.

References

1. *The Strolling Astronomer*, Vol. 17, pp. 137-151, 1963.

2. *The Strolling Astronomer*, Vol. 16, pp. 260-263, 1962.

A.L.P.O. COMETS SECTION REPORT: COMET TOMITA-GERBER-HONDA 1964c

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

The first bright comet since September, 1963 was discovered by Tomita of Tokyo Observatory in the morning sky of June, 1964. Subsequently the comet was spotted by Gerber at Cordoba, Argentina, and by Honda in Japan. A.L.P.O. observers followed the comet from June 14 to June 18 in the morning sky as it approached the sun. It was then seen low in the evening from June 29 to July 19, 1964. Following conjunction with the sun in August the comet was further followed in October by professional astronomers, but by that time it had become very faint. Near perihelion on July 2 the tail was spectacularly distorted as shown in Alan McClure's photographs published in *Sky and Telescope*, Volume XXVIII, pp. 174-177, 1964 (September).

Observations of Tomita-Gerber-Honda were contributed by the following A.L.P.O. members:

John E. Bortle	Mount Vernon, New York.	5-inch refractor & 10X50 binoculars.
Michael McCants	Houston, Texas.	6X30 binoculars.
David Meisel	Columbus, Ohio.	8X50 refractor & 10X50 binoculars.
Alan McClure	Los Angeles, California.	10X60 binoculars.
Dennis Milon	Tucson, Arizona.	7X35 binoculars.
William O. Roberts	Alameda, California.	5-inch refractor & 7X50 binoculars.

The following parabolic orbital elements computed by Michael McCants were used to reduce the visual magnitude estimates.

T	June 30.604, 1964
ω	58°471
Ω	309°240
i	161°779
q	0.4998 A. U.

Data for figure on page 222

	Corrected magnitude minus 5 log Δ	Distance to sun r
1964, June 14.4 U.T.	6.5	0.640 A.U.
14.44	6.6	.640
16.56	6.7	.625
18.56	6.4	.610
July 1.12	5.6	.500
4.17	5.7	.507
5.08	5.9	.511
5.13	6.0	.512
7.07	5.8	.524
7.12	5.1	.525
13.20	5.9	.583
19.21	7.3	.665

The greatest tail length reported visually was 2 degrees (about 2 million miles), by Michael McCants on July 1. After perihelion a straight tail about 1 degree long was usually seen. Between July 5 and 7 Meisel and Bortle estimated the degree of condensation of the coma as being from 6 to 8 on a scale of 0 = diffuse to 9 = stellar. No observer saw a star-like nucleus, most describing the central condensation as diffuse but well defined from the coma. Roberts described a diffuse condensation on June 14 and 16 and again on July 19. The over-all color of Tomita-Gerber-Honda was seen as blue with binoculars on June 18 by Milon, while on July 4 he saw it as green in a 12 1/2-inch reflector. John Bortle described the comet as bluish in a 5-inch refractor at 24X on July 7.

Concerning a possible correlation of solar activity with the meandering tail photographed by Alan McClure on July 3, Patrick McIntosh, Sacramento Peak Observatory contributes the following: "July 1964 was an extremely quiet month as far as solar activity is concerned. In fact it is now widely believed to be the month of sunspot minimum. The sunspot groups present near the time of the 'kink' in the tail of Tomita-Gerber-Honda were very small, short-lived, and inactive flare-wise."

Comet Tomita-Gerber-Honda 1964c

U. T. 1964				Observed Magnitude	Corrected Magnitude
June 14.4	McClure	10X60		5.5	5.5
14.44	Milon	7X35		5.4	5.6
16.56	Milon	7X35		5.3	5.5
18.56	Milon	7X35	Tail 3/4 degree. Bluish.	4.8	5.0
July 1.12	McCants	6X30	Tail 2 degrees.	4.5	4.7
4.17	Milon	7X35	Green with diffuse nucleus in 12 1/2-inch.	4.9	5.1
5.08	Bortle	10X50	No tail in 6-inch.	5.3	5.4
5.13	Meisel	8X50	Tail 15'. Coma less than 5'.	5.4	5.5
7.07	Bortle	10X50	1° tail, P.A. 85° in 5-inch. Bluish. Coma less than 3'.	5.4	5.5
7.12	Meisel	10X50	Tail 1 1/2 degrees.	4.7	4.8
13.20	Roberts	5-inch, 24X	Tail 12'. Coma 2'. Jet 5'.	6.0	5.6
19.21	Roberts	5-inch, 24X		7	6.6

The magnitude corrections are according to Bobrovnikoff's formula which adjusts the observed magnitude to a standard aperture of 2.67 inches, i.e.,

$$\text{Standard magnitude} = \text{Observed mag.} - 0^{\mathrm{m}}.167\,(\text{Aperture} - 2.67).$$

In the general formula for a comet's magnitude:

$$H = H_0 + 5 \log \Delta + 2.5n \log r,$$

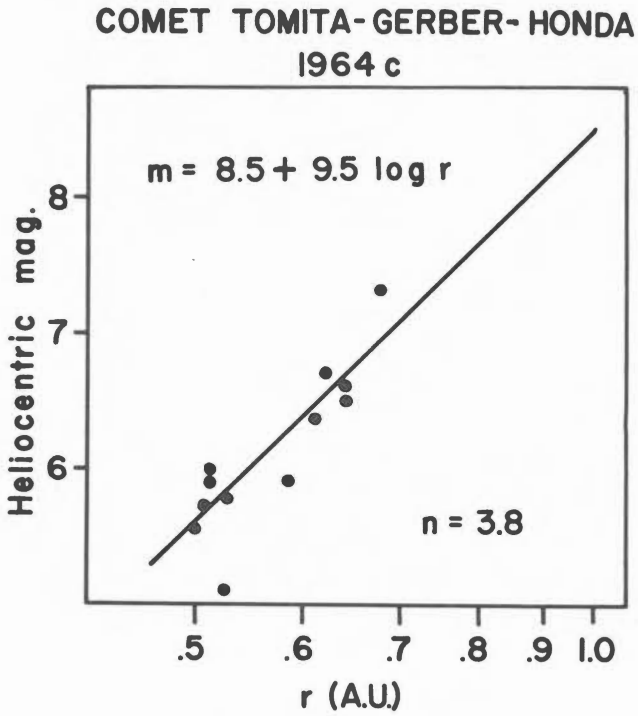

Figure 19. Corrected heliocentric magnitude at unit distance plotted against the distance to the sun in astronomical units on a log scale. A discussion of Figure 19 is given in the text. The graph was compiled by Michael McCants and was drawn by Steve Larson.

where Δ and r are the geocentric and heliocentric distances respectively, H_0 is a constant called the absolute magnitude, and n is a factor to be determined for each comet. In Figure 19 there is plotted the corrected magnitude $H - 5 \log\Delta$ reduced to the customary unit distance of 1 astronomical unit against log r. The slope of the interpolated line on Figure 19 gives the value of n, which here comes out to be 3.8, a value close to the average for comets in general. The absolute magnitude for Tomita-Gerber-Honda is 8.5.

SOME STUDIES OF PHASE PERTAINING TO MERCURY AND VENUS

By: Dale P. Cruikshank (editor of combined paper),
Geoffrey Gaherty, Jr., Charles H. Giffen, and John E. Westfall

Introduction

Four papers on the subject of the phases of the interior planets were presented at the Denver, Colorado Convention of the A.L.P.O. in August, 1964. The general topics of the Schroeter Effect, variation of phase, and estimating the date of dichotomy have stimulated great interest among observers in recent years. The time is drawing near for a definitive study of the phase anomalies of the interior planets; and it is felt that the data and ideas presented below will provide material for such a study, which is now in progress.

At the Denver Convention the four papers on phase were read in succession and were then summarized by one of the present authors (DPC). At the suggestion of Clark R. Chapman and Walter H. Haas, the four papers have been combined, preserving the individual authors' identity; and the following is a result of that synthesis.

Observations and analyses are presented to contribute to understanding the Schroeter Effect of phase discrepancy when Mercury, Venus, and the moon are near half-phase (dichotomy). Evidence is presented showing that Mercury does indeed have a phase discrepancy when the effects of image spreading (caused by seeing, irradiation, and diffraction) and incorrect estimation of phase are accounted for. Studies of the lunar phase by five observers using no optical aid reveal errors similar to those found when estimating in the telescope the phases of Venus and Mercury. A method of finding the date of dichotomy from visual observations of the phase of Venus (or Mercury) by least squares curve fitting is described, and the results of Westfall's Venus observations are given. Another method of dichotomy date determination by phase "probability" estimates is described, and the results of several observers' dichotomy determinations in the March-April, 1964 Venus evening apparition are given. Errors in phase estimates are discussed.

Schroeter noted in a morning apparition of Venus late in the eighteenth century that when the geometry of the orbits of Venus and the Earth indicated that the phase of Venus should be exactly one-half, the planet appeared in the telescope to have a phase of less than one-half. About 8 days later the observed half-phase or dichotomy was reached. This difference in the predicted and observed phase around dichotomy is now known as Shroeter's Effect and has been confirmed by many observers. An analysis by Hartmann (11) of 134 ALPO observations between 1951 and 1961 showed that the average magnitude of the Schroeter Effect on Venus is about 7 days and is the same at both eastern and western apparitions. He showed that there is a large scatter in the determinations of dichotomy. There are many reasons for the scatter, the most important of which are: 1) bias on the part of observers who know the predicted date of dichotomy and make their estimates accordingly if they, (a) are ignorant of the Schroeter Effect and draw the half-phase on the predicted date or, (b) know of the Schroeter Effect and record half-phase about one week on the inferior conjunction side of predicted dichotomy; 2) widely varying apertures, magnifications, and filters and hence differing brightnesses of the Venus image compared to the background sky; 3) the difficulties of actually estimating phase when viewing the planet in only fair or poor seeing so that the terminator wobbles back and forth between a concave and convex shape.

The Schroeter Effect on Mercury

By: Charles H. Giffen

Large scatter of phase observations makes it difficult to decide whether Mercury has a dichotomy effect. Crude data from the 1963 A.L.P.O. Simultaneous Observation Program (unpublished) and from recent A.L.P.O. Mercury Section files indicate a very slight tendency towards underestimation of phase (1). This result can only be interpreted on the average, for the results vary greatly with the observers.

The raw data for Mercury do not follow the pattern of those for Venus, nor do they follow the pattern of those for a simulated planet (2). The phase errors for Mercury, Venus, and the simulated planet are, in raw form, -0.008 , -0.034 , and -0.024 respectively. The minus sign indicates underestimation of phase, and the phase "k" is the ratio of the area of the illuminated protion of the disk to the total area of the disk. The raw data indicate that the phase misestimation of Mercury amounts to very little, if anything, compared with that of Venus and the simulated planet.

Other facts appear in the raw data for Mercury and are not indicated by the average value of the phase misestimation near dichotomy. Larger telescopes yield rather significant phase underestimations, and smaller telescopes yield mostly phase overestimations. Phases greater than about $k = 0.450$, on the average, tend to be underestimated, while phases less than this value tend to be overestimated. This variation of phase misestimation with phase is rather pronounced with Mercury. These factors suggest that some mechanism affects the data.

One such mechanism is image spreading. A telescopic image is spread out by seeing, diffraction, and irradiation. The net result is to increase the phase of the image over that of the disk. Neglecting seeing and irradiation effects, an approximate solution for this (spread out) image phase k' is

$$k' = \frac{kdD + 2.3}{dD + 2.3} = \frac{kd + (2.3/D)}{d + (2.3/D)} = \frac{k + (2.3/dD)}{1 + (2.3/dD)} ,$$

where k is the (real) disk phase, d is the angular diameter of the disk in seconds of arc, and D is the aperture of the telescope in inches.

We may justify this approximate solution in the following manner. Since d is the angular diameter of the disk, kd is the breadth of the illuminated portion of the disk, (Figure 20). Now the image is spread out in every direction by some amount ϵ (which will be determined below). The effect of this spreading out is to increase d to $d + 2\epsilon$, and at the same time to increase the breadth of the illuminated portion of the disk from kd to $kd + 2\epsilon$. Therefore the image phase k' is

$$k' = \frac{kd + 2\epsilon}{d + 2\epsilon}$$

instead of kd/d = k. From diffraction theory, the width of the strip around the non-spread out illuminated portion of the disk where first order diffracted light falls will be 4.6/D; however, most of this light (indeed, all that will be detected by the eye) falls in the inner one-fourth of this strip, so that we should choose $\epsilon = 4.6/4D$. Substituting this value of ϵ gives the above expression for the (spread out) image phase.

Here are typical image phase values for Mercury and Venus at selected (real) disk phases and with various apertures D:

		k = 0.250	0.500	0.750
Mercury:		d = $8\overset{''}{.}9$	$7\overset{''}{.}2$	$5\overset{''}{.}9$
	D = 3	k' = 0.310	0.548	0.780
	D = 6	k' = 0.280	0.525	0.766
	D = 12	k' = 0.266	0.514	0.760
Venus:		d = 41"	24"	$14\overset{''}{.}6$
	D = 3	k' = 0.263	0.515	0.760
	D = 6	k' = 0.257	0.508	0.756
	D = 12	k' = 0.254	0.504	0.753

And here are the corresponding disk phase minus image phase values k - k' .

		k = 0.250	0.500	0.750
Mercury:				
	D = 3	k - k'= -0.060	-0.048	-0.030
	D = 6	k - k'= -0.030	-0.025	-0.016
	D = 12	k - k'= -0.016	-0.014	-0.010
Venus:				
	D = 3	k - k'= -0.013	-0.015	-0.010
	D = 6	k - k'= -0.007	-0.008	-0.006
	D = 12	k - k'= -0.004	-0.004	-0.003

One sees that the disk-image phase discrepancies k - k' are much more significant for Mercury than for Venus at fixed apertures. Also the variation of image phase k' with aperture at a fixed disk phase is much more pronounced for Mercury than for Venus. Finally, the variation of the disk-image phase discrepancy with the disk phase k is more pronounced for Mercury than for Venus. Clearly, the disk-image phase discrepancy becomes more pronounced as the disk diameter d or the aperture D (or both) becomes smaller.

Since there are so many significant variations of the image phase k', one should consider misestimations of the image phase instead of the disk phase k. This was done for the A.L.P.O. Simultaneous Observation Program observations of Mercury, and an image phase misestimation of -0.038 for Mercury at dichotomy resulted. The variations of image phase misestimation with varying aperture and disk phase were much less than those for raw disk phase misestimations, and scatter was greatly reduced.

Assuming an average aperture of 5 inches for the A.L.P.O. Venus Section observations analyzed by Hartmann, we obtain an image phase misestimation of about -0.044 for Venus at dichotomy. Thus there is good agreement between the image phase misestimations of Venus and Mercury, while there was considerable disagreement between the corresponding disk phase

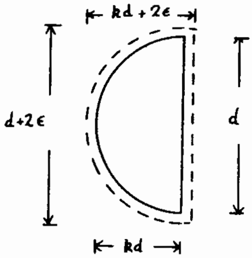

Figure 20. Diagram to show how the image phase of an interior planet near dichotomy differs from the geometrical disc phase. The disc is spread by an amount of ϵ in all directions because of diffraction, seeing, and irradiation. The result is to make k for the image phase more than 0.50 at geometrical dichomoty. See also discussion by Dr. Charles H. Giffen in accompanying text.

misestimations.

One may ask about the seemingly "small" phase misestimation of -0.024 for the simulated planet mentioned above; this is explained as follows. The angular diameters of the simulated disks were about 1800", and because of the high level of illumination of the room in which the phase estimations were made, the resolution of the eye was only about 180". Thus the image phase at the retina should have been about

$$k' = \frac{900 + 90}{1800 + 90} = 0.524$$

at "dichotomy". Therefore, the disk-image phase discrepancy k - k' was about -0.024, so that the misestimation of image phase amounted to about -0.05 — more in line with the Venus and Mercury results (which so far include only diffraction spreading of the image).

Both diffraction and seeing spreading of the image may be accounted for in a fairly simple way. An approximate solution for the corrected image phase k* in this case is

$$k^* = \frac{kdD^* + 2.3}{dD^* + 2.3} = \frac{k + (2.3/dD^*)}{1 + (2.3/dD^*)} ,$$

where D* is the effective aperture in inches ("resolution character" in my first "Foundations" article (3)), and all other symbols are as before. The effective aperture of a telescope in a given observing situation is the aperture another telescope would have in perfect seeing conditions to produce an image equivalent (as regards resolution) to that of the first. This is just the value of the revised seeing scale proposed in my second "Foundations" article (4). "Guesstimating" effective apertures (60 per cent of real aperture for Mercury observations and 80 per cent of real aperture for Venus observations), we obtain disk-image phase discrepancies k - k* of about -0.048 for Mercury and -0.012 for Venus. These give image phase misestimations of about -0.056 for Mercury and -0.046 for Venus, which are comparable to the -0.05 image phase misestimation value for the simulated planet (which had no seeing effects).

Although not clear, it appears likely that the irradiation effects would actually be included in seeing and diffraction effects as given by our formula for k* which uses the effective aperture D*. Aperture dependence of the misestimation effects seems really to be effective aperture dependence, and this is a strong point in favor of using the effective aperture D* (which can be determined quite simply) as a way of "measuring" planetary seeing.

Summary. This analysis gives a good correspondence between the image phase misestimations of Mercury and Venus. An image phase misestimation of about -0.05 is found to hold for Mercury, Venus, and a simulated planet. The variations of disk-image phase discrepancies for Mercury offset the corresponding observed anomalies of disk phase misestimation seen in the raw data. One may conclude that Mercury, like Venus, exhibits the Schroeter dichotomy effect — in the sense that the images of Mercury and Venus are underestimated by similar amounts.

A Study of the Moon's Phase with the Naked Eye

By: Geoffrey Gaherty, Jr.

In order to examine factors causing the considerable scatter in visual estimates of the phases of the interior planets, it is useful to have control observations. There have been many attempts to observe artificial planets with telescopes or binoculars. In the work described below another approach was taken; the Moon as seen with the naked eye was used to simulate an interior planet. In the second half of 1963, 321 phase estimates were made by members of the Montreal Centre of the R.A.S.C., many of them by inexperienced observers. For this preliminary study, only the observations of the five most experienced observers (K. Brasch, K. Chalk, G. Gaherty, I. Williamson, and G. Wedge) have been used. These 65 estimates were plotted on a graph.

The following tentative conclusions can be drawn from a study of the observations:

1. The phase tends to be underestimated. The mean deviation between observed and predicted phases (O - C) is - 5.4% (expressed in terms of the Moon's diameter). This difference is clearly due to the falling off of light along the terminator.

2. The deviation varies as a function of the Moon's phase. Similar effects are observed on Mercury and, to a lesser extent, on Venus, and are probably mainly of psychological origin. An exception to this is a large deviation in the range 70 - 79%; this feature is undoubtedly caused by the presence of extensive <u>maria</u> along the terminator at this phase (most observations were made of the waxing Moon). This result suggests a possible technique for studying the gross characteristics of the surface of Mercury.

3. The observations exhibit a large scatter. The standard deviation is 6.0% (in terms of the Moon's diameter), more than twice that found for Venus with the same observers (see Klaus R. Brasch, "A Study of the Phase of Venus, 1960-62", Strolling Astronomer, Vol. 17, pp. 173-178). This appears to be due to the fact that the Moon, as seen with the naked eye, subtends only about half the diameter of Venus when seen with a magnification of 150X.

Estimation of the Dichotomy of Venus by Least Squares

By: John E. Westfall

The Schroeter Effect on Venus has been known for almost two centuries. More recently, however, this effect has been recognized as a special case of an observed versus predicted phase difference that exists for all phases of the planet (5). Most observers have satisfied themselves with estimating the date of apparent dichotomy, defining the phase discrepancy as the difference between this date and the date predicted. The value thus determined is based on a single observation and is correspondingly uncertain. The estimation of the date of apparent dichotomy from several observations, in contrast, allows statistical techniques to be applied, giving a more precise value for the phase discrepancy.

The Method of Least Squares

The statistical method used by the author was the method of least squares (sometimes called regression analysis), which consists of determining the linear equation which best fits a series of observed values of two variables. Any single observation, indexed i in the sequence, has the values x_i and y_i. The least squares line best fitting the sequence of these values is described by the equation:

$$(1) \quad y = a + bx,$$

where a and b are parameters to be found by the equations:

$$(2) \quad b = \frac{n(\sum x_i y_i) - (\sum x_i)(\sum y_i)}{n(\sum x_i^2) - (\sum x_i)^2}$$

$$(3) \quad a = \frac{\sum y_i - b \sum x_i}{n},$$

where n is the total number of observations (i.e., paired x, y values) and all summations are from i = 1 to n (6).

In this study, y is the observed phase of Venus, hereafter written k_o, and x is the Julian Day of observation minus 2,438,400 .*

The observed phase versus time curve for Venus is not a straight line, but, for small ranges of x and y (for example, near dichotomy), a straight line fits the observations satisfactorily.

The Observations

During the evening apparition of Venus, in Spring, 1964, the author made some 34 phase estimates for Venus, beginning on January 18 and ending on June 3. The phase was estimated to hundredths of the apparent diameter of Venus. The instrument used throughout was a four-inch refractor with a combination of a Barlow Lens and a variable-power orthoscopic eyepiece giving 540 power.

Phase estimates were also made using the same telescope and magnification with a Wratten A (red) filter. The phase estimates secured with the filter were only slightly less than those found without the filter. On the average, the difference in k between the two sets of observations was only 0.0097. As he gained experience, the writer evidently subconsciously compensated for the filter's effect; if the first eight observations are ignored, the average difference drops to only 0.0035. The author feels that the slight filter effect was due solely to the decreased brightness of the image as seen with the filter, rather than to any effect caused by observing in red light rather than in integrated light. This confirms the conclusion reached by Cruikshank (7).

When the predicted and observed phase values were plotted together against time, it was usually found that the observed values were less than the predicted ones until about April 20. Between April 20 and about May 20, 1964, the observed phase exceeded the predicted. Finally,after May 20, the observed phase agreed well with the predicted, except for the final observation (on June 3) which was made under mediocre seeing conditions. When the observed phase was plotted directly against the predicted phase, it was found that for phases greater than about k = 0.44, the observed phase was less than the predicted, while, from k = 0.44 to k = 0.21, the opposite was true. Phases less than about k = 0.21 showed little difference between observation and theory.

The "cross-over point" at k = 0.44 is of special interest. Henry McEwen, observing from 1919 to 1927, found the predicted phase to exceed the observed at this point in all cases (8). Michelson and Petrov, however, found $k_o = k_c$ at about k = 0.55 (9). The graphed observations of the Montreal Centre of the R.A.S.C. in 1960-61 indicate a value of about k = 0.4 for this point, roughly similar to the writer's findings (10). However, the same group detected no "cross-over point" in 1962 - with one exception, the observed values fell below the predicted curve (10)! Finally, simulated phase observation experiments by the Amateur Astronomers Association in New York indicate an observed-predicted equality between k = 0.305 and 0.406, this result, presumably, due to psychological factors alone (2). The uncertainty of the "cross-over point" is just one example of the uncertainty of Venus phase estimates. Whether the differences between observers are due to "personal equation" or whether the Venus phase discrepancy changes from apparition to apparition is not clear, but it is clear that more research is needed on the subject.

Two observational biases were noted. First, it was much easier to estimate the apparent phase near dichotomy than at other times because the differnece between a slight curve and a straight line is much more visible than the difference between two slightly different curves. Second, phases tended to be easier to estimate as the phase decreased, due to the increasing angular diameter of the planet.

Estimation of Apparent Dichotomy

The writer estimated the date of apparent Cytherean dichotomy by fitting a least squares curve to the 11 observations nearest the date of apparent dichotomy. The line of best fit is described by the equation:

$$(4) \qquad k_o = 0.715 - 0.00252\ x,$$

where x = J.D. of observation - 2,438,400.

Solving for k_o = 0.500, the date of apparent dichotomy was found to be J.D. 2,438,485.1,

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*The form of the equations for a and b given here assumes that all of the observational error is in y, in this application all in the observed phase and nothing in the time. --Editor or March 30.6, 1964. The average error of one observation was ±3.0 days, and the average error of the dichotomy estimate was ±0.9 days. It is clear that the use of least squares on a number of observations allows a more accurate determination than any one observation alone.

The resulting date of dichotomy occurred 12.4 days before the predicted, giving an angular observed minus computed difference of + 7°.6 in the phase angle i, and an observed minus computed phase difference of -0.066 in quantity k.

The differences observed exceed those considered typical for the planet. Whether this is due to the observational error of a beginning student of Venus, or whether the Spring, 1964, apparition was unusual can best be decided by comparison with other phase observations during this apparition (see next section of this paper). At any rate, the method of least squares should prove a valuable tool in the hands of more experienced observers of Venus.

The Estimation of Personal Equation by Lunar Phase Observations

The question remains as to how much of the phase discrepancy of Venus was due to personal equation and how much was attributable to the planet itself. To help resolve this question, the writer made some 30 estimates of the phase of the moon. A 10-power hand telescope, of 0.4-inch aperture was used, giving an image of the moon roughly comparable in brightness and size to that of Venus in the larger instrument. (See Appendix A).

It was found that the observed versus computed phase curves of the moon and Venus are roughly similar. This result suggests that subjective and instrumental factors play a large role in the phase discrepancy. In detail, however, the curves for the two bodies differ. The "cross-over point" for Venus was about $k_o = k_c = 0.44$, while that for the moon was about $k = 0.48$. The apparent dichotomy for the moon differed only slightly from the predicted. In addition, phase estimates for the crescent lunar phase were always less than predicted; such was not the case for Venus, where the crescent phase estimates roughly agreed with the predicted ones.

Conclusion

Apparently, much of the phase discrepancy of Venus is attributable to personal and instrumental errors. Nonetheless, at least part of the observed versus predicted phase difference is peculiar to the physical nature of the planet itself. More research into the psychology of phase estimation is obviously needed to find the actual value of the Venus phase discrepancy and also to determine if this effect varies from apparition to apparition. Furthermore, each observer has his own personal equation.

A Method of Determining the Date of Dichotomy and Some Results of Dichotomy Estimates on Venus, March-April, 1964

By: Dale P. Cruikshank

An effort has been made to minimize the difficulties caused by seeing or an optically poor image of Venus as seen in the telescope when estimating the date of dichotomy. Alan Binder has suggested a method wherein observers estimate the "probability" or likelihood that the Venus terminator is concave, straight (indicating dichotomy), or convex on a scale of 0 to 1 in 0.1 unit intervals. The total of the three estimated probability numbers must equal 1.0. For example, several days before dichotomy the observer might be uncertain about the actual curvature of the Venus terminator because of seeing or an otherwise poor image. His uncertainty would lead him to estimate that the probability of a gibbous terminator is 0.8 but that there is a certain likelihood (say 0.2) that it could be straight. The probability of a crescent shape is considered to be zero. Thus, this method allows the observer to integrate over his poor observing conditions and to make a sort of quantitative estimate of the phase.

To be sure, a single observation of this sort is of no use. But, if the same observer using the same telescope, magnification, and filter, if any, and observing at about the same time of day each time makes five or more probability estimates on either side of dichotomy, a plot of his observations can yield his actual date of observed dichotomy and a good value for his probable error. Figure 21 shows such a plot made from the observations of Charles L. Ricker during the evening apparition in the Spring of 1964. Ricker used a 6-inch telescope with a magnification of 200X and found dichotomy to occur on April 2.7 ± 1.7 days, 1964. To determine his observational error, we note the positions of the cross-over points of the gibbous and dichotomy curves on one side of dichotomy, and of the crescent and dichotomy curves on the other side. For convenience the magnitude of the errors is taken as two-thirds of their values obtained from the cross-over points.

The accuracy of an observer's series of observations can also be estimated on the basis of the shape of the curves drawn through his points. Furthermore, the errors should not be the same on each side of dichotomy; the error on the superior conjunction side should be about 1.3 times the error on the other side because of the differing rate of change of the phase of the planet. It is for these several reasons that this probability estimate method of dichotomy determination is superior to simply waiting until the terminator looks straight and then recording dichotomy.

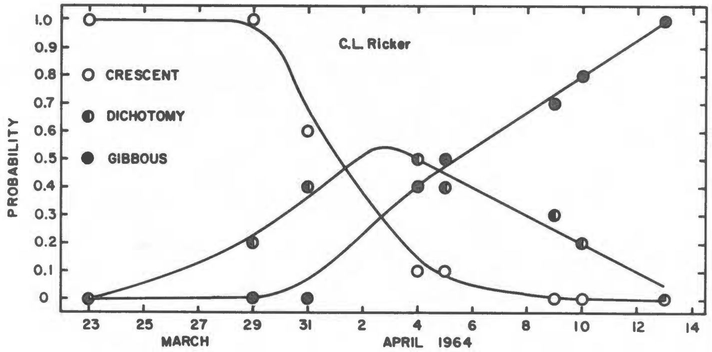

Figure 21. Observations by C. L. Ricker of the dichotomy of Venus in March-April, 1964, using Mr. Alan Binder's method of probability estimates. See also discussion by Dale P. Cruikshank in accompanying text.

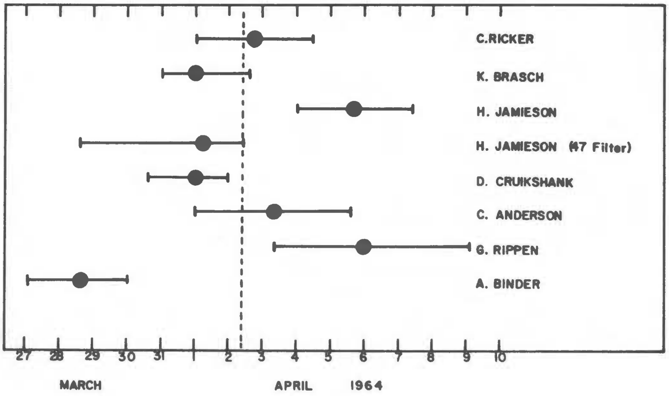

Figure 22. Determinations of observed dichotomy of Venus by seven A.L.P.O. observers in March-April, 1964. The circles give the date determined by means of Binder's method of probability estimates. The lines left and right of each circle give the error of this determination. See also discussion by Dale P. Cruikshank in accompanying text.

Seven observers contributed 8 determinations of dichotomy using this method during the evening eastern apparition of Venus in the Spring of 1964. Their determinations with the indicated errors are given in Figure 22. The vertical dotted line on Figure 22 is the average value of all determinations weighted according to the individual errors. The total scatter of the determinations is 9.3 days; and if we include the errors, it is about 13.1 days. That this scatter occurs indicates that not all of the three factors noted before have been eliminated. We have, however, nearly eliminated the scatter from the determination of dichotomy in bad seeing. We have also reduced the scatter because of bias by the observer; it is much harder to bias uniformly a large number of observations than to bias a single dichotomy determination (assuming conformity to the elementary norms of honesty on the part of observers).

The terminator of Venus is dim, and a dim telescopic image will show the terminator more concave than it should be. With low magnifications on small telescopes (giving a bright image) the terminator will appear to be more gibbous because of greater irradiation. This effect of image brightness is clearly shown in the observations plotted in Figure 22. The two latest estimates in time were made by Jamieson (no filter) and Rippen. Jamieson used about 25 power per inch of aperture, and Rippen most often used only 10 per inch. This made their images bright, and irradiation caused them to judge the terminator systematically too gibbous. All other observers used powers from 31 to 44 per inch of aperture, which is still less than the optimum for observing the bright image of Venus. Jamieson made one set of determinations with a dense violet filter which reduced the brightness of his image and in this set found a date for dichotomy agreeing well with those of the other observers.

Another effect is shown by Rippen's observations. With a small image (56X on a 6-inch telescope) it is more difficult to determine the shape of the terminator. This difficulty is reflected in the large error in Rippen's determination. We may infer from this and from other evidence that there is a lower limit to the magnification per inch of aperture (and hence the aperture) with which accurate phase estimates can be made. For phase estimates one should use about 65X per inch of aperture, but this is so high as to give poor images with most telescopes and ordinary seeing conditions. Nonetheless, not less than about 40X per inch should be used. If a bad image results, the method described here will help correct for the uncertainties.

Final Notes

The date of observed dichotomy at the 1964 evening apparition is April 2.4, and the predicted date is April 12.0. The magnitude of the difference, or the Schroeter Effect, is therefore 9.6 days, a bit larger than the average found by Hartmann.

This method is also useful in the case of Mercury, but probability estimates must then be made at least every day because of the very rapid phase changes of Mercury near dichotomy.

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Appendix A (Westfall)

Somewhat more comparable results can be expected if the sizes and the brightnesses of the moon and Venus are made as nearly equal as possible. The aperture and magnification ratios for the two bodies necessary to satisfy these criteria can be computed as follows:

Let: s = semidiameter of Venus
S = semidiameter of the moon
d = aperture of telescope used for Venus
D = aperture of telescope used for the moon
m = magnification used for Venus
M = magnification used for the moon
a = albedo of Venus = 0.59
A = albedo of the moon = 0.07
r = distance of Venus from the Sun in astronomical units = 0.723
R = distance of the moon from the Sun in astronomical units = 1.000
i = relative image brightness of Venus
I = relative image brightness of the moon.

Then, to achieve equal image size:

$$(1)\qquad M = m\,\frac{s}{S};$$

and, for equal image brightness:

$$(2)\qquad D = d\,\frac{M}{m}\,(i/I)^{\frac{1}{2}},$$

where:

$$(3)\qquad i/I = \frac{a}{A}\,(R/r)^2,$$

giving:

$$(4)\qquad D = d\,\frac{M}{m}\,\frac{R}{r}\,(a/A)^{\frac{1}{2}}.$$

Inserting the proper values for r, R, A, and a, (4) reduces to:

$$(5)\qquad D = 4.0\,d\,\frac{M}{m}.$$

Combining (5) with (1) yields:

$$(6)\qquad D = 4.0\,d\,\frac{s}{S}.$$

If the ratios of aperture and magnification satisfy equations (1) and (6), both image size and image brightness of the moon, on the average (i.e., disregarding the effect of lunar topography), will be similar to those of Venus.

MARS OBSERVATIONS, 1964-1965

By: Alan Binder

Introduction

Due to the large inclination (about 22°) of the north pole of Mars towards the earth during the 1964 - 1965 apparition, the northern maria and deserts of Mars were well placed for study. Since summer for the northern hemisphere began on March 31, 1965 a few weeks after opposition on March 9, the dark markings were well developed and contrast between them and the deserts was at a maximum. However, these two favorable circumstances were somewhat offset by the small apparent angular diameter of Mars (14".00 at maximum).

During the period between December 6, 1964 and May 5, 1965, I was able to make 66 observations of Mars with a 4.15-inch, F/22.5 Dall-Kirkham reflector. The observations were made using an 8 mm. orthoscopic ocular which gave 300X. The objective of these observations was to continue a program started during the 1962-63 apparition of Mars (Binder, 1963, p. 217). In view of this continuing program, this report includes not only results obtained during this apparition but also a comparison of these results with those obtained during the preceding apparition.

North Polar Cap

Figure 23 shows the decrease in apparent diameter of the North Polar Cap as a function of heliocentric longitude (λ). Points obtained during 1962-63 are indicated by open circles and show the shrinking of the cap during the Martian spring (northern spring begins at λ = 87°, and northern summer begins at λ = 177°). The 1964-65 data, represented by dark dots, show the size of the cap from midspring to early summer. Where the curves overlap in time, they both have the same shape. The shapes of these two curves are in excellent agreement with similar ones for both the northern and southern caps (de Vaucouleurs, 1953, p. 295; Slipher, 1962, pp. 19-20). Though the curves would show that the cap was larger during this apparition than the last, this apparent difference in size may be due to the effects of using a different telescope and a different magnification for the two sets of observations.

As shown in an earlier report (Binder, 1963, p. 217), small scale periodic irregularities in the recession curve of the polar cap can be used to find the shape and offset of the cap with respect to the areographic north pole. Figure 24 gives the results from both apparitions for direct comparison. The outer curve shows the cap at λ = 135° during 1963. The inner curve represents the cap at λ = 150° during 1965. This difference in λ represents a 32-Martian-day advancement of the northern spring. Even though the second curve is necessarily smaller than the first, their shapes are remarkably similar considering the method of determination. Since the wasting of the cap was more advanced for the second curve, it is to be expected that the shape of the cap would be somewhat different due to different rates of retreat along different portions of the cap's edge. The center of the cap found for this apparition is at 89° N. latitude and 290° longitude. This position is the same as given by Lowell (1911, pp. 68-69) and is very close to the position obtained from the 1962-63 apparition (88.5°N. latitude, 320° longitude).

Surface Features

Figure 25 shows the appearance of Mars during the 1964-65 apparition, which occurred during late spring in the northern hemisphere! While the features in the north were well exposed, those in the southern hemisphere were greatly foreshortened, especially M. Sirenum, M. Cimmerium, & M.Tyrrhenum. Due to the time of the Martian year, the northern deserts were filled with faint markings; and the Utopia-Umbra area and Mare Acidalium were well developed. A comparison of Figure 25 with Figure 1 in the earlier report (Binder, 1963, p. 218) shows these seasonal changes quite well; the latter figure represents Mars during the northern midspring.

Clouds and Haze

Observations made of clouds and haze arcs are tabulated in Table 1 at the end of this paper. The classification is as follows: 1) Morning Clouds - well defined, white clouds on the morning side of the planet, 2) Evening clouds - well defined, white clouds on the evening side of the planet, 3) Morning haze - ill-defined, whitish arcs on the morning edge of the planet, 4) Evening haze - ill-defined, whitish arcs on the evening edge of the planet, 5) North polar haze - ill-defined, whitish haze over the north polar area.

A comparison of Table 1 with similar data tabulated in the 1963 article indicates that nearly twice as many atmospheric phenomena were observed during this apparition as during the preceding one. It is doubtful that this increase is due to an instrumental effect. The increased cloudiness is probably due to the increased amount of Martian atmospheric moisture, which is a result of the more advanced state of polar cap wasting for this apparition than for the last one. It is to be noted that the greatest increase is found for morning and evening haze arcs, which are general atmospheric phenomena and reflect the amount of atmospheric moisture.

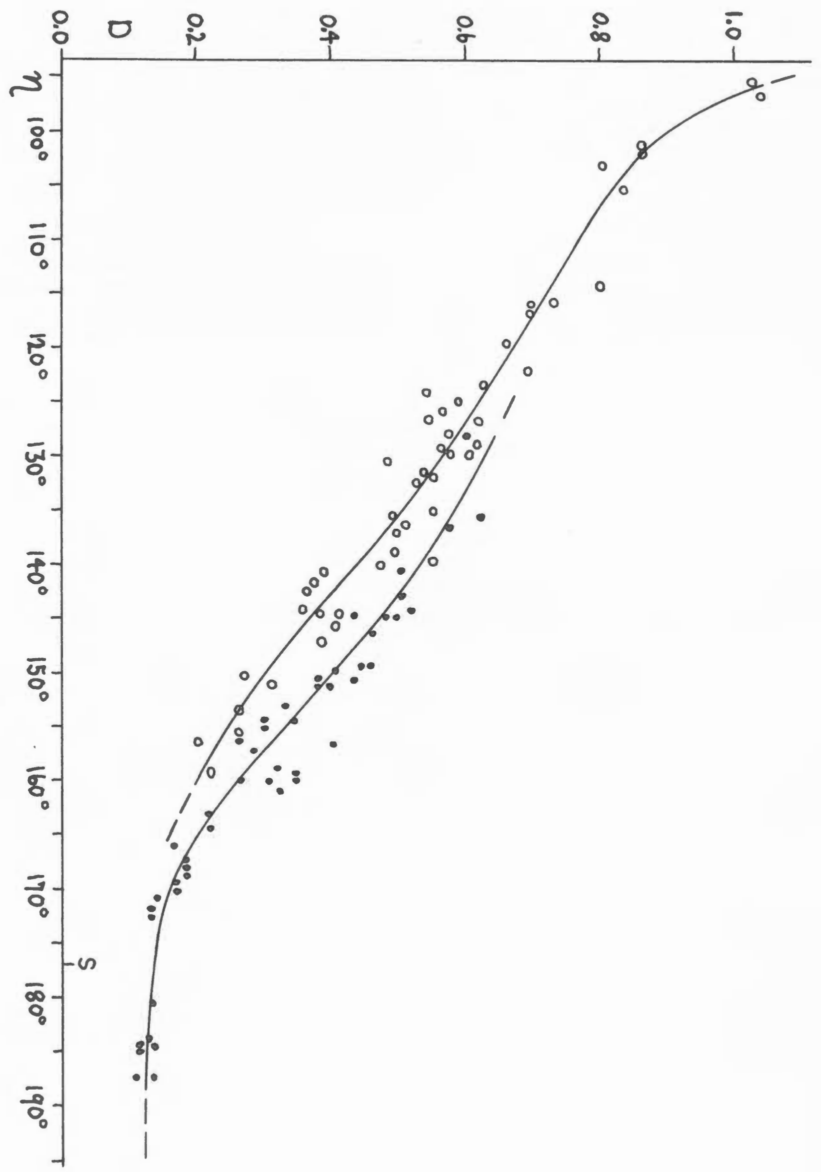

Figure 23. Decrease in the diameter of the North Polar Cap of Mars as a function of heliocentric longitude (η). Open circles represent data from the 1962-63 apparition, and dark dots represent data from the 1964-65 apparition. Spring for the northern hemisphere begins at $\eta = 87°$, and summer begins at $\eta = 177°$. The observed diameter (D) of the cap is given in terms of the apparent radius of the planet as the unit. To convert the diameter of the cap into areocentric degrees $(\frac{\theta}{2})$, the equation, $\sin(\frac{\theta}{2}) = \frac{D}{2}$, may be used. See also text.

Table 1 shows that about twice as many morning haze arcs were observed as evening haze arcs. This difference is probably due to the fact that the temperature on the evening side of the planet is higher than on the morning side (de Vaucouleurs, 1953, pp. 172-183).

As was the case during the 1962-63 apparition, discrete clouds were again found to be associated with dark areas almost every time that they were observed. Figure 26 shows the positions of such clouds which were observed during this apparition. It is to be noted that the clouds almost never obscure dark markings but that they are contiguous to, or close to, them. Observations show that a cloud precedes the dark marking if it is an evening cloud and follows the dark marking onto the disk if it is a morning cloud.

Almost every observation made when the Syrtis Major was close to either the morning or evening edge of the planet showed a cloud associated with it. This was also the case during the previous apparition. On the other hand, Mare Acidalium was devoid of any cloud activity at this apparition; this result is opposite to the 1962-63 results (Binder, 1963, p. 219).

On one occasion a morning cloud, which was following the Syrtis Major, was observed gradually to get smaller as it came farther and farther onto the disk. When the cloud finally dissipated, it was about 2½ hours from the sunrise point.

From Figure 26 and Table 1 it is to be noted that similar clouds reformed in about the same place for several days in a row. An excellent example of this behavior occurred on February 14, 15, and 16, 1965; morning clouds were observed following the Syrtis Major and covering the southern part of Aeria on these dates. Similarly, on April 20 and 22, 1965, discrete clouds were seen over Hellas when it was close to the evening limb. On April 24 and 25, 1965, Hellas was farther from the limb than on the two earlier dates, and it was covered by a light white "cloud". However, for the last two observations no well defined cloud was seen; and since the South Polar Cap was forming to the south of Hellas, Hellas may have been covered by haze associated with the south polar region. As Hellas approached the evening side of the planet, this haze may have condensed into a well-defined cloud.

On several occasions between April 20 and May 5, 1965, when the North Polar Cap was very small, the areas around the north pole appeared to be covered by an ill-defined cloud or haze. At times this aspect was most probably due to bad seeing which spread the small image of the cap. However, the correlation between seeing and the appearance of the haze is not convincing enough to exclude the possibility that haze layers did occur during this period.

Possible Large Nocturnal Frost Deposits

On January 29 and 30 and on April 12, 1965, a very large area (the diameter of the area was about ¼ that of the disk), approximately centered on the Tithonius Lacus area, was observed to be brighter than the rest of the desert in the vicinity. During these three observations the area of concern was on the morning side of the central meridian, and the area was back to the appearance of "normal" desert well before local noon. While these characteristics vaguely suggest that the phenomena were unusually large morning haze patches, it is possible that the patches were frost which was deposited on the ground during the night. The climatic conditions were favorable for this explanation. Mars passed aphelion ($\eta = 155°$) on February 6, 1965, and the sub-solar point at local noon was more than 20° north of the area. Thus, the area in question would be at about its lowest maximum temperature for the Martian year. The noon temperature would be several degrees below 0°C (de Vaucouleurs, 1953, p. 291). As was pointed out above, a maximum amount of atmospheric moisture was available at that time. Thus, a frost deposit could have formed during the night, and the low morning temperatures would have allowed the frost to persist far into the morning.

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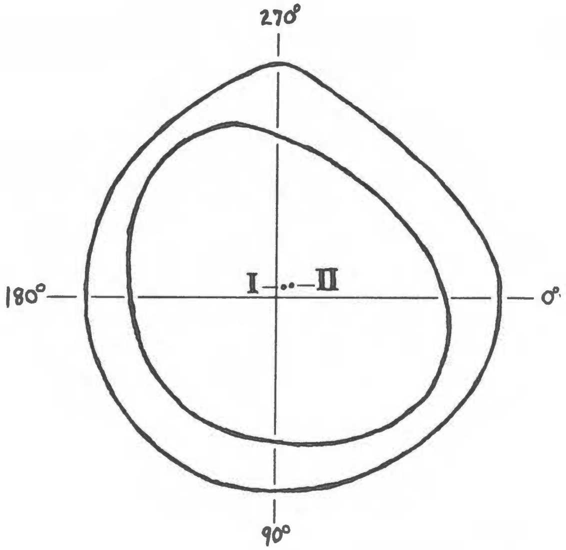

Figure 24. The shape of the North Polar Cap as determined from data obtained during the 1962-63 and 1964-65 apparitions of Mars. The outer curve represents the cap at η = 135°, from observations made in 1962-63. The inner curve represents the cap at η = 150°, from observations made in 1964-65. The light circles represent north latitudes 75° and 78°. The centers of the inner and outer curves are indicated by dots I and II respectively. Also, see text.

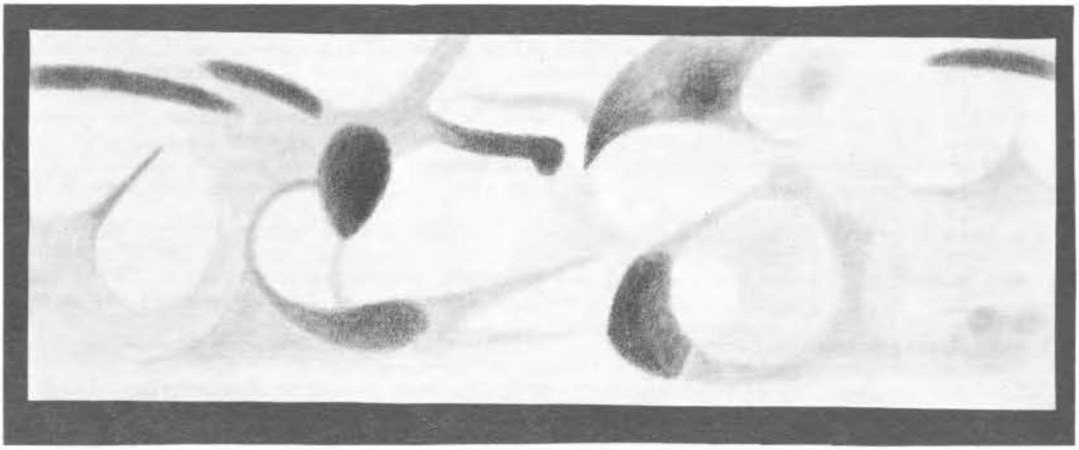

Figure 25. The generalized appearance of Mars for the 1964-65 apparition. The map represents the planet during late spring in the northern hemisphere. Also, see text.

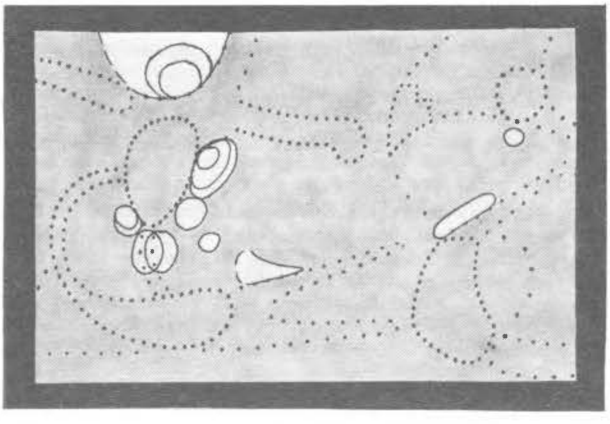

Figure 26. Positions of morning and evening clouds observed by Alan Binder during the 1964-65 apparition of Mars. The white areas may represent more than one cloud, if the clouds were about the same size and occurred in the same position. Also, see Table 1 and the text.

Table 1. Clouds on Mars.

Date 1965	Time U.T.	η	C.M.	MC	EC	MH	EH	NPH	Associated with
Jan. 11	08:40	143°6	228°	x					Syrtis Major
13	10:20	144.6	233	x					Syrtis Major
23	07:40	148.8	103		x				Xanthe
29	09:45	151.4	78			x			
Feb. 4	08:15	154.1	2			x			
4	08:15	154.1	2				x		
5	07:45	154.4	345			x			
5	07:45	154.4	345				x		
5	10:30	154.4	26			x			
14	06:45	158.4	250	x					Syrtis Major
15	06:55	158.9	244	x					Syrtis Major
16	07:25	159.3	243	x					Syrtis Major
16	08:40	159.3	261	x					Syrtis Major
20	07:50	161.0	213			x			
24	08:20	162.8	186			x			
24	08:20	162.8	186				x		
27	07:40	163.9	150			x			
27	07:40	163.9	150				x		
Mar. 4	07:55	166.3	110			x			
4	07:55	166.3	110				x		
8	09:10	168.0	93		x				Niliacus Lacus
8	09:10	168.0	93			x			
12	06:45	169.8	23		x				Aeria
12	08:25	169.8	48			x			
15	07:10	171.1	4			x			
15	07:10	171.1	4		x				Protonilus
17	07:10	172.0	346			x			
18	08:15	172.4	353		x				Syrtis Major
18	08:15	172.4	353			x			
19	05:40	172.9	306			x			
19	05:40	172.9	306				x		
20	05:05	173.3	289			x			
24	04:50	175.1	250	x					Syrtis Major
Apr. 6	04:00	180.9	113				x		
13	05:25	184.0	81				x		
20	02:30	187.1	335		x				Hellas
20	03:30	187.1	350		x				Syrtis Major
21	02:25	187.6	325		x				Hellas
21	02:25	187.6	325		x				Syrtis Major
21	02:25	187.6	325					x	
22	02:25	188.0	316		x				Hellas
22	02:25	188.0	316					x	
22	02:25	188.0	316		x				Syrtis Major
24	03:50	188.9	319		x				Hellas
24	03:50	188.9	319					x	
May 1	05:30	192.1	279					x	

MC - Morning Cloud, EC - Evening Cloud, MH - Morning Haze, EH - Evening Haze, NPH - North Polar Haze.

Postscript by Editor. Mr. Binder's article above is not intended as in any sense the final A.L.P.O. report on the 1964-5 apparition of the Red Planet. It appears well, however, to publish something of this kind early and while the apparition is still fresh in the minds of the observers. Mr. Brasch's work in compiling the report of all A.L.P.O. efforts will be helped and will become more significant as more of our members observe as intensively and as purposefully as Mr. Binder has done.

The formula in the caption of Figure 23 would show that Mr. Binder did not correct the computed size of the North Polar Cap for the tilt of the axis of Mars. Since the northern tilt of the axis was greater in 1964-5 than in 1962 -63, the cap would have looked a little larger in 1964-65 from this cause, though I have not determined by how much. Another physical effect on the measured size of a polar cap comes from the phase of the planet.

In Table 1 it is evident that morning cloud phenomena were more common before opposition on March 9 and hence when the morning edge of the planet was the limb. Likewise, evening clouds and haze were more common after opposition when the evening edge became the limb. One suspects some kind of optical effect in the detectability of clouds, which refined studies may need to take into account.

We thank our contributor for an exemplary report of what can be accomplished with a very modest aperture.

BOOK REVIEWS

Mondatlas, by Philipp Fauth. Olbers-Gesellschaft (Bremen, West Germany), 1964. Price $12.50. 38 pp. illustrated text, 6-sheet nomenclature map, 22-sheet large scale map.

Reviewed by Charles A. Wood

After 55 years of observation and 25 years of delay, Philipp Fauth's large map of the moon has been published. The Mondatlas is in three parts. A six-sheet nomenclature chart (Uebersichtskarte) at a scale of 1:4,000,000 shows topographic features in black with nomenclature overprinted in red, creating a not completely pleasing or readable effect. This map contains mostly the designations of the Blagg, Mueller, and Wesley International Astronomical Union map of 1935 but is more accurate and less ambiguous. Fauth added a few names, such as Mare Horologii-the Sea of Clocks, which later selenographers have understandably neglected. This is an excellent map; and had it had a more catholic distribution in the thirties, perhaps much of the useless mapping and tampering with nomenclature in later years would not have occurred.

The second part of this publication is a 38-page booklet (in German) containing a biography of Fauth by his son (a summary of which appeared in Sky & Telescope, Nov. 1959, pp. 20-24), an excerpt from Fauth's prodigious Unser Mond, and a short description of the principal features in each of the 25 map sections.

The most important part of this publication is the "grosse mondkarte" itself. Its scale of 1:1,000,000 (the same scale as the Air Force ACIC charts) gives a lunar diameter of 11½ feet, and each of the 22 sheets (4 "corner" sections are on one sheet) is 32" by 33". The sheets are too large to be used at the telescope so that comparison with the moon must be made via a good memory or a sketch. The map relies on more than 4800 positions accurately determined mostly by Saunder and Franz and on many more points fixed by interpolation on photographs. The map is thus based on more fiducial points than any other lunar map (except for the recent Lunar and Planetary Laboratory and ACIC charts); yet positional errors occur. For example, an 8-mile crater between Tannerus and Tannerus C is out of position by nearly its own diameter. Relief is indicated by contour lines which do not represent absolute altitudes but rather arbitrary and variable elevation differences so that it is difficult to distinguish between prominent and minor detail. For example, about 40 ridges and hills are drawn equally prominent on the floor of Copernicus; yet in reality only a few major masses compose the central peak complex, and the other hills are much less conspicuous. Similarly, the central peak of Alphonsus is lost in the intricate representation of the low diametric ridge; and isolated peaks, such as Pico, disappear in the mare ridge system. Occasionally it is impossible to tell the difference between elevations and depressions. Fauth's observations were made with apertures up to 15½", but occasional detail is nontheless misdrawn, as the following:

The rille in Plato is grossly exaggerated in width and length, and the craterlets on Plato's floor are about 25% too large.

The conspicuous central peaks of Timaeus, Scoresby, Asclepi, and Helmholtz D are omitted. The central peak of Baco A is greatly out of place.

A 5-mile crater east (old directions) of Autolycus, and 2 large rings south of Mercurius do not exist.

Galvani is much too small, and the major detail between Repsold and Lavoisier is generally out of drawing and frequently dissimilar to reality.

Linné is drawn as a 5 mile crater!

Numerous small well defined 1-3-mile craters are missing, and frequently the representation as far as 25° from the limb is very stylized and inaccurate.

A test of the thoroughness of a mapmaker is to compare overlapping areas of adjacent sheets. A cursory check revealed an inconsistent overlap between sheets 22 and 23, and differences in the area between Demonax and Boguslawsky on sheets 23 and 24.

The purpose of most lunar maps is twofold - to represent detail accurately and to designate it unambiguously. Although Fauth's Uebersichtskarte generally indicates nomenclature clearly, the larger map does not. On sheet 15 the craters labeled Scoresby, Main, Gioia (sic), Shackleton, and Challis are misidentified. The Uebersichtskarte gives the correct nomenclature. The rule for the placement of letters for craters designated after named craters (e.g. Rosse C is a small crater near Rosse) is not followed so that in many cases a letter is placed enigmatically between two named formations. Furthermore, the Mondatlas contains at least one name introduced by Lamèch (Vally on sheet 11), and many of the Wilkins and Moore designations, none of which was given in accord with the sound nomenclatural principles expounded by Blagg and Saunder in the early part of this century. It has long been realized that the IAU nomenclature of 1935 is frequently hopelessly confused; and the name additions of Lamèch, Wilkins, and Moore have not improved it. Work is now in progress to provide unambiguous, official designations (Sky and Telescope, Dec., 1964, p. 342).

Had this map appeared 50, or even 25, years ago, it would have aroused much interest; and many amateurs would have published drawings confirming or questioning the existence of a particular rille or crater. Today the exquisite Lick 120" photographs, ACIC charts, and Ranger records lessen the value of any previous lunar map. The Fauth map is not esthetically pleasing. It is inconvenient to use and shares the inaccuracies of the maps it hoped to transcend. It will make no impact on modern lunar science; however, historians of lunar studies owe Hermann Fauth their thanks for making available this document.

Principles of Physical Geography, by F. J. Monkhouse. Philosophical Library, New York, 1964. 511 pp., Illustrated, $10.00.

Reviewed by J. Russell Smith

The author of this well-balanced textbook is professor of geography in the University of Southampton, England. In 21 chapters all phases of physical geography are covered. A clear and understandable account of each of the following topics is given: The Materials of the Earth's Crust, The Structure of the Earth, Vulcanicity, The Sculpturing of the Earth's Surface, Underground Water, Rivers and River Systems, Lakes, Glaciation, The Desert Lands, Coastlines, A Classification of Land-Forms, The Configuration of the Oceans and Seas, The Waters of the Oceans, Climate: General Features, Temperature, Pressure and Winds, Humidity and Precipitation, Climatic Types, The Soil, Vegetation, and The Vegetation of the British Isles.

The book is well illustrated with 171 maps and diagrams as well as with 98 excellent plates. A complete index makes this a ready reference for anyone interested in the various aspects of man's physical environment. Here's a book recommended to anyone interested in this field.

ANNOUNCEMENTS

Staff Changes. Our Lunar Dome Survey has reached the place where Harry Jamieson has requested an assistant. We have hence added as a new Lunar Recorder with such an assignment:

Reverend Kenneth J. Delano
22 Ingell St.
Taunton, Massachusetts

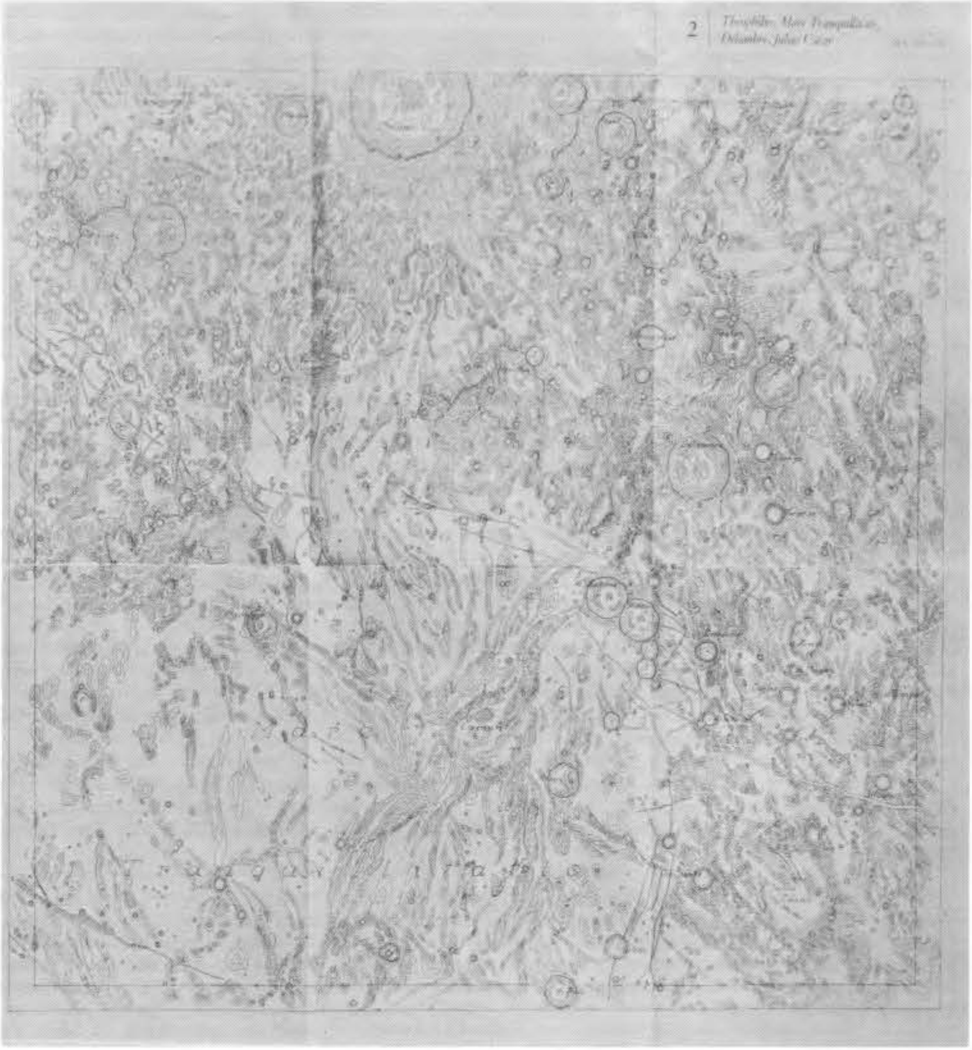

Figure 27. Sample lunar map section from the Philipp Fauth Mondatlas. See also review by Charles Wood on pp. 237-238.

Reverend Delano's name and lunar and planetary work will already be familiar to many of our readers. We appreciate his accepting new duties in guiding our lunar programs.

The Saturn Section has been reorganized as follows:

Recorder - Thomas A. Cragg
Mount Wilson Observatory
Mount Wilson, California

Assistant Recorder - Larry C. Bornhurst
165 Coral View
Monterey Park, California

Mr. Cragg certainly needs no introduction to our readers and has served as Saturn Recorder in the past. Mr. Bornhurst is well known to active West Coast amateurs. Both men are on the staff of the new Ford Observatory on Mt. Peltier in southern California, in the same general area as the Mount Wilson Observatory and J.P.L.'s Table Mountain Observatory. In fact, Thomas Cragg is the Director of the Ford Observatory.

All current 1965-6 Saturn observations should be mailed to Mr. Bornhurst at the address given above. We urge members to do so promptly, at least once a month; the potential value of observations is often greatly reduced by delays in reporting them. Any observations of Saturn during its 1964-5 apparition which have not been reported should be sent in <u>at once</u> to:

Dr. Joel W. Goodman
Dept. of Microbiology
University of California School of Medicine
San Francisco 22, California

We must regret that Dr. Joel Goodman has felt unable to continue as Saturn Recorder. We express to him our thanks for his considerable services during his years on the Saturn staff. His reports on the Ringed Planet were models of good writing and scientifically accurate reporting of amateur observational data. We hope that he will continue to participate in our Saturn programs as his time and professional duties permit.

<u>New Address for Klaus R. Brasch</u>. All correspondence with the A.L.P.O. Mars Recorder should now be directed to:

3105 Rue Germain
Fabreville, Quebec, Canada

Observers who have not yet sent Mr. Brasch all their work on the 1964-5 apparition of Mars are asked to do so <u>at once</u>.

<u>Sustaining Members and Sponsors</u>. As of July 10, 1965, we have in these special classes the following persons:

Sponsors - William O. Roberts, David P. Barcroft, Grace A. Fox, Philip and Virginia Glaser, Charles H. Giffen, John E. Westfall, Joel W. Goodman, the National Amateur Astronomers, Inc., James Q. Gant, Jr., David and Carolyn Meisel, Clark R. Chapman, Ken Thomson, Kenneth J. Delano.

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We are much obliged to all these colleagues for their loyalty and truly helpful financial aid. Sponsors pay $25.00 per year; Sustaining Members, $10.00 per year. The balance above the regular rate is used to support the work and activities of the A.L.P.O.

<u>Where Should the A.L.P.O. Meet in 1966</u>? The site of our 1966 Convention was discussed at our recent Convention in Milwaukee, but no final decision was reached. We have received a gracious invitation from the Astronomical League to meet with them at Miami over the July 4, 1966 holiday weekend. We have a standing invitation from the Western Amateur Astronomers to meet with them any year. We understand that their 1966 Convention is expected to be near San Francisco in late August.

We must reach a decision soon. <u>It will be helpful if interested readers will send us a postcard or a brief letter to express their preferences on this subject</u>. The wishes of those who would expect to attend at either place, Miami or near San Francisco, will be especially useful, still more the wishes of those who can give papers for the program or may contribute to the Exhibits display. May we hope to hear from you?

<u>Lunar Transient Phenomena and Collect Telephone Calls</u>. Readers of current astronomical writings will know of the considerable interest at the present time in "lunar transient phenomena." Some may know of the telephone network set up by NASA to achieve rapid

communications, critical to the confirmation and better study of abnormal lunar events. The Bradley Observatory at Atlanta is a member of this network. Mr. Leonard B. Abbey has offered to relay to A.L.P.O. members such information. Interested persons should write to Mr. Abbey at Box 22236, Emory University, Atlanta 22, Georgia and will have to agree to accept collect telephone calls from him whenever NASA uses the telephone network.

The Editor thinks that at the present time the A.L.P.O. has a valuable potential for lunar surveys of this kind because of the experienced and reliable lunar observers among our members. He would hence urge qualified persons to avail themselves of the service which Mr. Abbey is offering. The Editor would also like to see the A.L.P.O. set up at least a systematic visual patrol of a few selected areas. However, the response to the "Moon Look" note on pg. 208 of our last issue was so slight as to leave doubts about the worth of further planning of this kind. One may also expect that within a few years professional astronomers will be conducting such patrols with new, sophisticated, and very costly instrumentation.

Attention is also invited to Mrs. Winifred Cameron's article on pp. 2-3 of The Eyepiece, the monthly bulletin of the A.A.A. Observing Group, for June, 1965.

W.A.A. Convention. Readers in the Western States are reminded that the W.A.A. will meet at Reno on August 19-21, 1965. Further information can be obtained from Dr. O. Richard Norton, Desert Research Institute, University of Nevada, Reno, Nevada 89507. Plans now definitely include a cookout and a star party at Pyramid Lake on the evening of Friday, August 20. Convention headquarters will be the Fleischmann Atmospherium-Planetarium.

Availability of Plato Outline Charts. Mr. Clark Chapman reports that such lunar outlines are now available for Lunar Training Program trainees. The charts were contributed by Mr. Patrick McIntosh. It has been gratifying that a large number of A.L.P.O. members have enrolled in the Lunar Training Program. Members should realize, however, that close attention to the precepts laid down by Mr. Chapman and many hours of careful observing at the telescope are necessary if the program is to be as helpful as possible. Neither can Mr. Chapman reasonably be expected to answer questions in such a project about such distantly related subjects as making telescope mirrors, advanced and specialized lunar studies, and the philosophy of amateur of amateur observing. Learning is hard work; it also brings its own rewards.

THE PLANETS AND THE MOON IN AUGUST AND SEPTEMBER, 1965

By: Walter H. Haas, Editor

Mercury. The innermost known planet is at inferior conjunction on August 15, at greatest elongation west on September 2, and at superior conjunction on September 27. As usual, these dates are given by Universal Time. The planet may be visible in the telescope in the evening sky for a few days at the beginning of August. Otherwise, we have a favorable morning apparition in late August and early September, the most favorable morning one of the year in northern latitudes. The planet will be at perihelion on September 7 and thus near greatest elongation; the rapid motion in the orbit will make the period of possible observation shorter, but Mercury will also be brighter because closer to the sun. On September 8 at 3^h, U.T. Mercury will pass 0.7 degrees north of Regulus.

Observers are invited to make careful estimates of the phase for some days around dichotomy; here they should carefully follow the precepts set forth in the article "Some Studies of Phase Pertaining to Mercury and Venus" in this issue. It is strongly recommended that observers keep themselves unaware of the exact value of the phase while making this study. Psychological bias is a subtle thing!

The 59-day rotation for Mercury recently proposed on the basis of radar studies raises the need to reexamine practically all visual work on the planet. Visual periods rest upon the positions of features relative to the terminator; accordingly, we want drawings showing markings as accurately placed as possible. If the rotation is indeed accomplished in 59 days, then the features will move about six degrees of longitude per day relative to the mean terminator, a drift which in my opinion ought to be detectable after three to five days.

Venus. This planet will be its usual brilliant self in the evening sky throughout August and September, though the rather low tilt of the ecliptic to the horizon will make Venus lower in the sky at sunset than it usually is at the present phase. Some physical data are:

Date	Angular Diameter	K	Elongation from Sun
1965, Aug. 1	11″9	0.86	29° East
Aug. 15	12.7	.83	32
Sept. 1	13.8	.78	37
Sept. 15	15.0	.74	40
Oct. 1	16.6	.69	43

Here K is the percentage of the whole disc regarded as circular illuminated by the sun. On August 5 at 8^h, U.T. Venus will be 0.6 degrees north of Uranus.

The notorius difficulty of studying Venus hardly needs to be stressed here. Readers of this periodical are invited to pursue various projects described in recent issues by A.L.P.O. Venus Recorders. Among these are ultraviolet photography, intensive studies of the brightness and relative prominence of the north and south cusp-caps, similar studies of the bordering cusp-bands, careful comparisons of the observed phase with the geometric phase (again best conducted in such a way as to avoid possible bias from knowledge of the geometric phase), and investigations of the possible effect upon the appearance of Venus of standard color filters of known transmissions.

Mars. The Red Planet will still be fairly well placed in the evening sky but so remote from the earth as to show little detail in ordinary apertures. Large telescopes are recommended. Some physical data are:

Date	Angular Diameter	Tilt	Heliocentric Longitude η	CM at 0^h, U. T.
1965, Aug. 2	6″0	+24°	237°	27°
Aug. 16	5.7	+22	244	250
Aug. 30	5.4	+20	252	113
Sept. 13	5.2	+17	259	336
Sept. 27	5.0	+14	267	199

Thus the northern hemisphere is tipped toward the earth. The season is late summer in the northern hemisphere and late winter in the southern hemisphere. In fact, the vernal equinox of the southern hemisphere occurs on September 28, 1965. We may expect a large and brilliant south polar cap to be disclosed soon after this date. In the United States and Canada the longitudes of Mars photographed by the Mariner spacecraft on July 14, 1965 will be best presented near August 25 and again near September 30. It is urged that readers will get their best views by observing Mars early in the twilight, even before it is visible to the naked eye; the greater altitude above the horizon and the lessened irradiation will assist the visibility of the detail.

Jupiter. The Giant Planet is now well placed in the morning sky, reaching the meridian at 8:05 A.M. by local time on August 15 and at 6:21 A.M. on September 15. On August 24 near 21.7 hrs., U.T. Jupiter will occult the 7.5- magnitude star BD + 22° 1032 for observers in Australia, India, and elsewhere. This star a little earlier will have a close conjunction with Jupiter IV, and observers in the United States should watch carefully for a possible occultation of the star by satellite IV between about 9^h30^m and 10^h30^m, U.T. on August 24. The longitude of the Great Red Spot is now near 25° in System II. It will hence transit the C.M. of Jupiter near 10^h32^m on August 16, near 9^h36^m on September 2, and near 11^h10^m on September 16. Use the period of rotation of about $9^h55^m42^s$ to obtain other times as desired.

Jupiter offers much to the amateur observer. Observations during the 1964-5 apparition were disappointing in both quantity and quality, and we strongly urge better coverage of this ever-changing planet. Beginning students can obtain a most helpful Jupiter Handbook from either the Jupiter Recorder, Mr. Glaser, or the Editor for only 50¢.

Saturn. The Ringed Planet reaches opposition on September 6. On that date the Saturnicentric latitude of the earth is 4°3 N., and the Saturnicentric latitude of the sun is 4°2 N. The rings are thus approaching their 1966 edgewise presentation. Observers are requested to look carefully for the shadow of the ball on the rings within about two weeks of opposition, both before and after, and for the shadow of the rings on the ball just south of the rings throughout August and the first few days of September. Since these shadows possess maximum contrast and are of computable sizes, reliable observations of them in sufficient amounts can give basic information about the limits of telescopic resolution of planetary features. Other interesting observations of Saturn include drawings, photographs, color and intensity estimates of the various features, central meridian transits of available detail, and latitude measurements with various methods.

Special interest must attach to the eclipses, transits, and occultations to which the inner satellites are now subject. A detailed listing of these phenomena appears on pp. 42-45 of the 1965 Handbook of the British Astronomical Association, from which a few samples are given below. Others may be found by using the known periods of revolution of the satellites around Saturn. Before opposition satellites will disappear in eclipse and will reappear from occultation; after opposition they will disappear in occultation behind Saturn and will reappear from eclipse in its shadow. Attempted observations with various apertures of the transits of satellites and their shadows are much needed because of the lack of reliable observations about the visibility of such phenomena.

Date	Phenomenon	Beginning	Approximate Duration
1965, Aug. 10	Dione, eclipse-occultation	8^h13^m, U.T.	202 mins.
Aug. 13	Tethys, eclipse-occultation	10 54	176
Aug. 14	Dione, shadow transit	10 44	167
Aug. 14	Dione, transit	11 0	184
Aug. 18	Rhea, shadow transit	3 27	179
Aug. 18	Rhea, transit	3 44	167
Aug. 20	Rhea, eclipse-occultation	9 38	201
Aug. 25	Tethys, shadow transit	8 25	166
Aug. 25	Tethys, transit	8 33	162
Sept. 9	Dione, occultation-eclipse	10 37	200
Sept. 12	Tethys, occultation-eclipse	6 52	175
Sept. 13	Tethys, transit	5 30	157
Sept. 13	Tethys, shadow transit	5 33	166
Sept. 16	Dione, transit	7 0	164
Sept. 16	Dione, shadow transit	7 4	181
Sept. 21	Rhea, occultation-eclipse	0 41	210
Sept. 23	Rhea, transit	6 51	119
Sept. 23	Rhea, shadow transit	6 58	195

Uranus. Being in conjunction with the sun on September 8, this planet can scarcely be observed. The conjunction with Venus on August 5 has already been mentioned.

Neptune. This planet is visible in the evening sky during August and September. Some physical data follow:

Date	Right Ascension	Declination	Local Time Meridian Transit
1965, Aug. 15	$15^h1^m 24^s$	-15°19'	5:26 P.M.
Sept. 15	15 3 25	-15 29	3:26

A very close geocentric conjunction of Neptune and the moon at 1^h on September 1, U.T. might be an occultation at some stations (exact data not available). James Bartlett reports recently at least partially confirming Maxwell Hall's nineteenth century observation of a variation in the brightness of Neptune with a period of about 8 hours. Here is in truth an interesting project for possessors of very small telescopes, which may in fact be preferable for such a study. The procedure requires intensive observations (when possible, for several hours on each date) with the techniques familiar to variable star observers.

Moon. Those concerned with "lunar transient phenomena" will find Aristarchus and vicinity in sunlight from August 8 to August 23 and again from September 7 to September 22, U.T. dates. Intensive observations by a A.L.P.O. members near 3^h on August 9, 3^h on August 10, and 3^h on September 8 (U.T., of course) are suggested. Alphonsus will be in sunlight from August 5 to August 19 and from September 3 to September 18.

Double Saturnian Shadow Transits. Mr. Craig L. Johnson directs attention to two occasions in August for United States observers when two shadows will be simultaneously on the disc. On August 25 the shadow of Tethys will transit from 8^h25^m to 11^h8^m, U.T., and the shadow of Dione will begin to transit at 9^h30^m. On August 27th shadow of Rhea will transit from 4^h31^m to 7^h21^m, and the shadow of Tethys will transit from 5^h44^m to 8^h27^m. Let's all be watching!

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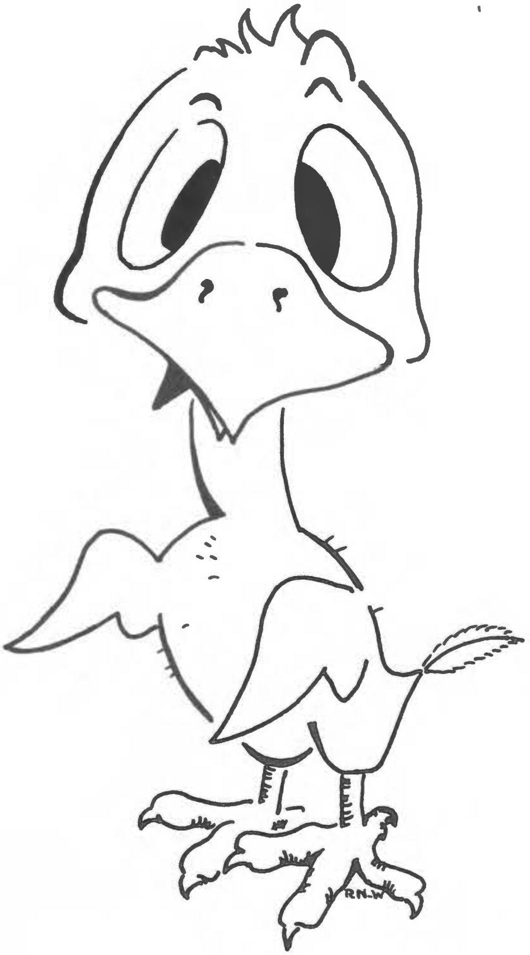
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