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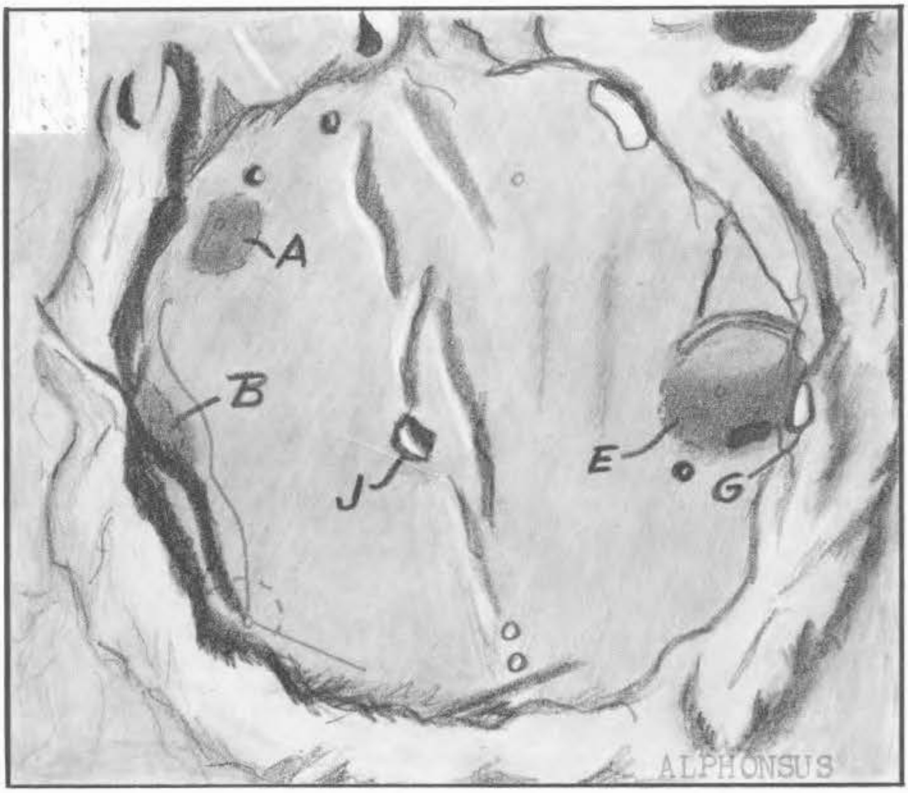

Drawing of the lunar crater Alphonsus by Inez N. Beck on July 4, 1968, 1 hr., 48 mins. to 2 hrs., 23 mins., Universal Time. 6-inch reflector, 152X. Seeing 8 (very good), transparency 5 (limiting magnitude). Lunar south at top, lunar east in IAU sense at left. Colongitude 12.8 degrees. The drawing shows the average morning appearance of Alphonsus. See report on Alphonsus by Christopher Vaucher on pages 60-68.

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IN THIS ISSUE

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THE 1971 APPARITION OF JUPITER

By: Paul K. Mackal, A.L.P.O. Jupiter Recorder

Approximately 400 observations of the Giant Planet were submitted to the Jupiter Section during 1971. Of these, 170 proved useful for the present qualitative report. Opposition was on May 23, 1971; conjunction occurred on December 10, 1971.

I. Inventory of Observers and Useful Observations Obtained in 1971

(1) James C. Bartlett, Jr.; Baltimore, Maryland; 4.25-inch reflector; 28 verbal reports. (2) Inez Beck; Wadsworth, Ohio; 6-inch reflector; 1 full disc drawing. (3) Phillip W. Budine; Willingboro, N. J. (W.A.S.); 4-inch refractor and 8-inch reflector; 4 full discs and 5 strip sketches. (4) Charles F. Capen; Lowell Observatory at Flagstaff, Arizona; 24-inch refractor and 12-inch refractor; 2 full discs and 6 ultraviolet photographs. (5) Ronald Doel; Willingboro, N. J. (W.A.S.); 10-inch reflector and 8-inch reflector; 7 full discs. (6) Prof. Jean Dragesco; Cameroums, Africa (Yaouudé); 26-cm. reflector (10-inches); 65 full discs and 19 black and white photographs. (7) Rae J. Ferreri; Brooklyn, New York City; 6-inch reflector; 2 full discs. (8) Prof. Walter H. Haas; Las Cruces, N. M.; 12.5-inch reflector; 12 verbal reports. (9) Alan W. Heath, F.R.A.S. (B.A.A.); Nottingham, U. K.; 12-inch reflector; 1 full disc and one intensity report. (10) Dr. Raymond Hide; H.M.M.O., Bracknell, U. K.; 2 papers. (11) Kevin L. Krisciunas; Naperville, Ill.; 6-inch reflector; 2 full discs. (12) Paul K. Mackal (B.A.A.); Mequon, Wisconsin; 6-inch reflector; 1 full disc and 2 strip sketches. (13) E. H. Mayer; Barberton, Ohio; 15.6-cm. reflector; 19 full discs. (14) Gary Meisner; Naperville, Ill.; 6-inch reflector; 2 full discs. (15) Dennis Milon; Harvard Observatory at Cambridge, Mass.; 9-inch refractor; 1 black and white photograph. (16) Patrick Moore, O.B.E. (B.A.A.); Sussex, U. K.; 12-inch reflector and 3-inch refractor; 2 full discs. (17) Mike Otis; Aberdeen, South Dakota; 8-inch reflector; 5 black and white photographs. (18) Elmer J. Reese; New Mexico State University Observatory at Las Cruces, N. M.; 24-inch reflector; 1 strip sketch. (19) H. A. Scholks; Saar, Germany; 4.5-inch reflector; 2 full discs. (20) Eric Thiede; Washburn Observatory at Madison, Wisconsin; 15.6-inch refractor; 1 full disc, 2 strip sketches, and 2 verbal reports. (21) Wynn K. Wacker; Washburn Observatory at Madison, Wisconsin; 15.6-inch refractor; 1 full disc and 1 strip sketch. (22) Richard J. Wessling; Milford, Ohio; 12.5-inch reflectors; 3 full discs.

II. Inventory of New Members in the A.L.P.O. Jupiter Section, 1971

Mr. Arpin, Montreal, Canada; Bruce Blundell, Jamaica, N. Y.; Tom Colligan, Port Washington, N. Y.; Jack Jones, Sheridan, Wyo.; Steve Kevan, McLean, Va.; D. Kluba, Cincinnati, Ohio; A. Haida, Brooklyn, N.Y.C.; George Manning, Brooklyn, N.Y.C.; J. L. Montani, Perth Amboy, N. J.; T. Mulligan, Jamaica, N. Y.; C. Roberts, Birmingham, Ala.; Béla Szentmártoni, Kaposvár, Hungary; and John F. Wharton, Willingboro, N. J. In particular, allow me to welcome the collective membership of the New York City Amateur Astronomers' Association.

III. Distribution of Useful Observations

1971 Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
8	4	2	4	26	27	31	31	6

1971 Oct.	Total
4	143

The average number of full discs (visual or photographic) per month was fourteen or nearly one disc every two days.

IV. The Qualitative Aspects of Jupiter in 1971

North Polar Region and North North Temperate Belt. The NPR was well extended southward and reached the latitude of the N.T.B., beginning in January. The N.N.T.B. was noticed first by Budine with its preceding end at 268° II on Jan. 16, '71. At 42° II a faint N.Te.Z. was observed by Budine on Jan. 17, '71, and also a very thin N.N.T.B. By April Mayer did not record an N.N.T.B. in the longitudes of the Red Spot. There was some indication of an indentation of the N.P.R., according to Mayer, on Apr. 17, '71, at 78° II.

A border belt to the N.P.R. was visible to Dragesco and Mayer in mid-May from 100° to 200° II. The N.N.T.B. was seen again in the N.P.R. by Wessling with a following end at 20° II. Rifts in the N.P.R. were noticed at 269° II by Meisner on May 29, '71. On June 4 Mayer noticed the preceding end of the N.N.T.B. at 9° II and the following end at 64° II. There was also a resurgence elsewhere of the belt, excepting the region from 86° to 179° II. The small section noted by Mayer merged with the rest of the belt by June 28, according to the Recorder. To Reese and Bartlett the northern hemisphere in general and the N.T.B. in particular were very warm in color during June, i.e., "reddish-brown". The N.N.T.B. was visible at 137° II on July 1, according to Thiede. Dragesco obtained a black and white photo of the belt on July 2 at 223° II, and on July 3 at 70° II Capen obtained a blue photo of the N.N.T.B. By mid-July the N.P.R. darkened, and the N.N.T.B. faded. Northern hemisphere zones also became darker at the same time (see below). On July 16, however, Dragesco reported a dark section in the N.N.T.B. on a black and white photo at 36° II. This section was also recorded and placed by Mayer on July 17. On July 21 and July 22 Capen and Mayer observed the N.N.T.B. with a p.e. at 355° II. A black and white photo taken by Milon on Aug. 1 does not show the N.N.T.B. in this region. This absence was confirmed by Doel on Aug. 3. Signs of a fading N.N.T.B. at 238° II were revealed on a B&W photo by Dragesco on Aug. 3, however. Faint indications of the belt persisted throughout the rest of the apparition.

North Temperate Belt and North Tropical Zone. Let me begin by quoting a few lines from Reese's "Summary of Jovian Latitude and Rotation-period Observations from 1898 to 1970" in regard to the position of the N.T.B.:

> "There appears to be a tendency for certain belt edges in a given hemisphere to move in unison. An example of this might be the north edge of the North Equatorial Belt, the south edge of the North Temperate Belt, and the N.N. Temperate Belt." (Feb., 1971.)

On Jan. 16, '71, Budine observed a dark patch in the N.T.B. from 258° to 298° II, and also a very bright N.Tr.Z. Throughout February the N.T.B. was strong in all longitudes, according to Dragesco. Similarly the N.Tr.Z. was bright in all longitudes. The N.Tr.Z. remained bright in April while the N.Te.Z. became dull in places, according to Mayer and Beck. By late May Wessling indicated some shading in the N.Tr.Z. as well. On May 20 Bartlett called the N.Tr.Z. "orange-yellow" at 345° II, and also on May 28 at 54° II. Both the N.Tr.Z. and the N.Te.Z. became dusky with the darkening of the N.P.R., but by June 28 the N.Tr.Z was "cream-colored" and wide, according to Bartlett and the Recorder. By June 1 both zones were termed "brownish-gray" at 290°II by Bartlett. In early June a few fragments from the N.E.B. were seen in the N.Tr.Z. by Wessling and Scholks. The reddish color in the N.T.B. was fading by mid-June, according to Heath and Bartlett; and it became brown and remained conspicuous, indicating an obscuring haze from the N.P.R. The N.Tr.Z., however, remained pale "orange-yellow" or "pale orange" in late June, according to Bartlett. Such activity was confirmed on black and white photographs by Dragesco on July 2 at 178° II and by Capen on July 3 at 115° II. Spots and festoons were obvious in the NTr.Z. throughout July, according to Dragesco. Two bright spots were noted by him on July 17 with centers at 193° II and 203° II. A dark spot on the N.T.B. was picked out by Capen on July 21 at 330° II. Such activity persisted throughout August. On Sept. 15 Doel caught the N.E.B.$_n$ very faint with a preceding end at 333° II.

North Equatorial Belt and Equatorial Zone, North. The N.E.B. was in its single aspect, but only the N.E.B. (s. edge) contributed to the formation of the belt since the N.E.B.$_n$ was nearly invisible throughout the 1971 period. Usually, the single aspect is the result of the mutual decrease of activity of both the components. The N.E.B. did become active in 1971 in this atypical case. We must always be careful not to take any of these classification schemes as final.

In January the N.E.B.$_s$ was still easy to differentiate with a dusky N.E.B.Z. to the north. See Figures 1 and 2. Large festoons typical of 1970 were also seen in January. Large bright ovals were seen in the E.Z.$_n$, and these were symmetrical in shape. By February, however, a white spot was seen by Dragesco at 30° II which was clearly non-symmetrical in shape (indicating greater turbulence). In discussing white ovals in the E.Z.$_n$ I shall be referring to the longitudes of their centers obtained by using a grid on Dragesco's discs, which were carefully drawn for just this purpose. Somewhat flattened kidney-shaped white ovals were noticed flanking this first oval at 30° II, at 52° I, and another at 117° I. By the 4th of February two of these spots broke up into two smaller ones, each from 100° to 150° I, while two spots joined to form one oval on February 2 from 147° to 177° I. Finally, great festoons in the E.Z. were noted by Jean Dragesco on March 7 and on March 17, at 333° I and at 115° I respectively. Such a drastic change or increase of turbulence indicated a revival of the belt. Indeed, in April Mayer and Beck recorded similar impressions to those Dragesco saw earlier. On May 3 Dragesco noted a curious white oval at 223° I flanked by two festoons and two elongated ovals on both sides. Dragesco also noted a broken N.E.B.$_n$ at 168° II on the same disc. On February 8 he noted the N.E.B. in its new single aspect just following the older aspect with a dark festoon flanked by large white ovals, each of which was 45° long, at 314° I. An even darker festoon complex was observed on the same evening at 339° I connecting the N.E.B. with the S.-E.B.$_n$. Clearly, in late May the region was undergoing some upheaval as indicated on two discs by Wessling, on another by Meisner, and on one more by Scholks. According to Walter Haas, the N.E.B. was reddish-brown in February and April of 1971, and he remarked on May 1:

> "The N.E.B. is much weaker and narrower (s. comp. only?) than it has usually been in recent years."

However, by late May and June of 1971 the belt became more obvious and retained its reddish-brown color. On June 13 Haas found the N.T.B. reddest of all the belts. His ranking placed the S.T.B. darkest through May, but the N.E.B. became more dark to him and to Bartlett by June. Bartlett called it "strongly reddish-brown". Certainly not so much color had been seen by the ALPO Jupiter Section in the region since March 30, 1968. The changed rank of the N.E.B. (s. comp.) indicated a revival of this belt, which the Recorder found very pronounced by June 28, 1971, and concurrent with the June S.E.B. Disturbance. This revival was confirmed by Otis on five black and white photos. A disc by Rae J. Ferreri also suggested as much. According to the Recorder the N.E.B. became considerably wider and darker as material formed about the core line which had been the N.E.B.$_s$ up till mid-June. The dark material was thus equally distributed on the north and south sides of the N.E.B., while the N.E.B.Z. more or less disappeared. Brackish sections formed and were imbedded in the N.E.B. Heath also noted the change just described on July 1 and Capen on July 3. The most pronounced region was in the vicinity of the first S.E.B. Disturbance of the apparition, which erupted on June 20, according to Reese, and was confirmed by Wacker, Thiede, and Mackal. (It was also carefully observed by Dragesco and Scholks.) Both the Recorder and Bartlett noted the darkening of the color of the N.E.B. during June and July. Wacker suggested that another zenological event had taken place on the planet. On July 18 Dragesco noted a thin section of the N.E.B. or a gap at 20° II on a B&W photo. On July 29 the prominent N.E.B. (s. comp.) was also recorded by Pat Moore. Photos throughout August indicated a stable N.E.B. which ceased to be active (before the activity in the S.E.B.-S.T.B. latitudes) or subsided, thus suggesting that no zenological disturbance was the cause of so much activity. The N.E.B. remained obvious throughout the rest of the period and did not become faint. Detached dark spots were noticed by Doel and Budine through late August and September. Dragesco also noted many such features throughout the period of upheaval as well. On August 16 Krisciunas noted a backward festoon connecting the N.E.B. to the S.E.B.$_n$ at 298° I. The belt appeared to be stable, but fading was not totally absent in late August in several longitudes.

The interpretation of so much data, much of it contradictory, may seem difficult; but if we can assume that during the 1970 conjunction with the Sun Jupiter underwent a cessation of activity, in particular along the N.E.B.$_n$ and the S.Tr.Z., with a levelling off and slow decrease in the activity of the N.E.B.$_s$, we may then easily explain all the events which led to the revival of the N.E.B. (s. comp.) independently of those events which led to the first S.E.B. Disturbance. The N.E.B. retained its high rank throughout 1971 and remained number one in relative belt conspicuousness till the end of the period. Certainly, single aspects of the belt discussed in earlier periods are not related to the events discussed today.

<u>Equatorial Zone, South, Equatorial Band, and South Equatorial Belt, North</u>. The E.-Z. area was active in 1971 but much less so than it had been in three successive apparitions--1967-68, 1968-69, and 1970. The E.Z.$_s$ was not very obvious, though bright most of the time and often hazy rather than brilliant. This fact suggests that the notion of a zenological disturbance must be completely ruled out. The E.Z.$_s$ was not too bright in 1970 either. There was some E.B. activity, but it is difficult to classify it. Budine and Dragesco kept an early record of the area characterized as the E.Z.$_n$ and found it to be as colorless as the E.Z.$_s$. The first observation of the clear E.Z.$_n$ was on February 2 by Dragesco at 162° I. There were also a few dusky columns associated with this whitening of the region. By February 9 Jean Dragesco noted a dull E.Z.$_n$ at 185° I. This dullness continued through April 4, according to Mayer. It is highly suggestive that eruptions of the N.E.B. and of the E.Z.$_n$ are independent sets of events, the former entailing the formation of festoons and the latter entailing the formation of white ovals and bright patches. The last sign of E.Z.$_n$ light patches was on January 30, according to Dragesco, at 45° I.

Clearly, all of the large bright ovals seen in February by Dragesco were simply framed sections of the $E.Z._n$ and were not actual white marks so that we may conclude that symmetrical ovals are for the most part real marks or spots whereas asymmetrical ovals are simply framed features which are bounded by N.E.B. columns or festoons!

The $S.E.B._n$ was rather solitary during the first four months of the apparition until the $S.E.B._s$ began a slight revival prior to the outbreak of the first and second S.E.-B. Disturbances in June and July of 1971. The $S.E.B._n$ became darker in early May, according to Dragesco. It caught up with and surpassed in darkness the S.T.B. by June 13, according to Walter Haas. A darker E.B. also formed in late May, according to Mayer, concurrent with the revival of the N.E.B. On May 27 Dragesco showed the E.B. and $S.E.B._n$ separated by a thin bright $E.Z._s$. The preceding end of the $E.Z._s$ was at 0° II, according to Wessling. For many observers the E.B. and $S.E.B._n$ began to merge by June, or at least to appear as a separate and unique belt complex. A very thin $E.Z._s$ remained observable, however. Bartlett described it as "dull white". Brackish sections formed in the $S.E.B._n$ in early June (a sure sign of activity), according to Dragesco and Meisner. See Figures 12, 13, and 14. The E.B. merged with the $S.E.B._n$ at 287° I on June 11. See Figure 14 for the final developments. On Mayer's disc there appeared to be an uplifted E.B. preceding and following the CM, which produced the joining point. An N.E.B. festoon also appeared to be associated with the critical juncture. The $S.E.B._n$ was very dark from 156° to 212° I, following the first S.E.B. Disturbance, on June 24, 1971. The Recorder placed the p.e. of the dark $S.E.B._n$ at 186° I on June 28. The EZ_n had by then become dusky in the vicinity of the Disturbance. See Figure 30. The $E.Z._s$ remained bright everywhere except at the point of eruption of the Disturbance. The stable condition of the $E.Z._s$ was noted by Dragesco on a B&W photo taken on July 2 at 18° I. The Disturbance near the f. portion past the R.S. resulted in complete interaction of the E.B. and the $S.E.B._n$ on July 13 at 284° I (see Figure 25). It extended out to 350° I as of July 16, according to another B&W photo by Dragesco. The E.B. became nore active in July, according to Bartlett, while $N.E.B._s$ activity appeared more quiet. However, this activity was so slight as to be hardly noticeable to most observers. It was complex activity concurrent with the Disturbance and nothing of a disturbance in and of itself. On August 3 Dragesco noted two ovals in the $E.Z._s$ bursting up through the $S.E.B._n$ at 290° I (247° II) much like a set of white ovals observed by the Recorder in 1963-64. Certainly this aspect was complex activity too and not a disturbance. However, on Figures 14 and 15 it does look as if the area is "disturbed" or agitated. In any case the features did not last long and did not travel in the way we usually expect for any S.E.B. Disturbance. The $E.Z._s$ continued to assert itself and to become wider in early August, according to Dragesco and Wacker. The interaction of the E.B. and $S.E.B._n$ persisted in some longitudes, however, according to Doel and Mayer. Dragesco and Moore saw the $E.Z._s$ widening for the most part. It appears likely to the Recorder that a thin, and perhaps dusky in places, faint $E.Z._s$ encircled the entire planet by late August. The $S.E.B._n$ subsided a bit too in late August and became so many "barges" and faint sections. Here, of course, the $E.Z._s$ was most obvious to all observers. Large white ovals appeared to be forming in the zone by early September, according to Doel. The zone remained weak and inactive wherever the $S.E.B._n$ was still strong and dark, however.

<u>Red Spot, South Temperate Belt, South Temperate Zone, South South Temperate Belt, and South Polar Region</u>. Dragesco noted great activity in the S.Te.Z. and along the north side of the S.S.T.B. throughout the apparition and especially towards the end of it. I am not aware that too much activity of this sort was seen by many other observers, however. Apparently only larger apertures, 10 inches or more, afforded such a view. The spots were numerous enough to warrant calculation of the rotation period of the S.Te.Z. and the S.S.T.B., however. White spots were as frequent as dark ones. A good deal of new activity had been noticed here throughout the 1960's by the A.L.P.O. Jupiter Section.

The S.T.B. was the darkest belt at the beginning of the 1971 apparition. It seemed brown without much red color throughout the period. Both Haas and Bartlett appear to agree about this color. The S.T.B. was quite active on its southern and northern borders, and a large rod was observed by the Recorder just following the Red Spot on June 28. Oval BC was at 283° II on January 16, '71, according to Budine. Oval DE was at 34° II on January 28, '71, according to Dragesco. Oval FA was at about 97° II on May 23, '71, according to Mayer.

Haas placed the preceding end of the Red Spot at 357° II on June 13, '71. The p.-e. of the R.S. was at 354° II on June 28, '71, according to the Recorder. The following end of S.Te.Z. oval FA was at 65° II on the same date. The R.S. itself was rather obvious in 1971 because of a bright S.Tr.Z., and it appeared neither more or less obvious than it was in either 1969 or 1970 to the Recorder and Heath. Heath called the Red Spot "deep rosy red" at the beginning of the apparition. It looked "brick red" to the Recorder, and Chick Capen called it "bright brick orange" in July. The Spot looked elongated and of a uniform dark color overall. The S.Tr.Z. Disturbance remained visible throughout August after having dragged the R.S. from its original position in late December of 1970 to the 350° II position in late June, at which time it ceased to influence the Spot and remained ahead of S.Te.Z. oval DE through September. The original conjunction of the R.-S. and the S.Tr.Z. Disturbance is shown by Budine in Figure 2. The Disturbance became less active, however, once it had passed the R.S., as can be seen on a disc by Dragesco at 233° II on August 15, '71, Figure 52.

The S.P.R. remained a constant light brown or gray throughout the apparition, the only inactive portion of the planet. The S.E.B.$_s$ was connected to the f.e. of the R.S. from late June and July through August, according to Mackal, Dragesco, and Moore. Oval FA neared conjunction with the R.S. on August 28, '71. The S.Tr.Z Disturbance was last seen by Dragesco at 226° II on September 8, '71, and looked further reduced to the Recorder. Finally, Doel noted a false R.S.H. on September 15 north of the R.S. at 18° II. This aspect was very different from the remarkable darkening of the R.S.H. noted by Mackal and Capen on March 30, 1968.

In finally accepting the Taylor Column hypothesis I have several points of some interest to make. This diversion is justified in light of the fact that Dr. R. Hide provided me with two papers which discuss the subject at some length. Particulate matter of the kind suggested by R. Wildt would be most stable in a Taylor Column. The column would tend to be denser than the surrounding region for one thing. The particulate material could rise along the edges of the column, reach a maximum distance in light of initial energy, energy acquired in motion, and gravitational forces--form a ring of dark red matter about the Spot, sometimes forming blunt ends (1962-1964), and slowly diffuse over the central face of the Spot (1965-1971). Vortical motion in the Spot as well would tend to work in the opposite direction so that a ringed aspect would be more common than would normally be expected by the Taylor Column hypothesis mechanism alone. Finally, when the R.S. was associated with a red S.E.B.$_s$ it would tend to be red overall, and the ringed aspect would temporarily disappear altogether (unpublished paper given at the A.L.P.O. Las Cruces Convention in 1968). Quoting Dr. Hide:

> "The expression 'Taylor Column' was first coined (so far as I am aware) by Hide (1961) as a convenient term in the discussion of the flow phenomenon in Jupiter's atmosphere that--on the proposal that astronomers subsequently termed the 'Taylor column theory'--underlies the Great Red Spot. The various phenomena to which the term 'Taylor Column' has been applied by fluid dynamicists have in common two general characteristics: (a) they occur in fluids through which--owing to rapid rotation, strong stable density stratification, or magnetohydrodynamic effects--mechanical energy can be transmitted by transverse wave motions, and (b) the appropriate coherence length C is so large that the dimensionless steering parameter sigma is much greater than one. 'Taylor Columns' ... are not necessarily stagnant, they can occur in baroclinic as well as in barotropic fluids, ... they can be produced by forced disturbances of the density or pressure fields as well as the velocity field."*

In 1962-1964 Philip R. Glaser suggested that the R.S. was associated with volcanic activity on the surface of Jupiter. Since the Taylor Column hypothesis and the observation of March 30, 1968, by Mackal and Capen give some evidence in favor of this view, we may assume that underneath the R.S. is an extended plateau region. When the Column strays from the direct horizontal or tilted horizontal, we should expect something like the R.S.H. phenomenon. The evidence for vorticity of the R.S. is also on shaky foundations, and much more evidence is needed to support both positions. Fundamentally, the Recorder sees no necessity to consider either one of these hypotheses as inconsistent with the remaining hypothesis. Quoting again:

> "The suggestion that the Great Red Spot is the end of a 'Taylor Column' in Jupiter's atmosphere accounts for the observations in an unforced way without implying unlikely physical conditions in Jupiter's atmosphere and deep interior, ... [e.g., the floating barge hypothesis.]"**

Summing up:

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*Hide, R. "On Geostrophic Motion of a Non-Homogenous Fluid." J. Fluid Mech.
**Hide, R. "Motions in Planetary Atmospheres." Meteorological Magazine.

"The central theoretical difficulty in all dynamical studies of motions in planetary atmospheres is that of understanding interactions between motions on different length and time scales. Current deficiencies in our knowledge of the scales of motion present in the atmospheres of the major planets (...) will not be remedied until better photographs and thermal maps have been obtained over a long period of time."**

"Fluids that rotate at speeds not much greater than the speed of sound within them (e.g., atmospheres of earth and Mars) differ fundamentally in their behavior from fluids that rotate hypersonically (e.g., atmospheres of Jupiter and the other major planets), and it is therefore worth noting that the study of hypersonically rotating fluids remains an almost untouched area of fluid dynamics."**

V. The South Equatorial Belt Disturbances of 1971

South Equatorial Belt Zone; South Equatorial Belt, South; and South Tropical Zone. The S.E.B.$_s$ was weak but visible in the early months of 1971. It was faint at 283° II on January 16, '71, according to Budine. Some of our observers could not pick it out at all because, according to the Recorder, it was an exclusively red band without much brown at all. A certain abnormal sensitivity to red is required to perceive it under these conditions. In any case it was picking up some strength just prior to the first outbreak of the S.E.B. Z. on June 20. See Figure 18. The actual discovery of the Disturbance appears rather difficult to settle at this moment since it devolves upon the correct definition of those features considered to be indicative of an impending eruption and the arbitrary precursor events which are roughly correlated with these basic features to be found at the outbreak of all the S.E.B. Disturbances. The Disturbance most definitely took place on June 20, 1971, and was discovered simultaneously by the International Planetary Patrol and Elmer Reese. According to the Patrol Program chairman in N.A.S.A., the event started with a tiny spot barely detectable in ultraviolet light on June 18. Red photos did not reveal this feature. This spot is not visible in frame one of the UV photos supplied by Dr. Capen for the International Planetary Patrol Program, but may have been visible on a negative. In any case the second frame does show sufficient evidence of the beginnings of a major eruption in the S.E.B. Z. It is a categorical fact at this time that an eruption on the S.E.B.$_n$ does not constitute a Disturbance in the classical sense, though it might be considerably agitated. Likewise, it is becoming less clear that an eruption on the S.E.B.$_s$ is necessarily indicative of an impending S.E.B. outbreak just because certain scholars have implied as much. An eruption can be an indicator of S.Tr.Z. activity or of an S.Tr.-Z. Disturbance. I think the observations of 1966-67 and 1970 support this modified view. The fact of the matter was that the S.E.B.$_s$ was getting more active before the outbreak, but no one would hazard to suggest that this fact heralded the Disturbance. Why should we suppose that anything else is an herald of the Disturbance? The S.Tr.Z. is often bright when no Disturbance takes place. In any case the spot observed by the professionals, other than Reese, could have been indicative of S.E.B.$_s$ activity and not S.E.B. Z. activity. Quoting Elmer Reese:

"We have photographed what is obviously the outbreak of a great new disturbance in the South Equatorial Belt near longitude (II) 80°. The disturbance was first recorded on June 20. A poor quality photograph on June 16 showed no development whatsoever."*

On June 24, '71, the preceding end was at 80° II on a blue-light sketch which has been published in Sky and Telescope, where a brief discussion of the early development of the Disturbance is considered. Frames in ultraviolet supplied by Dr. Capen indicate the rapid motion of the preceding end relative to other features in the area. It was at 69°.4 II by June 28, '71, according to the Recorder. Another festoon appeared at 53° II and became the new p.e. in the S.E.B. Z. In my view the bright oval which accompanied the Disturbance for the first several weeks of its existence was the actual indicator of the impending Disturbance. On June 29 Dragesco caught a second white oval in front of the new festoon. See Figure 26. A dark shoulder in the S.E.B.$_n$ was also noticed by Mackal and Dragesco in July. Festoons and ovals also appeared in the S.Tr.Z. from 93° to 103° II on July 16. A spot was also seen at 145° II on July 16 by Wynn Wacker and Eric Thiede. More festoons, white spots, and condensations were evident on the 17th of July. However, a great surprise was in store. On July 18, 1971 Elmer Reese found a second outbreak at long-

*Reese, E. J., letter of June 25, 1971 to the Recorder.
**Hide, R. "Motions in Planetary Atmospheres." Meteorological Magazine.

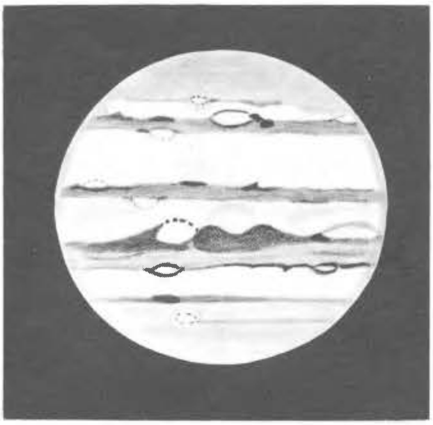

Figure 1. Jan. 16, 1971. P. W. Budine. 244°I, 283°II. 4-inch refrac., 167x. Note p.e. N.N.T.B., N.E.B., E.Z., & BC.

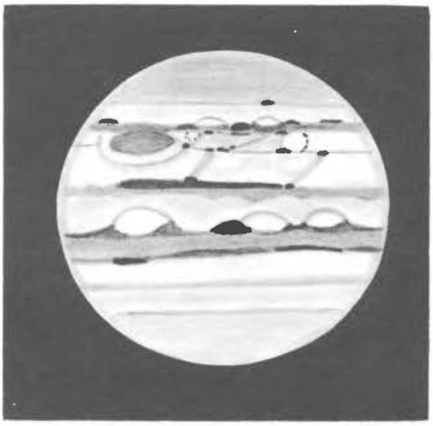

Figure 2. Jan. 17, 1971. P. W. Budine. 10°I, 42°II. 4-inch refrac., 167x & 214x. Note dull N.Te.Z, S.Tr.Z. dist., & S.E.B.n.

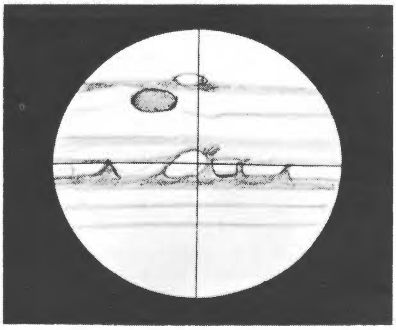

Figure 3. Jan. 28, 1971. J. Dragesco. 89°I, 36°II. 10-inch reflec., 265x. DE. E.Z.n.

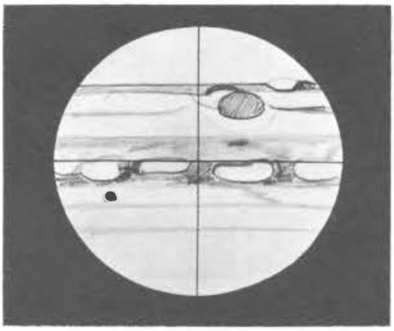

Figure 4. Jan. 30, 1971. J. Dragesco. 67°I, 355°II. 10-inch reflec., 265x. N.Tr.Z. E.Z.n.

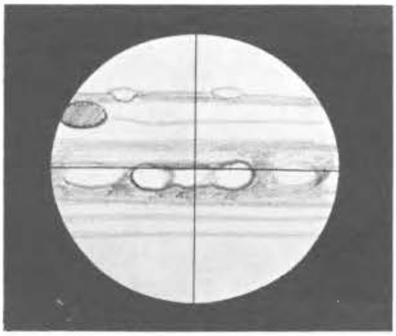

Figure 5. Feb. 2, 1971. J. Dragesco. 162°I, 71°II. 10-inch reflec., 265x. E.Z.n.

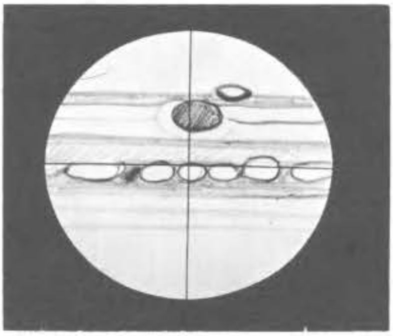

Figure 6. Feb. 4, 1971. J. Dragesco. 116°I, 11°II. 10-inch reflec., 265x. E.Z.n.

itude 144° II, preceded by another bright spot in the S.E.B. Z.--"the brightest thing on the disc at the time"--according to Wynn Wacker on the same night. The original spot at 144° II was now seen to be at a new position, 148° II. We were thus witnessing the second occurrence, to our knowledge, of a double S.E.B. Disturbance! In describing the analogous 1943 event Wynn Wacker suggested that there was a notable difference between the two

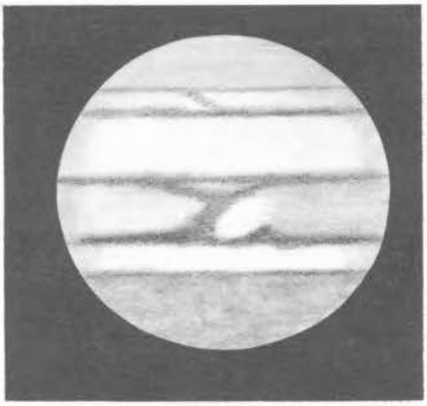

Figure 7. Apr. 15, 1971. I. Beck. 92°I, 176°II. 6-inch reflec., 152x. E.Z.n.

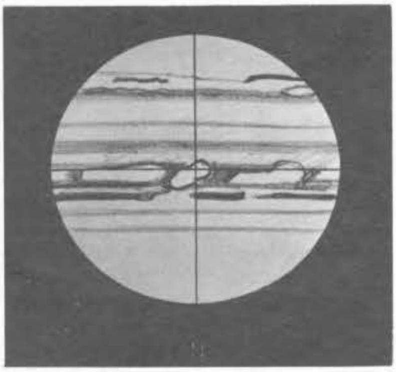

Figure 8. May 3, 1971. J. Dragesco. 223°I, 168°II. 10-inch reflec., 265x. E.Z.n.

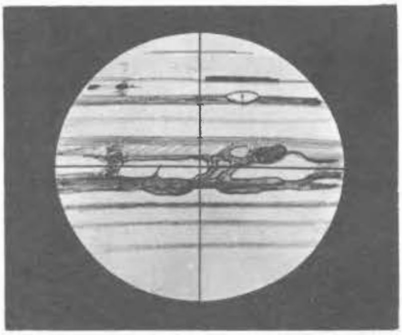

Figure 9. May 8, 1971. J. Dragesco. 304°I, 205°II. 10-inch reflec., 265x. E.Z.n.

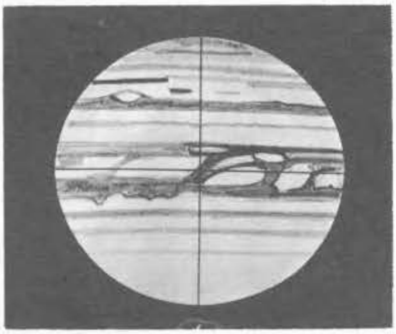

Figure 10. May 8, 1971. J. Dragesco. 359°I, 265°II. 10-inch reflec., 265x. Note double festoon on CM.

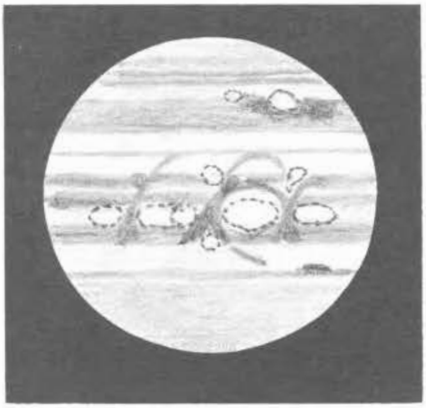

Figure 11. May 29, 1971. H. A. Scholks. 85°I, 185°II. 4.5-reflec., 150x. Note N.E.B.

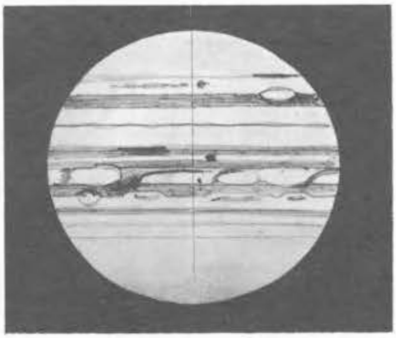

Figure 12. June 8, 1971. J. Dragesco. 162°I, 137°II.* 10-inch reflec., 265x. Note dark patch in S.E.B.n.

double Disturbances:

"At that time (1943), spots were formed by an apparent eruption of dark material

*These CM's are wrong. Perhaps 137°I, 162°II.

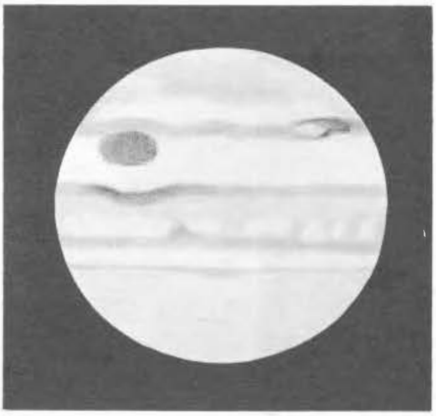

Figure 13. June 9 1971. G. Mesner. 22°I, 45°II. 6-inch reflec., 200x & 250x. Note dark patch in S.E.B.n underneath R.S.

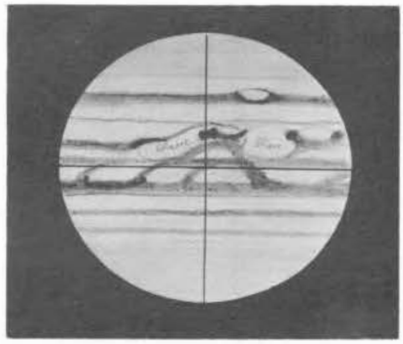

Figure 14. Aug. 3, 1971. J. Dragesco. 270° I, 227° II. 10-inch reflec., 265x. Note the S.E.B.n complex activity.

Figure 16. Aug. 3, 1971. J. Dragesco (B&W). 280°I, 238°II. 10-inch reflec., 265x. Note S.E.B.n and E.Z.s activity.

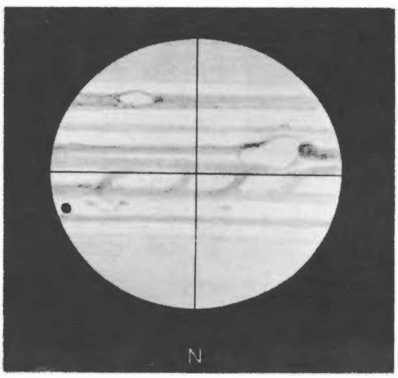

Figure 15. Aug. 5, 1971. J. Dragesco. 252°I, 195°II. 10-inch reflec., 265x. Note S. E.B.n activity.

Figure 17. Sept. 15, 1971. R. Doel. 29°I, 18°II. 8-inch reflec., 150x. Note weak N.E.B.n and false R.S.H.

near 20° II (see Peek, 1958), and were carried in a preceding direction along the S.E.B.$_n$ and in a following direction along the S.E.B.$_s$, just as in most disturbances. After about 20 days, however, a second source of dark material appeared at 288° II, apparently triggered by the arrival of the leading S.E.B.$_n$

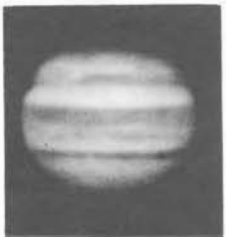

Figure 18. June 18, 1971. I.P.P.P. 7:07 UT. 136°I, 89°II.

Frame 1 - Released by Lowell Observatory staff and N.A.S.A.

Figure 19. June 20, 1971. I.P.P.P. 8:07 UT 128°I, 66°II.

Frame 2 - Discovery photograph taken at Mauna Kea Observatory, U.S.A. (Anonymous.)

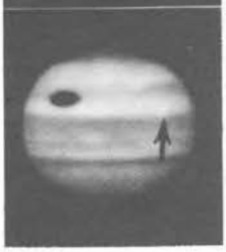

Figure 20. June 21, 1971. I.P.P.P. 13:13 UT 113°I, 41°II.

Frame 3 - Confirmation photograph taken at Perth Observatory, Australia.

Figure 21. June 22, 1971. I.P.P.P. 9:12 UT 124°I, 46°II.

Frame 4 - Note expansion of white oval, and decrease of intensity, monotonic.

Figure 22. June 23, 1971. I.P.P.P. 15:59 UT 170°I, 82°II.

Frame 5 - Mauna Kea and Perth Observatories.

Figure 23. June 24, 1971. I.P.P.P. 11:24 UT 160°I, 66°II.

Frame 6 - Mauna Kea and Perth Observatories.

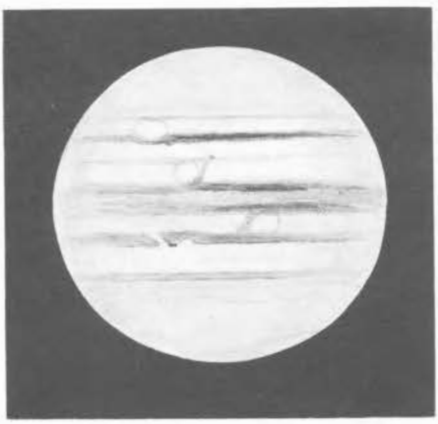

Figure 24. June 24, 1971. W. K. Wacker. 15.6-inch refractor. 176°I, 86°II. Disturbance #1.

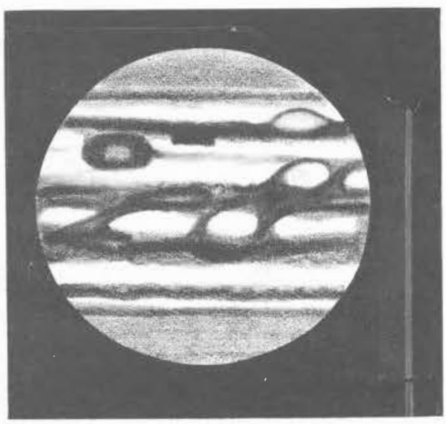

Figure 25. June 28 1971. P. K. Mackal. 6-inch reflector, 212x. 171°I, 39°II. Disturbance #1.

spots. (point 'X'.) ... It appeared that one of the leading S.E.B.$_s$ spots triggered the eruption of dark material from a source following the primary source. The dark spot seen at 163° II would then have been generated by the secondary source, since it appeared in a higher longitude than would be ex-

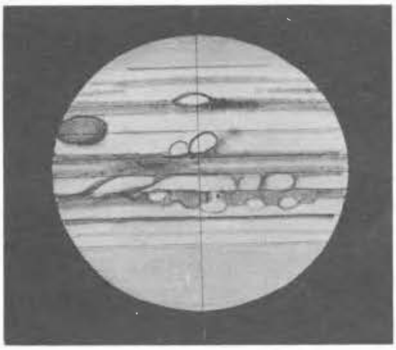

Figure 26. June 29, 1971. J. Dragesco. 202°I, 65°II. 10-inch reflector, 265x. Discovery drawing of second white oval of disturbance #1.

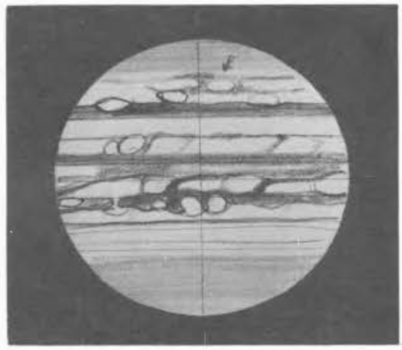

Figure 27. June 29, 1971. J. Dragesco. 238°I, 101°II. 10-inch reflector, 265x. Note early developement of the SEBs branch of the disturbance.

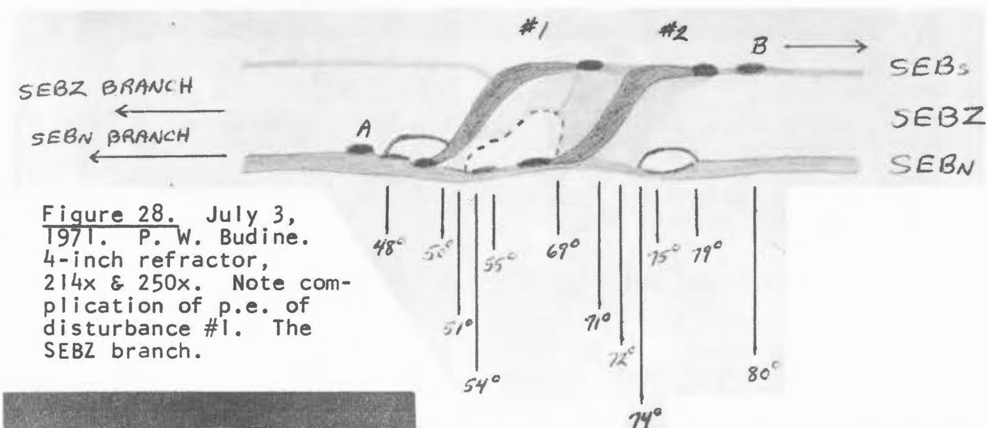

Figure 28. July 3, 1971. P. W. Budine. 4-inch refractor, 214x & 250x. Note complication of p.e. of disturbance #1. The SEBZ branch.

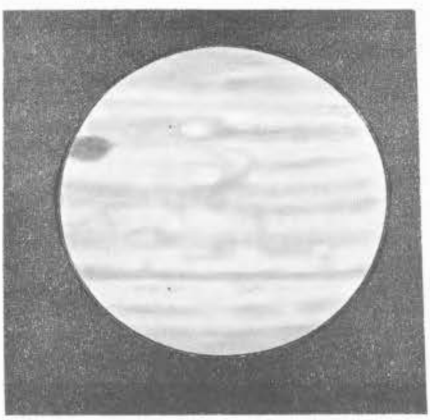

Figure 29. July 3, 1971. C. F. Capen. Blue-light drawing. 231°I, 71°II. 24-inch refractor, 810x, 400x, & 200x.

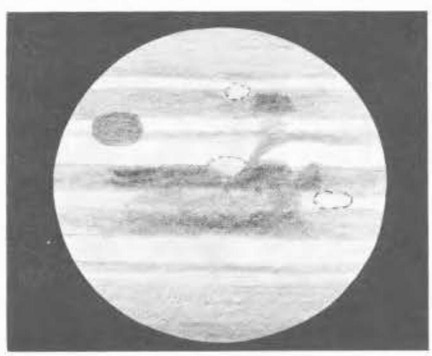

Figure 30. July 6, 1971. H. A. Scholks. 244°I, 55°II. 4.5-inch reflector, 150x. Note E.Z. activity.

pected if it were the leading spot of the south branch of the primary disturbance."**

**Wacker, W. K.; letter of August 1, 1971 to the Recorder.

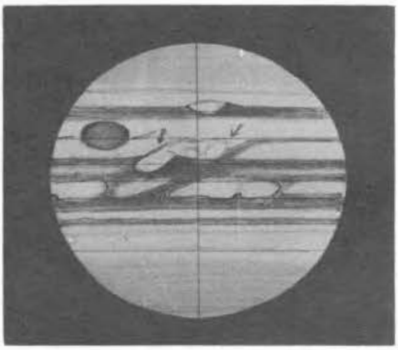

Figure 31. July 11, 1971. J. Dragesco. 274°I, 48°II. 10-inch reflector, 265x. Note S.E.B.n shoulder.

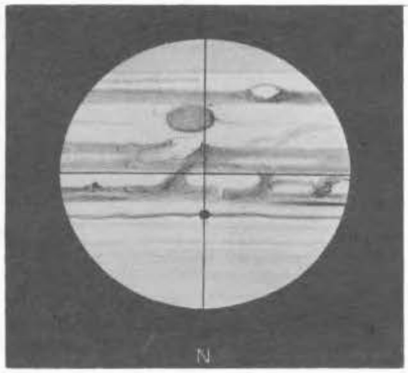

Figure 32. July 16, 1971. J. Dragesco. 283°I, 18°II. 10-inch reflector, 265x.

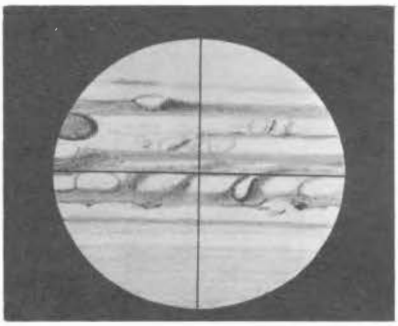

Figure 33. July 16, 1971. J. Dragesco. 338°I, 73°II. 10-inch reflector, 265x. Note STrZ activity.

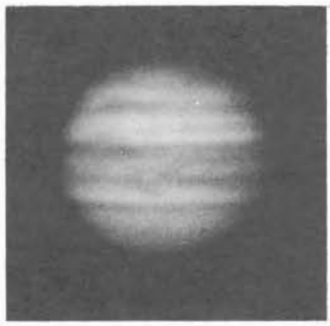

Figure 34. July 16, 1971. J. Dagesco. (B&W) 358°I, 92°II. The SEBs branch of disturbance #1.

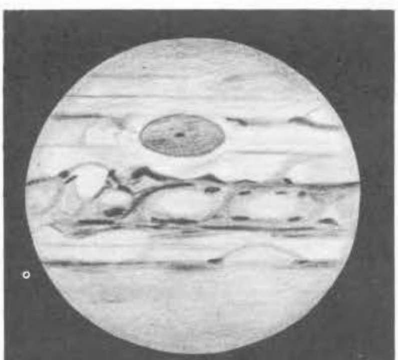

Figure 35. August 3, 1971. R. Doel. 44°I, 9°II. 6-inch reflector, 175x.

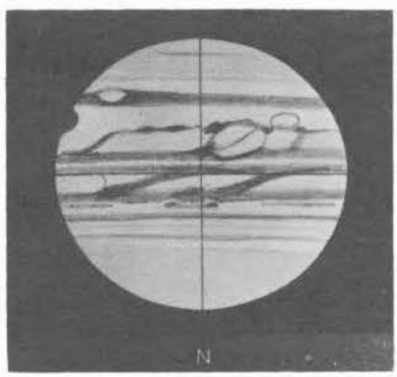

Figure 36. August 7, 1971. J. Dragesco. 152°I, 80°II. 10-inch reflector, 265x. Interaction of S.E.B.s & S.E.B.n.

The Recorder, however, is skeptical about the significance of this dark spot and really considers the bright white oval to be the indicator of the second Disturbance just as an even brighter white oval was the indicator of the first Disturbance. In this connection

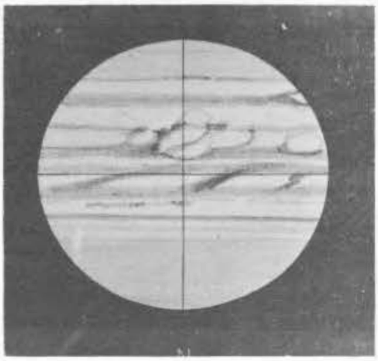

Figure 37. August 7, 1971. J. Dragesco. 170°I, 97°II. 10-inch reflector, 265x. Note f.e. of disturbance #1.

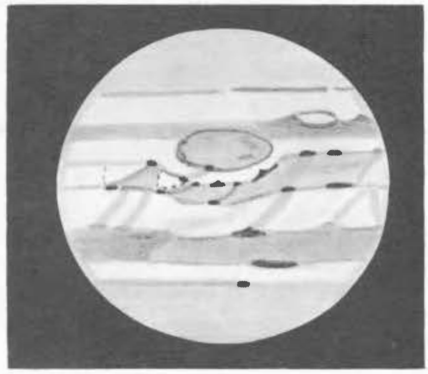

Figure 38. August 8, 1971. P. W. Budine. 83°I, 9°II. 4-inch refractor, 167x & 214x. Note p.e. of disturbance #1.

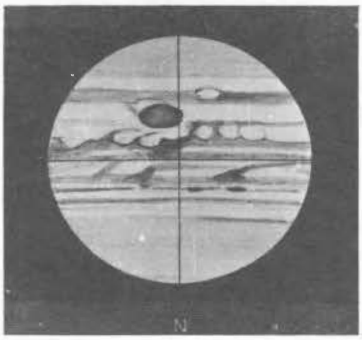

Figure 39. August 9, 1971. J. Dragesco. 105°I, 21°II. 10-inch reflector, 265x.

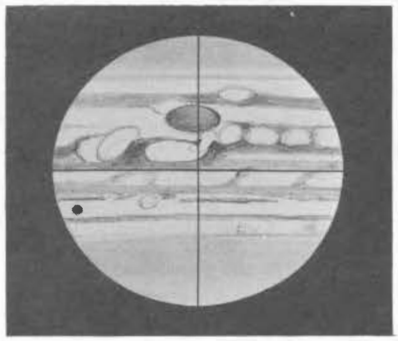

Figure 40. August 21, 1971. J. Dragesco. 190°I, 10°II. 10-inch reflector, 265x.

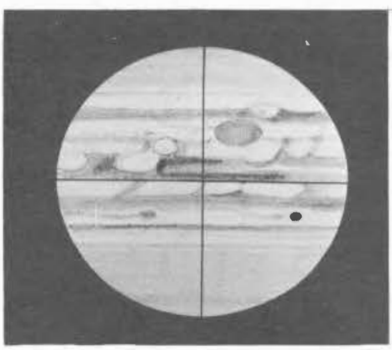

Figure 41. August 28, 1971. J. Dragesco. 227°I, 353°II. 10-inch reflector, 265x.

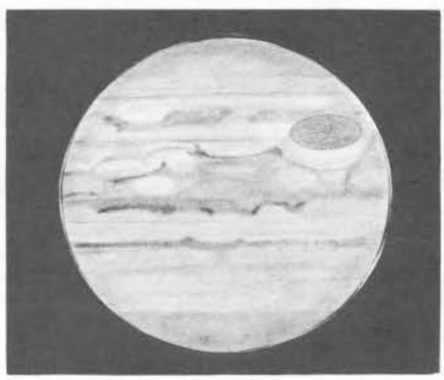

Figure 42. Sept. 9, 1971. R. Doel. 292°I, 332°II. 6-inch reflector, 169x.

it might again be posited that the spot observed was associated with ordinary S.E.B.$_{s}$ activity even though it moved abnormally or with some S.Tr.Z. event. Such a feature is easier to identify when it is present since it usually has a brilliant intensity and is sub-

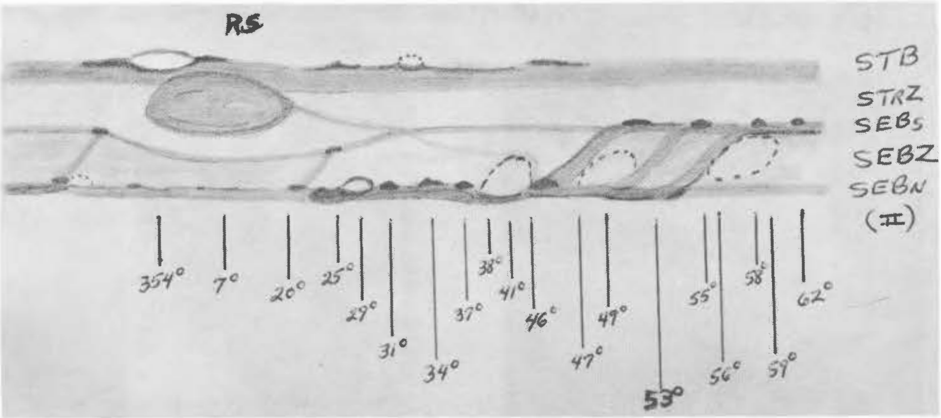

Figure 43. Strip sketch of Jupiter on October 2-3, 1971 by P. W. Budine, showing the latitudes of the Red Spot and the South Equatorial Belt Disturbance. $C.M._2$ = 40°. 4-inch refractor, 214X. Note the following end of the S.E.B. Z. branch of Disturbance No. 1. The numbers below the vertical lines are the longitudes (II) of the indicated features as determined from C.M. transits.

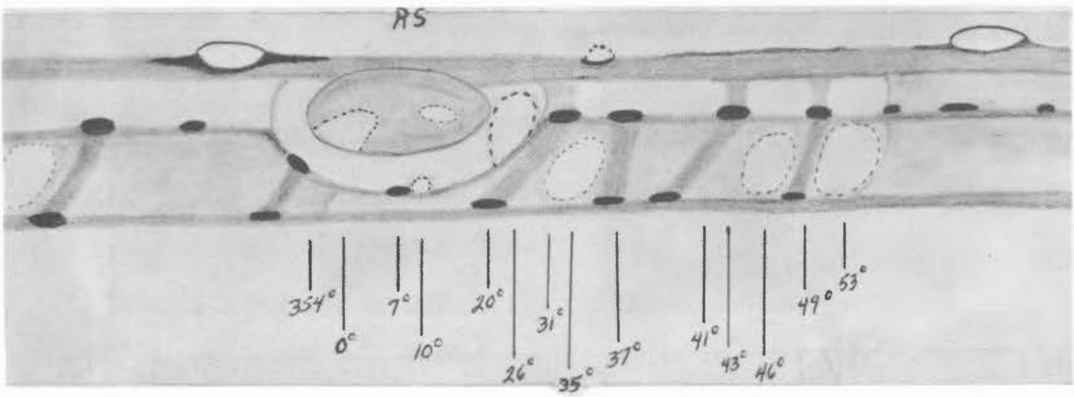

Figure 44. Strip sketch of Jupiter on October 14, 1971 by P. W. Budine, showing the latitudes of the Red Spot and the South Equatorial Belt Disturbance. $C.M._2$ = 22°. 4-inch refractor, 214X. Note the duskiness of the South Equatorial Belt Zone and developments in the South Tropical Zone.

****

ject to very gradual morphological changes.

Before proceeding with my discussion and for the sake of historical accuracy, I should like to list the discoverers of the two Disturbances: (1) #1--Elmer J. Reese and the International Planetary Patrol staffs, and (2) #2--Elmer J. Reese and the Washburn Observatory team, consisting of Wynn Wacker and Eric Thiede. Any late evidence brought to my attention will not be given consideration here. Having set the record straight, something which I am called on to do from time to time, I shall proceed with a discussion of the noteworthy events which followed the initial eruptions of the two S.E.B. Disturbances. The reader should refer to the drawings and comments as we go along. A brief inventory of true features associated with each Disturbance over System II longitudes for various key dates is provided:

Table 1.

Disturbance #1:		No. of features:
June 20, 1971	80° II	3
June 28, 1971	65°--? (II)	5

(table and text continued on page 57)

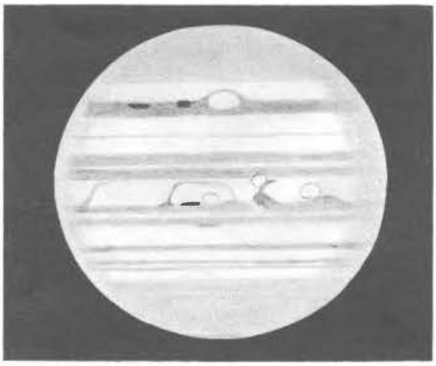

Figure 45. July 1, 1971. E. Thiede. 282°I, 137°II. 15.6-inch refractor, 240x. No activity indicating disturbance #2.

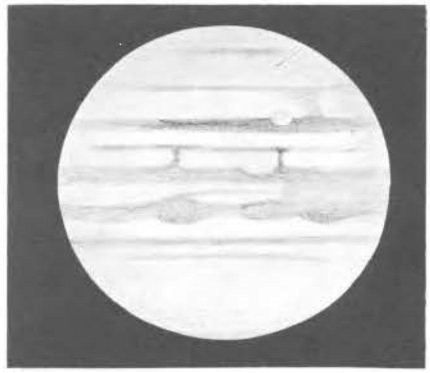

Figure 46. July 28, 1971. E. Mayer. 144°I, 154°II. 15.6-cm reflector, 208x. Disturbance #2 on CM.

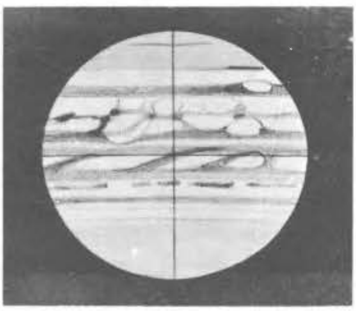

Figure 47. Aug. 7, 1971. J. Dragesco. 185°I, 112°II. 10-inch reflector, 265x. Both disturbances on disc.

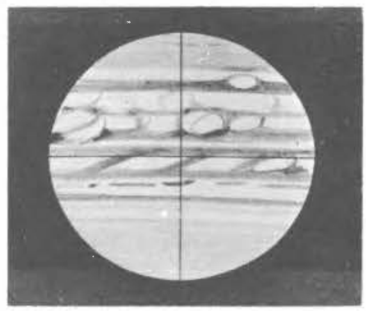

Figure 48. Aug. 7, 1971. J. Dragesco. 199°I, 126°II. 10-inch reflector, 265x. p.e. disturbance #2 on CM.

Figure 49. Aug. 7, 1971. R. Doel. 230°I, 164°II. 10-inch reflector. Developement of disturbance #2.

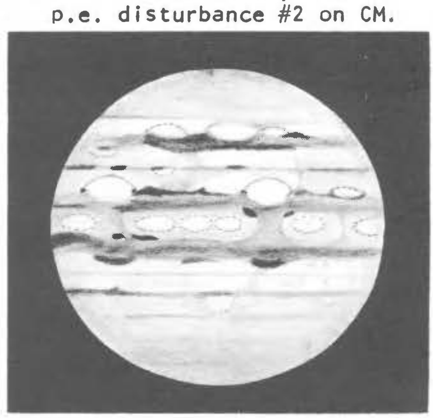

Figure 50. August 9, 1971. R. Doel. 223°I, 141°II. 8-inch reflector, 150x. p.e. disturbance #2 at 130°II.

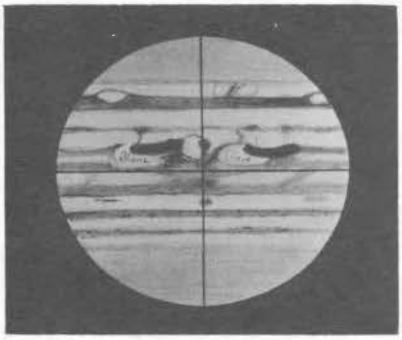

Figure 51. Aug. 15, 1971. J. Dragesco. 336°I, 202°II. 10-inch reflector, 265x. Note S.E.B.n activity.

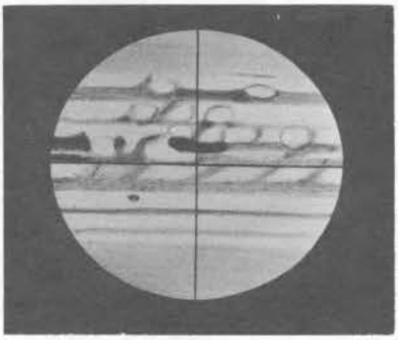

Figure 52. Aug. 15, 1971. J. Dragesco. 8°I, 233°II. 10-inch reflector, 265x. Note f.e. of disturbance #2. And S.Tr.Z. disturbance.

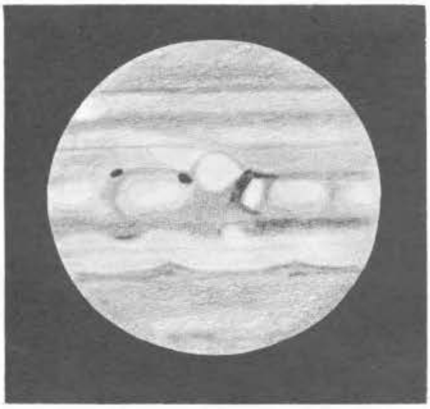

Figure 53. Aug. 24, 1971. R. Doel. 20°I, 184°II. 8-inch reflector, 150x. Note S.E.B.Z. brilliant white oval.

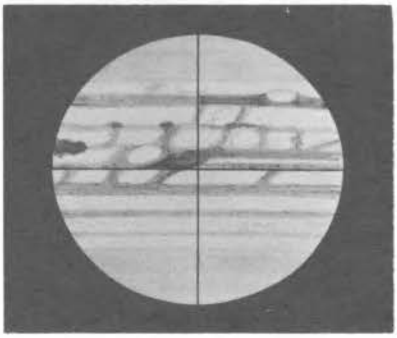

Figure 54. Aug. 27, 1971. J. Dragesco. 79°I, 213°II. 10-inch reflector, 265x.

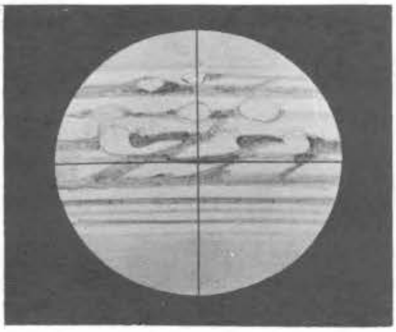

Figure 55. Sept. 6, 1971. J. Dragesco. 204°I, 262°II. 10-inch reflector, 265x. Note white ovals on S.E.B.s.

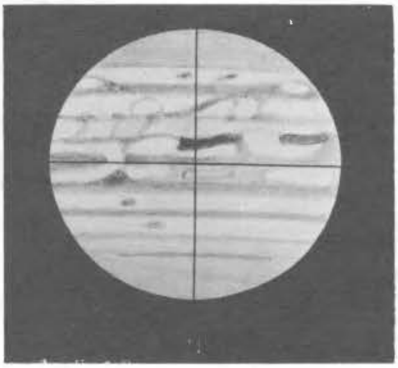

Figure 56. Sept. 8, 1971. J. Dragesco. 182°I, 226°II. 10-inch reflector, 265x. Note f.e. of disturbance #2.

Table 1. (cont.)

Disturbance #1:		No. of features:
July 3, 1971	60°—115° II	17
July 16, 1971	RSH—135° II	21
August 7, 1971	RSH—142° II	30
August 8, 1971	342°—? (II)	40

Table 2.

Disturbance #2:		No. of features:
July 18, 1971	144° II	2
July 28, 1971	140°—169° II	4
August 9, 1971	115°—186° II	10
August 15, 1971	115°—232° II	16

The most important conclusion to draw from a comparison of the two tables is that the first Disturbance was by far the more active one. This situation prevailed throughout the rest of the observing period. Observations through August proved somewhat confusing since various branches of the two Disturbances became localized in latitude, though not in longitude. The number of visible features appeared to increase linearly from August through September and then to reverse linearly in October when, according to Budine, for both Disturbances there were 18 major spots on the 2nd and 3rd, 16 major spots on Oct. 14, and only 8 such spots on Oct. 18. A good deal of fragmentation was taking place all along, and hence the total number of all spots through October was continually increasing geometrically.

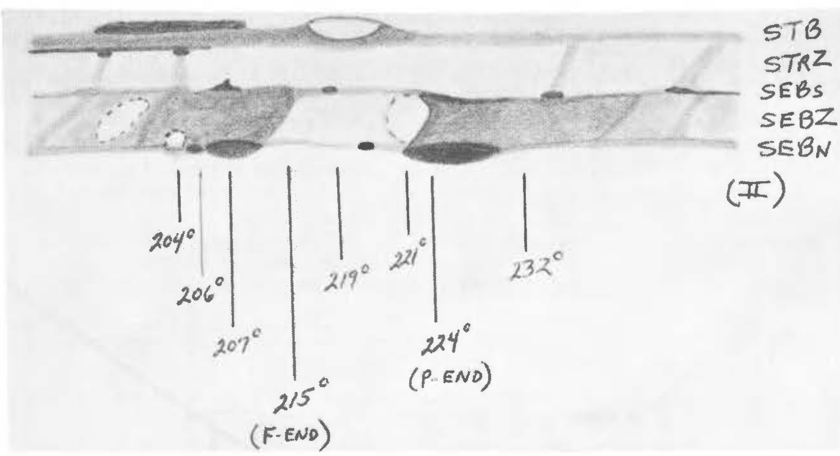

Figure 57. Strip sketch of Jupiter on October 18, 1971 by P. W. Budine, showing the South Equatorial Belt, the South Tropical Zone, and the South Temperate Belt. C.M.$_2$ = 219°. 4-inch refractor, 167X and 214X. Notice how the following end of S.E.B. Disturbance No. 2 is followed by the preceding end of Disturbance No. 1. The numbers below the vertical lines are the longitudes (II) of the indicated features.

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SATURN CENTRAL MERIDIAN EPHEMERIS: ~~1973~~ 4

By: John E. Westfall

The two tables on pages ~~58~~ and ~~59~~ give the longitudes of Saturn's geocentric central meridian (C.M.) for the illuminated (apparent) disk for 0^h, U.T. for each day in 1973. These tables are a continuation of those for 1970~~-71 and 1972~~, previously published in the J.A.L.P.O., and incorporate corrections for phase, light-time, and the Saturnicentric longitude of the Earth.

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SATURN, 1973

LONGITUDE OF CENTRAL MERIDIAN OF ILLUMINATED DISK

SYSTEM I -- 0^h U.T.

Day	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.
1	031°1	275°0	144°8	024°4	139°4	018°2	133°9	014°8	257°5	018°1	264°4	027°5
2	155.1	039.0	268.6	148.3	263.2	142.0	257.7	138.7	021.5	142.2	028.5	151.6
3	279.1	162.9	032.5	272.1	027.1	265.8	021.6	262.7	145.5	266.2	152.5	275.7
4	043.2	286.9	156.4	036.0	151.0	029.7	145.5	026.6	269.5	030.3	276.6	039.8
5	167.2	050.8	280.3	159.8	274.8	153.5	269.4	150.5	033.5	154.3	040.7	163.9
6	291.2	174.8	044.2	283.6	038.7	277.4	033.3	274.5	157.5	278.4	164.8	288.0
7	055.3	298.7	168.1	047.5	162.5	041.2	157.1	038.4	281.5	042.4	288.9	052.2
8	179.3	062.6	291.9	171.3	286.3	165.1	281.0	162.4	045.5	166.5	053.0	176.3
9	303.3	186.6	055.8	295.1	050.1	288.9	044.9	286.3	169.5	290.5	177.1	300.4
10	067.3	310.5	179.7	059.0	173.8	052.8	168.8	050.2	293.5	054.6	301.2	064.5
11	191.4	074.4	303.5	182.8	297.7	176.6	292.7	174.2	057.5	178.7	065.3	188.6
12	315.4	198.4	067.4	306.6	061.5	300.5	056.6	298.1	181.5	302.7	189.5	312.7
13	079.4	322.3	191.3	070.5	185.3	064.3	180.5	062.1	305.6	066.8	313.6	076.8
14	203.4	086.2	315.1	194.3	309.2	188.2	304.4	186.0	069.6	190.9	077.7	200.9
15	327.4	210.1	079.0	318.1	073.0	312.0	068.3	310.0	193.6	314.9	201.8	325.0
16	091.4	334.0	202.8	082.0	196.8	075.9	192.2	074.0	317.6	079.0	325.9	089.1
17	215.4	098.0	326.7	205.8	320.6	199.7	316.1	197.9	081.6	203.1	090.0	213.2
18	339.4	221.9	090.6	329.6	084.5	323.6	080.0	321.9	205.7	327.2	214.1	337.3
19	103.4	345.8	214.4	093.5	208.3	087.4	203.9	085.8	329.7	091.2	338.2	101.4
20	227.4	109.7	338.3	217.3	332.1	211.3	327.8	209.8	093.7	215.3	102.3	225.5
21	351.4	233.6	102.1	341.1	096.0	335.2	091.7	333.8	217.7	339.4	226.4	349.6
22	115.3	357.5	226.0	104.9	219.8	099.0	215.6	097.7	341.8	103.5	350.5	113.7
23	239.3	121.4	349.8	228.8	343.6	222.9	339.5	221.7	105.8	227.6	114.6	237.8
24	003.3	245.3	113.7	352.6	107.5	346.8	103.4	345.7	229.8	351.6	238.7	001.9
25	127.3	009.2	237.5	116.4	231.3	110.6	227.3	109.7	353.9	115.7	002.8	125.9
26	251.2	133.1	001.4	240.3	355.1	234.5	351.3	233.6	117.9	239.8	127.0	250.0
27	015.2	257.0	125.2	004.1	119.0	358.4	115.2	357.6	241.9	003.9	251.1	014.1
28	139.2	020.9	249.1	127.9	242.8	122.2	239.1	121.6	006.0	128.0	015.2	138.2
29	263.1	-----	012.9	251.7	006.7	246.1	003.0	245.6	130.0	252.1	139.3	262.3
30	027.1	-----	136.8	015.6	130.5	010.0	126.9	009.6	254.1	016.2	263.4	026.4
31	151.1	-----	260.6	-----	254.3	-----	250.9	133.6	-----	140.3	-----	150.4

MOTION OF THE CENTRAL MERIDIAN

01^h -- 035°2	09^h -- 316°5	17^h -- 237°8	10^m -- 005°9	01^m -- 000°6
02 -- 070.3	10 -- 351.7	18 -- 273.0	20 -- 011.7	02 -- 001.2
03 -- 105.5	11 -- 026.8	19 -- 308.2	30 -- 017.6	03 -- 001.8
04 -- 140.7	12 -- 062.0	20 -- 343.3	40 -- 023.4	04 -- 002.3
05 -- 175.8	13 -- 097.2	21 -- 018.5	50 -- 029.3	05 -- 002.9
06 -- 211.0	14 -- 132.3	22 -- 053.7		06 -- 003.5
07 -- 246.2	15 -- 167.5	23 -- 088.8		07 -- 004.1
08 -- 281.3	16 -- 202.7	24 -- 124.0		08 -- 004.7
				09 -- 005.3
10	15	40	55	90
12	27	42	57	72

"System I" assumes a sidereal rotation rate of 844°00/day (period = $10^h\ 14^m\ 13^s.1$), intended for use with features in the NEB, EZ, and SEB. "System II", intended for the rest of the ball (excluding the NPR and the SPR), assumes a sidereal rotation rate of 812°00/day (period = $10^h\ 38^m\ 25^s.4$). These rates are only approximations because latitude-dependent rotation rates for Saturn are more uncertain than, say, for Jupiter; but longitudes calculated from the accompanying tables should give conveniently small drift rates for most features. A.L.P.O. Saturn observers are urged to make central meridian timings, combined with latitude measures (or at least estimates) whenever possible, so that these rotation rates, and any future C.M. tables, can be made more accurate.

SATURN, 1973

LONGITUDE OF CENTRAL MERIDIAN OF ILLUMINATED DISK

SYSTEM II -- 0^h U.T.

Day	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.
1	078°9	050°9	104°7	072°5	307°5	274°3	150°0	118°9	089°6	330°1	304°2	187°3
2	170.9	142.9	196.6	164.3	039.4	006.2	241.9	210.9	181.6	062.1	036.3	279.4
3	263.0	234.8	288.5	256.2	131.2	098.0	333.8	302.8	273.6	154.2	128.4	011.5
4	355.0	326.8	020.4	348.0	223.1	189.9	065.6	034.7	005.6	246.2	220.5	103.6
5	087.0	058.7	112.3	079.9	315.0	281.7	157.5	126.7	097.6	338.3	312.6	195.7
6	179.1	150.7	204.1	171.7	046.8	013.6	249.4	218.6	189.6	070.3	044.7	287.9
7	271.1	242.6	296.0	263.5	138.6	105.4	341.3	310.5	281.5	162.4	136.8	020.0
8	003.1	334.5	027.9	355.4	230.4	197.2	073.2	042.5	013.5	254.4	228.9	112.1
9	095.1	066.5	119.8	087.2	322.2	289.1	165.1	134.4	105.6	346.5	321.0	204.2
10	187.2	158.4	211.7	179.1	054.0	020.9	257.0	226.3	197.6	078.5	053.1	296.3
11	279.2	250.3	303.5	270.9	145.8	112.8	348.9	318.3	289.6	170.6	145.2	028.4
12	011.2	342.3	035.4	002.7	237.6	204.6	080.7	050.2	021.6	262.7	237.3	120.5
13	103.2	074.2	127.3	094.6	329.5	296.5	172.6	142.2	113.6	354.7	329.4	212.6
14	195.2	166.1	219.1	186.4	061.3	028.3	264.5	234.1	205.6	086.8	061.5	304.7
15	287.2	258.1	311.0	278.2	153.1	120.2	356.4	326.1	297.6	178.9	153.6	036.8
16	019.2	350.0	042.9	010.1	245.0	212.1	088.3	058.1	029.6	270.9	245.7	128.9
17	111.2	081.9	134.7	101.9	336.8	303.9	180.2	150.0	121.6	003.0	337.8	221.0
18	203.2	173.8	226.6	193.7	068.6	035.8	272.1	242.0	213.7	095.1	069.9	313.1
19	295.2	265.7	318.4	285.6	160.5	127.6	004.0	333.9	305.7	187.2	162.0	045.2
20	027.2	357.6	050.3	017.4	252.3	219.5	095.9	065.9	037.7	279.2	254.1	137.3
21	119.2	089.5	142.2	109.2	344.1	311.3	187.8	157.9	129.7	011.3	346.2	229.4
22	211.2	181.4	234.0	201.0	076.0	043.2	279.7	249.8	221.8	103.4	078.3	321.5
23	303.2	273.3	325.9	292.9	167.8	135.1	011.7	341.8	313.8	195.5	170.5	053.6
24	035.2	005.2	057.7	024.7	259.6	226.9	103.6	073.8	045.8	287.5	262.6	145.7
25	127.1	097.1	149.6	116.5	351.5	318.8	195.5	165.7	137.8	019.6	354.7	237.7
26	219.1	189.0	241.4	208.4	083.3	050.7	287.4	257.7	229.9	111.7	086.8	329.8
27	311.1	280.9	333.3	300.2	175.1	142.5	019.3	349.7	321.9	203.8	178.9	061.9
28	043.0	012.8	065.1	032.0	267.0	234.4	111.2	081.7	053.9	295.9	271.0	154.0
29	135.0	-----	157.0	123.9	358.8	326.3	203.1	173.6	146.0	028.0	003.1	246.1
30	227.0	-----	248.8	215.7	090.7	058.1	295.1	265.6	238.0	120.1	095.2	338.2
31	318.9	-----	340.7	-----	182.5	-----	027.0	357.6	-----	212.1	-----	070.2

MOTION OF THE CENTRAL MERIDIAN

01^h-- 033°8	09^h-- 304°5	17^h-- 215°2	10^m-- 005°6	01^m-- 000°6
02 -- 067.7	10 -- 338.3	18 -- 249.0	20 -- 011.3	02 -- 001.1
03 -- 101.5	11 -- 012.7	19 -- 282.8	30 -- 016.9	03 -- 001.7
04 -- 135.3	12 -- 046.0	20 -- 316.7	40 -- 022.6	04 -- 002.3
05 -- 169.2	13 -- 079.8	21 -- 350.5	50 -- 028.2	05 -- 002.8
06 -- 203.0	14 -- 113.7	22 -- 024.3		06 -- 003.4
07 -- 236.8	15 -- 147.5	23 -- 058.2		07 -- 003.9
08 -- 270.7	16 -- 181.3	24 -- 092.0		08 -- 004.5
				09 -- 005.1

To find the central meridian at any given time, find the 0^h, U.T. central meridian for the appropriate date and system, and then add the hours and minutes corrections from the related table "Motion of the Central Meridian," as shown in the example below.

<u>Example</u>.—A dark spot in the SEB transits the central meridian at 07^h 23^m on February 7, 1973 (U.T.). (System I applies to the SEB.)

System I C.M. at 0^h U.T., 7 Feb., ~~1973~~ . . . . ~~298°7~~
+ Motion of the System I C.M. in: 07^h 246.2
20^m 011.7
03^m 001.8
System I C.M. at 07^h 23^m U.T., 7 Feb., 1973 . . . . 558°4 443.3
\- 360.0
198°4
(198°)

Note that if the calculated longitude exceeds 360°, one subtracts 360°. Also, in general, it is more realistic to round calculated longitudes to the nearest whole degree.

ALPO SELECTED AREAS PROGRAM: ALPHONSUS

By: Christopher Vaucher, A.L.P.O. Lunar Recorder

Observers of Alphonsus, one of six craters that were studied in the Selected Areas Program, made 186 observations over a 5-year period. Of these, 152 observations were made from sunrise at Alphonsus (3° colongitude) through the next 7 days, while only 34 observations were made from noon (93° col.) to sunset (183° col.). Listed below are the participants who submitted observations of Alphonsus, including the telescopes and the number of observations made by each.

Inez N. Beck, Wadsworth, Ohio	6" Refl. 39 obs.
Kenneth J. Delano, Taunton, Mass.	12½" Refl. 4 obs.
Carl F. Dillon, Jr., Lowell, Mass.	6" Refl. 37 obs.
Chet B. Eppert, Elkins Park, Pa.	6" Refl. 2 obs.
Ronald Fournier, Lowell, Mass.	6" Refl. 16 obs.
Harry D. Jamieson, Cleveland, Ohio	10" Refl. 3 obs.
H. W. Kelsey, Riverside, Calif.	8" Refl. 39 obs.
R. Krezovich, Syracuse, N. Y.	3" Refr. 1 obs.
John Kronquist, Marquette, Mich.	4" Refl. 1 obs.
William Richrath, Westchester, Ill.	6" Refl. 2 obs.
Charles L. Ricker, Marquette, Mich.	10" Refl. 1 obs.
Martin Senour, Rochester, N. Y.	6" Refl. 1 obs.
Karl Simmons, Jacksonville, Fla. & Tucson, Ariz.	10" Refl., 8" Refl., 5" Refr., 4½" Refr., 4" Refr. 22 obs.
Douglas Smith, Vinton, Va.	6" Refl. 4 obs.
Gary Stover, Charleston, W. Va.	4½" Refl. 1 obs.
Christopher Vaucher, Portland, Ore.	8" Refl., & 6" Refl. - 9 obs.
Bruce A. Waddington, Long Beach, Calif.	8" Refl. 4 obs.

Needless to say, no report would have been possible were it not for the good coöperation and dedication of these observers.

The following is a breakdown of the 186 reports received, giving the number of observations made per 10° colongitude interval after sunrise at Alphonsus:

Col. 0°-10°	36	Col. 50°-60°	13	Col. 100°-110°	9	Col. 150°-160°	1
Col. 10°-20°	24	Col. 60°-70°	10	Col. 110°-120°	2	Col. 160°-170°	3
Col. 20°-30°	11	Col. 70°-80°	10	Col. 120°-130°	3	Col. 170°-180°	1
Col. 30°-40°	25	Col. 80°-90°	2	Col. 130°-140°	4		
Col. 40°-50°	21	Col. 90°-100°	8	Col. 140°-150°	3		

It is quite evident from the above list that observers preferred the evening hours (from 0° to 90° colongitude) to viewing later in the night (from 90° to 180° colongitude). This observational bias should be kept in mind when the reader reviews the published graphs of the intensity estimates of the various features in the crater. Naturally, the estimates made from 0° to 90° colongitude will be more accurate than those for the later colongitude estimates since they are based on many more observations.

The following historical review in this report was done by H. W. Kelsey. The author wishes to express his gratitude to Mr. Kelsey for his assistance.

History. The Rev. T. W. Webb, who lived from 1807 to 1885, has published this description of Alphonsus in Celestial Objects for Common Telescopes[1]: "Alphonsus, 83 miles in diameter, has a steep central peak of 3900 feet (4500 according to Schmidt), about the height of Vesuvius: under a high light two bright specks, and several defined blackish patches, vary the surface, in those places perfectly level. Lorhmann drew 6 dark spots; Schmidt, on the other hand, found but 3 dark spots and 1 faint spot. The latter also saw 2 rilles in both Alphonsus and Arzachel."

Additionally, several other nineteenth century observers recorded and published their hypotheses regarding the dark patches.[2] Among these were, Beer, Mädler, Elger, Goodacre, A. S. Williams, and H. Klein. Williams also reported seeing fine dark rilles joining the dark spots together. In 1882, Klein in describing the dark patches stated that there are

(text continued on page 61)

INDEX TO VOLUME 22 OF THE STROLLING ASTRONOMER

By: J. Russell Smith

(Published from January, 1970 to February, 1971)

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indications that the dark material was ejected from craterlets near the centers of the patches and spread around the adjacent areas.[3] Klein's description can now be accepted as accurate. The confirming proof came from the data returned by Ranger IX, which impacted in Alphonsus.

Early in the present century, W. H. Pickering reported on the patches and found them to be darkest under a high sun. He also discerned a craterlet near the center of each patch.[6] In 1940, Charles Cyrus made observations agreeing well with Pickering's, and confirmed that the patches are darkest under a high sun.[7] H. P. Wilkins[4] and Patrick Moore[5] have pointed out the apparent variation in intensity of these patches, with Moore attributing the apparent darkening of the patches to the changing solar lighting conditions. More recently, V. A. Firsoff[8] acknowledges this course of changing intensities, but calls attention to a somewhat similar process that is in progress in the lunar _maria_ as a whole.

Thus from this small historical sample, it is apparent that the dark patches have been the main points of interest in visual observations of Alphonsus. Isn't it of some significance that after more than a century these dark patches are still a source of observational interest?

In April, 1954, Dinsmore Alter[9] began a photographic study of Alphonsus. This study was made at the Cassegrain focus of the 60-inch reflector of the Mount Wilson Observatory. It is interesting to note that this program was undertaken not because of any anomalous condition observed in Alphonsus, but as a result of a hazy appearance of Ptolemaeus on one of the plates in the Moore-Chappell series. Alter's procedure was to expose his plates in pairs. One plate of each pair was taken in blue-violet and the other in the infrared. Each pair was exposed with a minimum interval, averaging about 1.5 minutes, between plates and during moments of optimum seeing conditions.

Four photographic pairs were made of Alphonsus and Arzachel on Oct. 26, 1956 from $12^h\,0^m$ to $13^h\,16^m$ U.T. Arzachel was selected as a control feature in studying the photographic series. These plates reveal that the selenographic detail in Arzachel was equally well defined in the blue-violet and the infrared. At the same time, the selenographic detail in Alphonsus in the blue-violet when compared with the infrared was noticeably poorly defined on the eastern and north-eastern floor (IAU system was used here and in succeeding direction references). As a result of this evidence, Alter suggested that the recorded loss of detail on the floor of Alphonsus in the blue-violet plates could be caused by a local lunar haze. He ruled out the possibility that the observed loss was due to local surface color because, out of the many plates exposed, these on Oct. 26, 1956 were the only ones registering degraded definition in the blue-violet.

As a result of Alter's photographic observations, N. A. Kozyrev[10] of Pulkova Observatory began a spectroscopic study of Alphonsus. He used a prism spectrograph attached to the 50-inch reflector of the Crimean Astrophysical Observatory. On November 3, 1958, $3^h\,0^m$ to $3^h\,30^m$ U.T., the spectrum of Alphonsus' central peak showed a bright gaseous emission. The most prominent emission bands were the one at 4756 Å and the band group of the molecule C_2 at 4735, 4713, and 4696 Å. When the official report of this scientific observation was released, there was an immediate interest developed among amateur observers to determine whether the apparent volcanic outburst had altered the appearance of the central peak and its environs. Expectedly, this search was accelerated by the exciting possibility of another eruption because, on the Earth, an outburst is frequently followed by additional ones.

Since that time, there have indeed been other reported eruptions of the central peak. One such eruption was reported recently in the _Journal of the Association of Lunar and Planetary Observers_. This event was observed by Daniel H. Harris[11] on the night of June 26, 1966, using the 48-centimeter reflecting telescope at the Whittier College Observatory.

It is certainly agreed that the results obtained by Alter and Kosyrev were a major contribution to a more complete knowledge of the Moon. However, the critical question, do the Alphonsus dark patches actually become darker under a high sun, remains ever present and contestable. In the discussion below of the more conspicuous features and areas in Alphonsus, the reader should refer to the key sketch of Alphonsus, Figure 58, showing Marks A through J (excluding H, which was omitted) as well as transient dark bands located in the crater.

Harry Jamieson did a vertical and horizontal study of certain features in Alphonsus. Below is a list of the areas studied in Jamieson's survey, giving the diameter and vertical measurements of each area (a + indicates height, while a - indicates depth):

FEATURE	DIAMETER (kilometers)	VERTICAL (height or depth) (meters)
Mark J	---------	+1060
Mark C	1.08-1.67	-165
Mark D	1.39-1.70	-180 to -215
Mark F	0.75	-75

Unfortunately, no similar figures are available for the other marks in Alphonsus. The author would like to thank Mr. Jamieson for his efforts, and his contribution to the completion of this file. The reader is advised to refer to the above list from time to time, while reading about each feature.

Mark J. Mark J is Alphonsus' most distinct bright feature, the famous central peak. It is usually apparent as a bright speck, located in the near center of the crater on top of a low hill chain running SSE to NNW. In general, J is nearly always sharp and well defined in almost any aperture telescope. Everyone recorded seeing J, and observations were made of this peak from 4° colongitude to 180° col. The range of intensity estimates went from an intensity of 7 (lowest estimate) to 10 (highest estimate)* All the above estimates were taken from individual observations. Inez Beck almost always recorded J at an intensity of 9 or 10, while H. W. Kelsey usually marked J as 8 or 9. Carl Dillon's estimates agree well with Beck's, but Christopher Vaucher's intensities for J match Kelsey's. Thus, the average intensity range for J is from 8 to 10. The graph for J (Figure 59) in-

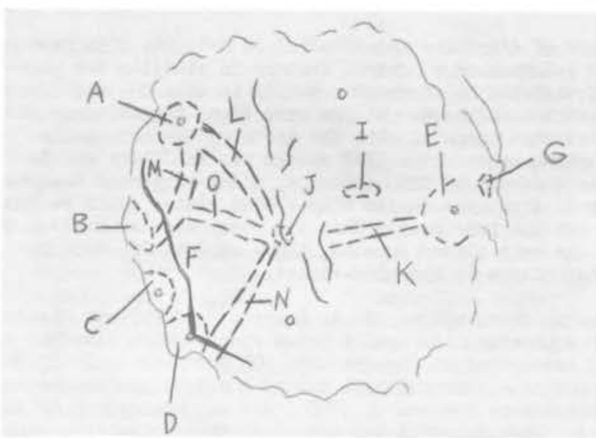

Figure 58. Key map to lunar crater Alphonsus. Shows nomenclature employed in Lunar Recorder Christopher Vaucher's article "ALPO Selected Areas Program: Alphonsus". Lunar south at top, lunar east in the I.A.U. sense at left. In the I.A.U. system west is the hemisphere of Mare Humorum, and east is the hemisphere of Mare Crisium.

dicates no general increase or decrease in intensity; however, two major intensity peaks and one minor peak are evident. The minor peak is at 60° colongitude; the two major peaks are near 100° and 140° of colongitude respectively. It is of interest to note that the peaks occur at 40° intervals from one another. At this time, there is no reasonable explanation for why this is.

Mark G. Located by the west wall of Alphonsus, just west (IAU direction) of dark halo E, lies mark G, which is another brighter peak in Alphonsus, although not so brilliant nor so well defined as J. Not every observer recorded seeing G, nor did the observers who usually recorded G always sight this feature. Out of 186 total observations of Alphonsus, G was recorded only 113 times. Participants who normally saw this peak are: Carl F. Dillon, Jr., Inez Beck, Ronald Fournier, Kenneth J. Delano, H. W. Kelsey, Bruce A. Waddington, and Karl Simmons. Of the 17 total observers of the crater, only 7 recorded G. Of course, most of these 7 observed Alphonsus regularly, submitting more than a couple observations. As an average, Beck's intensity estimates of G ranged from 10 near sunrise to 8 at sunset. Fournier's intensities for this peak remained constant throughout every lunation; he, however, is the only observer to note no differences in intensity for G. Dillon, on the other hand, records the greatest intensity changes. He estimates G near sunrise as 10, gradually

*The lunar intensities discussed by Mr. Vaucher are on a scale of 0 (shadows) to 10 (most brilliant features).

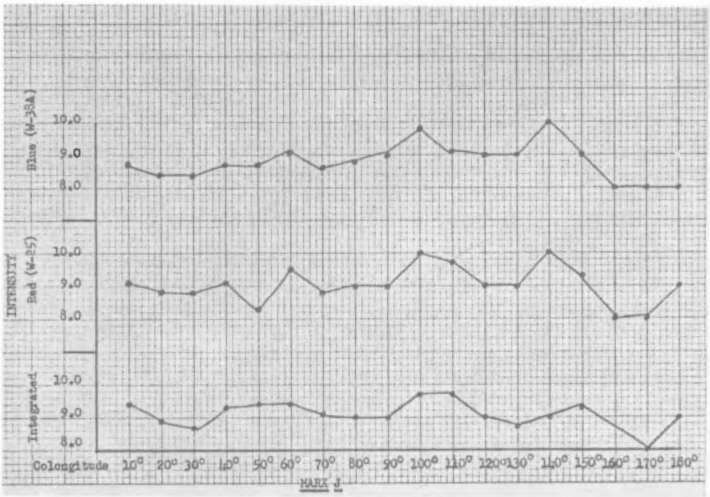

Figure 59. Observed intensity variations of Mark J, the central peak of Alphonsus, in blue, red, & integrated light. The graphs for Figures 59-61 were drawn by Mr. Christopher Vaucher on the basis of ALPO data contributed to the Selected Areas Program. See also text. The different features are identified in Figure 58.

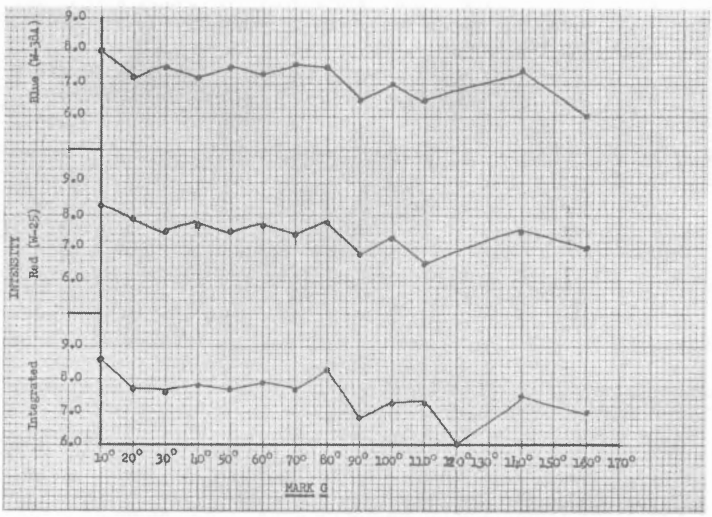

Figure 60. Observed intensity variations of Mark G, a bright peak near the west wall of Alphonsus, in blue, red, and integrated light. See also text.

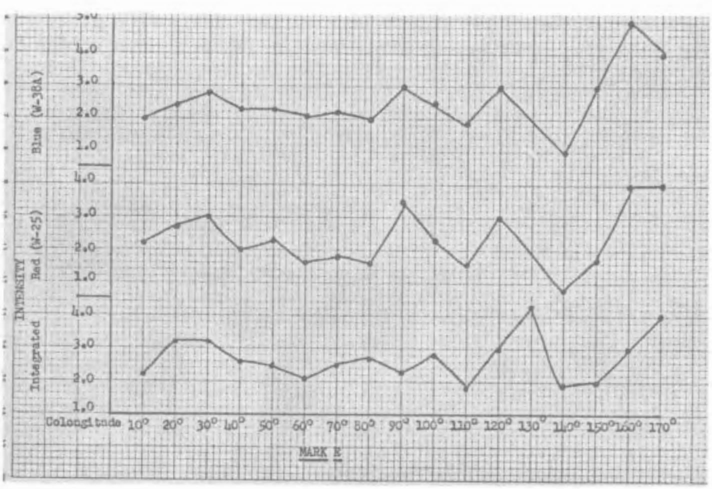

Figure 61. Observed intensity variations of Mark E, a dark patch near the west wall of Alphonsus, in blue, red, and integrated light. See also text.

decreasing to 7 at sunset. Simmons and Kelsey also observed this same general change. The graph of G (Figure 60) indicates a definite trend--showing G's intensity steadily lessening as the lunation progresses. The reason is that the east slope of G is not only steeper than the west slope, but is longer as well. Thus, G reflects more light at sunrise --when the east slope receives the sunlight, than it does at sunset--when the less steep, and not so long, west slope receives the sunlight. The above condition can be inferred from the intensity graph of G. Also, Lunar Orbiter Photographs V-118M and IV-108H_2 confirm this supposition beyond doubt.

Marks E, A, C, and D. These four areas are the darkest and best seen of the halo patches in Alphonsus. All four black halo areas are located alongside the walls of this crater. Haloes A, C, and D are found near the east wall, while halo E is seen by the west wall. Feature E was observed a total of 181 times, varying from a minimum intensity of 1 to a maximum of 5. It was first observed near col. 5° and was continually recorded until col. 174°. Dillon recorded E as intensity 2 near sunrise, decreasing to intensity 1 near noon, then increasing to 2 before sunset. Fournier's estimates agree well with Dillon's, as is true for Simmon's and Smith's intensities for E. Beck best records a shape change in E as the angle of the sunlight varies. Near sunrise, Beck usually observes E as being nearly circular. At noon, E's shape is often rather varied, depending on the observation. Sometimes it is recorded as being semi-elliptical; yet at other times it is seen as an ellipse, whose major axis runs east to west. Beck's observations of E near sunset show this area to be triangularly shaped, with the base running along the west wall. Still other observations depict this dark area as being semicircular at sunset. These differences could be dependent on the angle of solar illumination; however, it is not actually known why they occur. The graph of E (Figure 61) shows two major intensity decreases. The first occurs at 110° col. (in integrated, blue, and red light); and the second is at 140° col. At this time, the big question is--do these haloes actually get darker as the lunation progresses, do the brighter area get brighter, thus causing greater contrast, or both? Still more work is needed for an answer.

Mark A is the only one of all the dark areas not displaying shape changes. This halo is almost always seen as a circle, being observed from 9° to 180° colongitude. Mark A was seen on 162 occasions, with its intensity estimates ranging from 1 to 5. Most observers remarked that A (as well as E) was rather well defined and was most easily seen, the other dark haloes being more diffuse and not so dark. Kelsey shows the intensity of A near sunrise as 4, gradually decreasing until noon when it is 2. This intensity increases again until at sunset it is found to be 3. Vaucher's estimates agree closely with Kelsey's, as do Beck's. Fournier and Dillon's estimates are exactly one intensity unit darker for sunrise, noon, and sunset than are Kelsey's. The graph of this feature (Figure 62) looks nearly the same as the graph of E, only with greater intensity variations. Again, two major low points are indicated,--one at col. 110° and the other at col. 140° (in integrated, red, and blue light). Note also the major intensity peaks, again, as was the case with J (the central peak) and all the other graphs of the haloed craters, 40° of colongitude apart.

Marks C and D are two more dark-haloed craters in Alphonsus. Both areas, observers report, are usually more diffuse and lighter in tone than are Marks A and E. Mark C was observed 140 times, while D was seen on 143 occasions. Both features display very similar shape changes. As the lunation progresses, C and D are often seen as ellipses, semicircles, circles, and triangles, depending on the night and on the observer. Thus it can be seen that neither halo has any particular shape; but rather each varies widely from night to night, and from lunation to lunation. Both haloes were steadily observed from colongitude 10° to 180° (from near sunrise to sunset). The two graphs for C and D (Figures 63 and 64) appear nearly the same, with the first peak for C being greater than the equivalent peak for D. Again, it should be noted that these intensity peaks are 40° apart. Three noticeable intensity dips are also seen at cols. 110°, 140°, and 180°, but are more irregularly spaced.

Marks B and I. Mark B is a dark halo found near the east wall of Alphonsus, while Mark I, the smallest of the halo areas, is the only one not located along a wall, being found halfway between J and E (see Figure 58). Mark B is different from the other haloes in that it is usually recorded as being much brighter in intensity and is less easily seen than any of the other dark patches. At times, participants didn't even mention sighting B, even though all other dark haloes were visible on the same nights. Feature B was observed only 126 times out of the 186 observations. Simmons usually recorded B's intensity near sunrise (3° col.) as 5, but did not even see this halo from noon onwards until near sunset, when it was again observed as being intensity 4.5. Dillon and Fournier, however, noted B's intensity as usually 4 near sunrise, remaining constant throughout the lunar day. Kelsey's intensities strike a medium between Simmon's and Dillon's in that he observed B

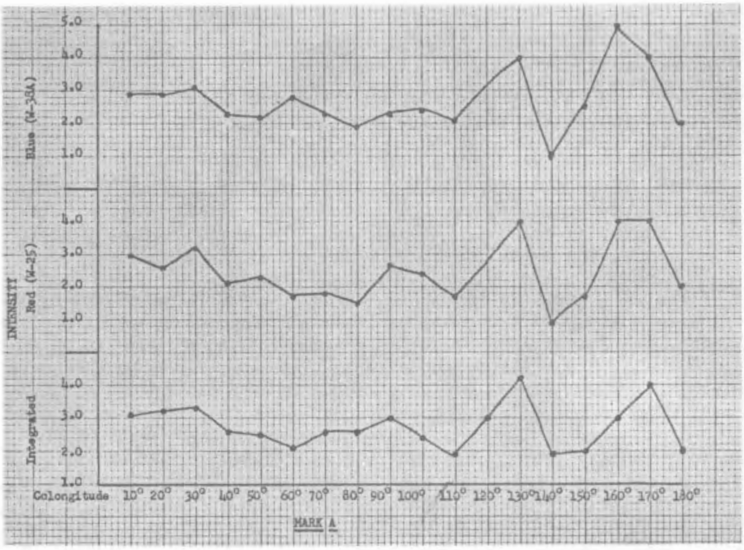

Figure 62. Observed intensity variations of Mark A, a dark patch near the east wall of Alphonsus, in blue, red, and integrated light. As elsewhere in this article, blue is with Wratten Filter 38A; red is with Wratten Filter 25. The graphs for Figures 62-64 were drawn by Mr. Christopher Vaucher on the basis of ALPO data contributed to the Selected Areas Program. See also text. The different features are identified in Figure 58.

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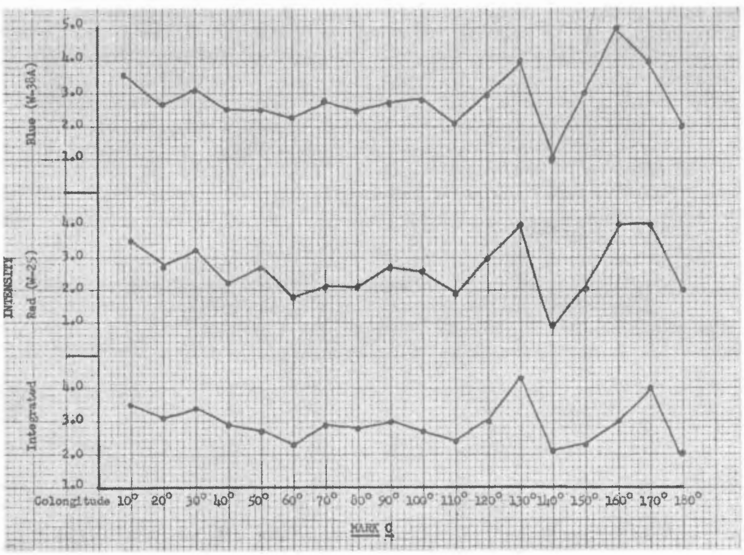

Figure 63. Observed intensity variations of Mark C, a dark patch near the east wall of Alphonsus, in blue, red, and integrated light. See also text.

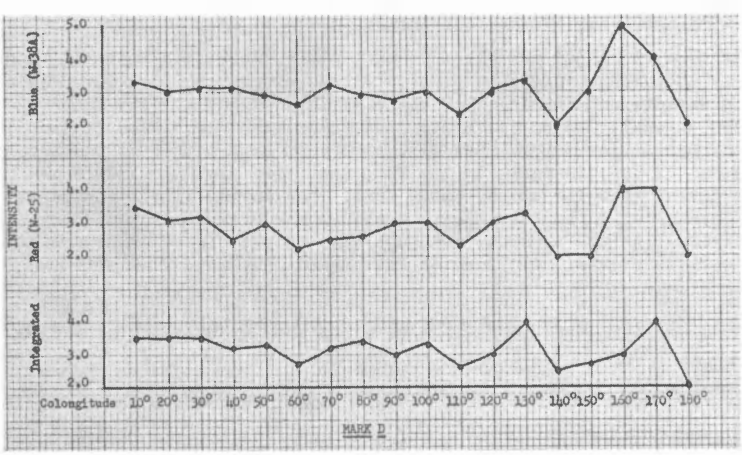

Figure 64. Observed intensity variations of Mark D, a dark patch near the east wall of Alphonsus, in blue, red, and integrated light. See also text.

as 4 at sunrise, 5 around noon, and then again 4 near sunset. Beck's estimates are in agreement with Kelsey's (except on occasions when she does not see B near lunar noon), as are Vaucher's. Feature B's only anomaly appears to be the fact that it often is not seen at all, and this absence usually occurs about noon at Alphonsus (at 93° col.). The graph for this dark patch (Figure 65) shows the same peaks and dips in intensity as do the other halo areas, with the exception that the average intensity is higher than for the other dark areas. Major dips occur at cols. 110°, 140°, and 180° while intensity peaks are found at cols. 90°, 120°-130°, and 160°.

Mark I is the last of the halo areas in Alphonsus. Most observers' intensity estimates of I are nearly the same, with slight variations dependent on the observer. Dillon, Kelsey, Waddington, Jamieson, and Fournier recorded I's intensity as 4 at sunrise, near 3 at noon, and again 4 near sunset. Other participants' estimates were close to the above values. Mark I was reported 124 times over a 5-year period. Of all the graphs of the dark haloes, only that of I (Figure 66) is significantly different from the others, even though the major intensity dips occur at the same colongitudes as on the graphs of the other halo areas. Peaks in intensity are at cols. 90° (in red light), 100° (in integrated and blue light), 130° (in red, blue, and integrated light), and at 160° (in red, blue, and integrated light). Marked intensity decreases occur at cols. 60° (integrated light), 70° (red and blue light), 110° (red, blue, and integrated light), 140° (blue and integrated light), and finally 150° (red light). As was said earlier, the graph for I does show interesting differences.

Mark F. This is the most prominent rille in Alphonsus, running along most of the east wall, and intersecting halo D while passing near haloes B and C. Rille F was observed on only 37 occasions, mostly near sunrise with the remainder of the sightings made at noon. No one saw F at or near sunset. Kelsey recorded seeing F the greatest number of times, with Dillon the only other major observer of this rille. Intensities vary from 2 to a maximum of 7, with no set pattern as to when F's intensity would change. Observers often commented that the southern portion of the rille (from near halo B southward) was often not seen, even when the rest of F was quite visible. This would be explained if this segment of the rille was narrower and/or also shallower than the northern half. Lunar Orbiter IV photograph $108H_2$ confirms the above supposition. No graph was made for this feature since there were too few observations.

Dark Bands K, L, M, N, and O. Six different observers reported sighting at least one dark band on the floor of Alphonsus, while one participant, Carl Dillon, observed five separate bands on numerous occasions. The following is a breakdown of the reports received, showing the number of observations made of each dark band by each observer:

DARK BANDS

	K	L	M	N	O
Carl Dillon	29	23	26	24	19
Ronald Fournier	9	7	9	2	0
Inez Beck	6	0	0	0	0
Bruce Waddington	2	0	0	0	0
Kenneth Delano	0	0	1	0	0
Harry Jamieson	1	0	0	0	0
TOTAL	47	30	36	26	19

Dillon and Fournier were the major contributors of these observations, with 121 and 27 sightings respectively (counting every band seen). All observers recorded intensities ranging from 3 to 5, the variation depending upon the observer. Also, all the bands appeared to remain the same intensity under all aspects of solar lighting. None of the bands are enhanced in any particular color. Usually, observers report them as being very vague and ill-defined--this is due, in part, to the fact that they are only 1 or sometimes 2 intensity units darker than the crater floor tone, thus having little contrast. Some Lunar Orbiter photographs of Alphonsus appear to show these dark zones, but they cannot be regarded as confirmed. At the present, although some of our finest observers have sighted these bands on certain nights, more reports are needed from more observers to reach valid conclusions.

The following unusual or infrequent conditions were reported as existing at various times in Alphonsus:

Kelsey----April 14, 1970--Col. 3°83 to 4°29, seeing 7 (good) and transparency 5. He

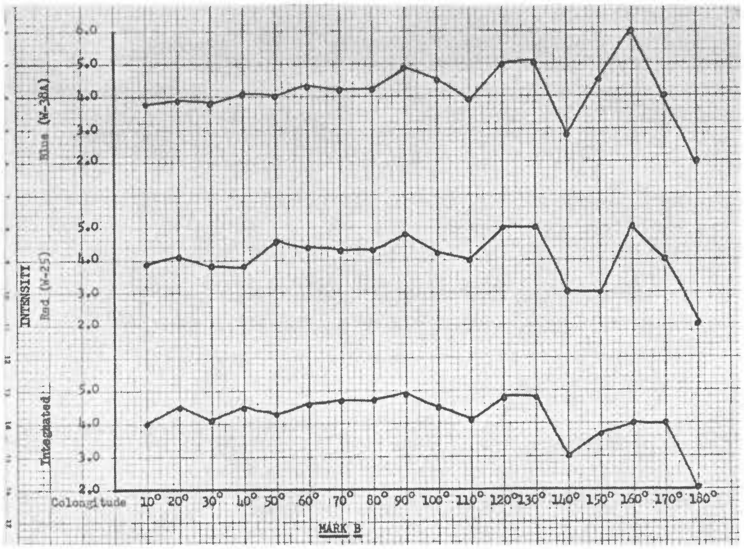

Figure 65. Observed intensity variations of Mark B, a dark patch near the east wall of Alphonsus, in blue, red, and integrated light. Figures 65 and 66 were drawn by Lunar Recorder Christopher Vaucher on the basis of ALPO data contributed to the Selected Areas Program. See also text. The different features are shown in Figure 58, the key chart.

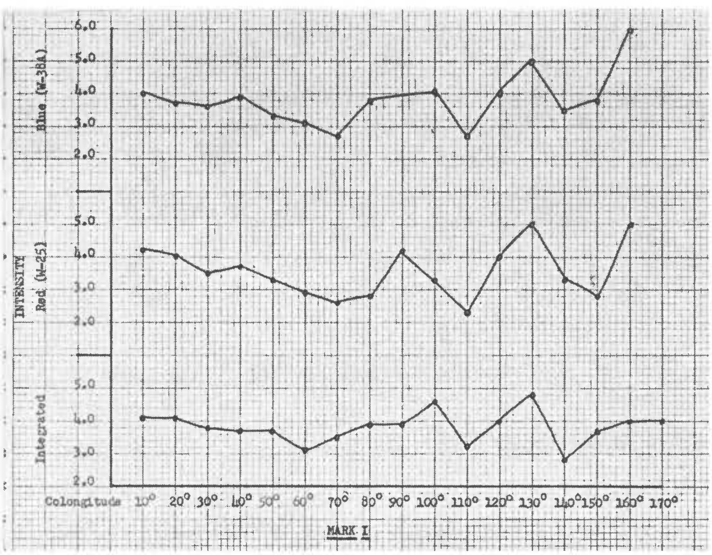

Figure 66. Observed intensity estimates of Mark I, a dark spot in the east central part of the floor of Alphonsus, in blue, red, and integrated light. See also text.

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recorded a general bright area of intensity 6 just south of the central peak. He noted that, as the colongitude progressed, the area grew in size from a small diamond shape to an oval roughly 6 times the size of the original area. When this observation was made, the entire crater floor (excluding the central peak) was in shadow. Mr. Kelsey believes the cause of his observation to be sunlight entering from a gap in the east wall of Alphonsus. Charles Ricker also has reported seeing this bright patch at nearly the same colongitudes (4°.43 to 4°.53).

Beck----August 25, 1969--Col. 58°.92 to 59°.05. Two bright oval areas (both intensity 6) near south floor.

Simmons----March 24, 1967--Col. 65°.4 to 65°.5. Two bright oval patches (both 7.5 intensity) located just west of Mark A (Figure 58). Vaucher also recorded these two patches (6.8 intensity) on several occasions.

Simmons----May 25, 1967--Col. 103°.8 to 103°.9. Three small bright patches, all 7.5 intensity, located between the central peak (J) and Mark E.

Vaucher----February 6, 1971--Col. 39°.0 to 39°.3. A rille (intensity 5) running from inside Mark E south along the edge of the southwest wall. Although no other observer has reported sighting it, this rille is confirmed by Orbiter IV photographs.

As can be seen, more work is needed to help clarify some of these anomalous conditions--especially the confirmation of the dark bands. It is hoped that more observers will become interested in the A.L.P.O. Selected Areas Program so that some of these seldom-seen events will be clarified.

Apologies should be made, especially to the Alphonsus observers, for the delay in completing this paper. The fact that the files were not complete enough to report on until recently, coupled with the uncommon rapidity with which the SAP records changed hands, all contributed to this delay. It is hoped that, despite this lateness, readers will find useful information in the article, and that it may inspire some of you to start participating in this fascinating program. All correspondence from those interested is most heartily welcomed by the author.

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2. Patrick Moore, "The History of Alphonsus", Strolling Astronomer. Vol. 13 (1959), Nos. 5-8.

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11. Daniel H. Harris, "An Absorption Spectrum From the Central Peak of the Lunar Crater Alphonsus", Strolling Astronomer, Vol. 22, Nos. 9-10, 1970.

COMET MAGNITUDE ANALYSIS: TOBA 1971a*

By: Charles S. Morris, A.L.P.O. Comets Section

A total of 66 visual observations of Comet Toba were made by nine ALPO observers between March 21 and August 14, 1971. These observers are:

John Bortle, Stormville, New York
Albert Jones, Nelson, New Zealand
Billy Keel, Nashville, Tennessee
Vic Matchett, Indooroopilly, Queensland, Australia
Michael Mattei, Harvard, Massachusetts
Dennis Milon, Harvard, Massachusetts
Michael Seslar, Rockledge, Florida
Karl Simmons, Jacksonville, Florida
David Sutherland, Penhook, Virginia

In order to determine the light curve and thus the magnitude formula for Comet Toba, all the observations were corrected for the changing Earth-comet distance. Also, these observations, with the exception of those made by David Sutherland, were corrected for the aperture effect by using the formula found by N. T. Bobrovnikoff (Popular Astronomy, Vol. 49, No. 467, 1941, and Vol. 50, No. 473, 1942). Even though the observations made by David Sutherland were made using a telescope with a large aperture, the resulting magnitude estimates were about the same as those taken with much smaller instruments. As a result, it was felt that the aperture correction was not necessary for these observations.

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*Submitted by Dennis Milon, A.L.P.O. Comets Recorder.

The resulting heliocentric magnitudes were then used to obtain the best straight line fit using the formula:

$$H_{\Delta} = H_o + 2.5n \log r,$$

where H_{Δ} is the heliocentric magnitude, H_o is the absolute magnitude of the comet, which is a measure of the intrinsic brightness of the comet, n is a number which indicates how the comet's brightness varies with heliocentric distance (e.g., n = 2 represents the inverse square law), and r is the comet's distance from the Sun. The values of r and delta (the comet's distance from the Earth) were taken from an ephemeris computed by Dr. Marsden (IAU Circulars, Nos. 2314, 2324, 2334). The resulting magnitude formula that was obtained by doing a least squares fit using the CDC 6500 computer at Michigan State University is given below.

$$H_{\Delta} = 6.67 + 10.30 \log r, \qquad n = 4.12$$
(Variation in r: 1.314-1.23-2.125)

The magnitude formula given above, if taken at face value, indicates that Comet Toba was a very average comet. However, one cannot take the above formula at face value because a plot of Comet Toba's light curve (Figure 67) indicates that the comet suffered a one-and-a-half to two-magnitude increase in brightness around July 10, 1971. A more reasonable magnitude formula was obtained by redoing the least squares reduction without the observations made after the brightening. The results of that reduction were:

$$H_{\Delta} = 5.39 + 20.93 \log r, \qquad H_o = 5.39 \pm 0.19, \qquad n = 8.37 \pm 0.55$$
(Variation in r: 1.314-1.23-1.708)

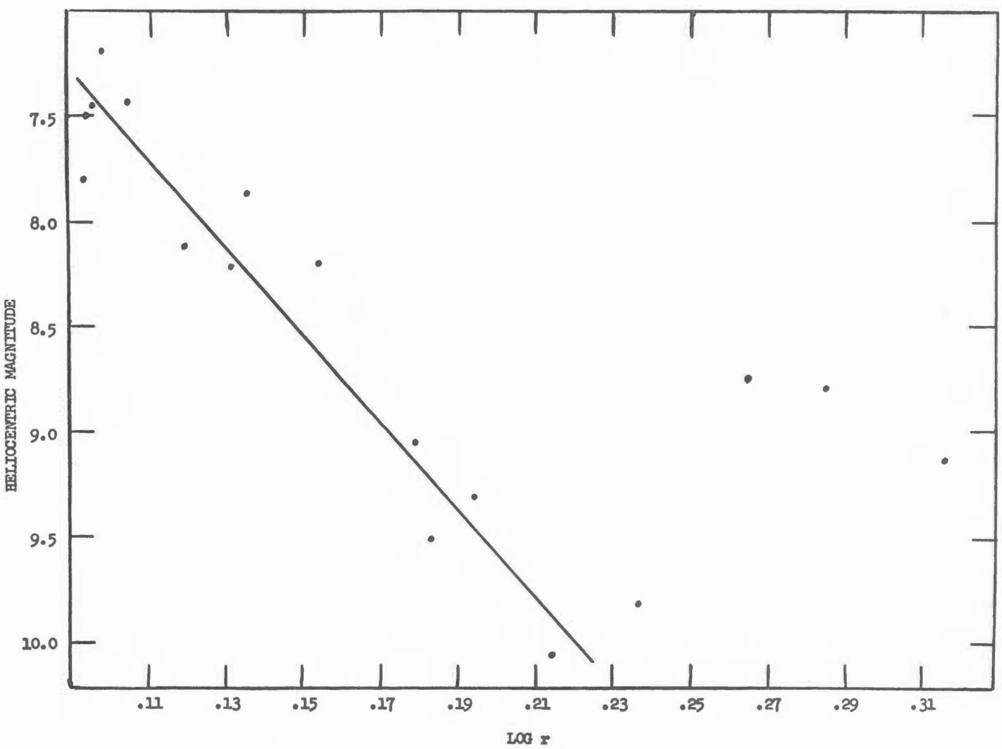

Figure 67. Graph by Charles S. Morris of post-perihelion light-curve of Comet Toba 1971a. Each dot represents the average of three visual observations. The straight line represents the equation $H_{\Delta} = 5.39 + 20.93 \log r$. See also text.

Figure 68. Two tails of Comet Toba 1971a are shown in this drawing from a photograph, taken by Thomas Kleine of Stade, West Germany, on April 19.11, 1971. The comet was then near 21 Pegasi and was of the 8th magnitude. The tail at position angle 29° was measured to be 56 minutes of arc long, while the fainter second tail measured 9 minutes of arc long.

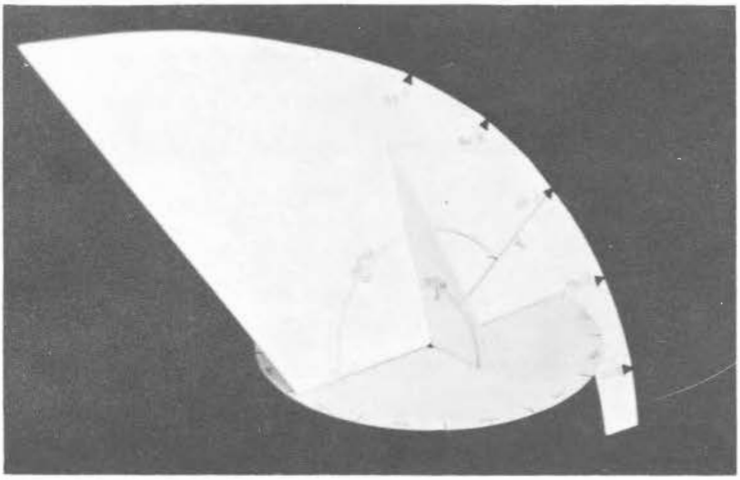

Figure 69. Photograph of a model of the orbit of Comet Toba 1971a constructed by John Bortle of Stormville, New York. The points on the edge of the parabola give the position of the comet from February to July, 1971; the circular piece is the orbit of the Earth. Photo by Mr. Bortle. Note how the comet crossed the plane of the Earth's orbit.

It can be seen from this reduction that Comet Toba had a very high value of n. Normally, n is between two and six with the average value being between three and four. In Toba's case, the value of n was more than twice the average value. This great value indicates that the comet's heliocentric brightness depended very greatly on the comet's distance from the Sun.

The absolute magnitude obtained indicates that Toba had an intrinsic brightness that was slightly greater than average ($H_0 = 6$ is the average absolute magnitude). This statement does not, however, apply after July 10, 1971. The increase in brightness which occurred around that time appears to have permanently affected the intrinsic brightness of the comet. If the value of n remained the same after the increase in brightness, the resulting absolute magnitude would be about 3.5. Therefore, the intrinsic brightness of Comet Toba was probably quite a bit above average after the increase in brightness.

The cause of this increase in brightness has not been investigated, but it appears unlikely that this drastic change was caused by an event on the Sun. In all likelihood, the cause of the change was intrinsic to the comet itself. However, a more detailed in-

COMET TOBA 1971a ALPO VISUAL MAGNITUDES

1971 UT				
March 21.39	Sutherland	9.0	16 inch	SAO Catalog
22.39	Bortle	9.1	10X50	wedge photometer
24.38	Mattei	9.3	6½ inch	SAO
24.40	Bortle	9.1	10X50	wedge photometer
26.39	Bortle	9.0	10X50	wedge photometer
26.39	Mattei	9.3	6½	SAO
28.40	Simmons	9.7	14X100	AAVSO
31.39	Bortle	8.9	10X50	wedge photometer
April 1.38	Mattei	9.0	6½	SAO
3.73	Jones	9.7	12½ inch	SAO, Leander McCormick sequence
4.38	Milon	9.0	4 inch	SAO
5.73	Jones	9.6	12½	McCormick
8.74	Jones	8.8	3 inch	McCormick
18.73	Jones	8.5	11X80	variable chart
19.38	Sutherland	8.4	16	SAO
21.36	Sutherland	8.8	16	SAO
22.35	Sutherland	9.1	16	SAO
23.33	Bortle	7.9	10X50	AAVSO
23.71	Jones	8.4	3	variable chart
24.35	Bortle	8.1	10X50	AAVSO, SAO
24.36	Sutherland	8.3	16	SAO
25.32	Sutherland	8.3	16	SAO
25.74	Jones	8.1	3	SAO
26.73	Jones	8.3	3	AAVSO
27.73	Jones	7.7	2 inch	SAO
27.73	Jones	8.3	2	AAVSO, Henry Draper catalog
May 2.30	Seslar	7.6	5 inch	AAVSO
5.33	Bortle	7.8	10X50	SAO
7.34	Bortle	7.7	10X50	SAO
7.74	Jones	7.6	2	SAO
8.74	Jones	7.6	2	McCormick
18.73	Jones	9.0	3 inch	SAO
21.75	Jones	7.7	2	McCormick
22.75	Jones	7.8	2	McCormick
23.64	Matchett	9.5	12 inch	SAO
23.76	Jones	8.3	2	SAO
24.76	Jones	7.6	2	SAO
24.76	Jones	7.9	2	AAVSO
26.75	Jones	7.4	2	SAO
28.75	Jones	7.7	2	SAO
29.38	Keel	7.6	7X35	AAVSO
June 12.35	Jones	8.1	11X80	T Tuc field
12.35	Jones	9.7	12½	T Tuc field
13.40	Jones	8.4	3	T Tuc field
14.46	Jones	9.0	3	SS Ind field
14.46	Jones	10.0	12½	SS Ind
15.48	Jones	9.3	3	SS Ind
16.46	Jones	9.2	3	SS Ind
19.46	Jones	8.6	11X80	T Oct field
19.76	Jones	8.7	11X80	T Oct
20.50	Jones	9.4	3	T Oct
20.50	Jones	9.3	11X80	T Oct
29.48	Jones	10.2	3	U Oct field
July 3.77	Jones	11.9	12½	variable field
5.75	Jones	10.7	3	variable field
5.75	Jones	11.8	12½	variable field
10.31	Jones	9.3	3	variable field
17.37	Jones	10.6	12½	variable
18.38	Jones	11.3	12½	variable
19.42	Jones	11.4	12½	variable
28.42	Jones	11.4	12½	RS Cen field
30.44	Jones	11.4	12½	RS Cen
31.32	Jones	11.6	12½	RS Cen
Aug. 13.45	Jones	12.6	12½	W Cen field
14.32	Jones	12.3	12½	W Cen

vestigation will have to be carried out to determine the most probable cause for this increase in brightness.

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MUTUAL PHENOMENA OF JUPITER'S SATELLITES, JUNE 6-OCTOBER 30, 1973

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

The eclipses, occultations, transits, and shadow transits of Jupiter's four Galilean satellites are known to every observing amateur. Probably relatively few amateurs realize, however, that these satellites can also occult each other and can be eclipsed in each other's shadows. Such mutual phenomena can occur only when the Earth and the Sun are very close to the plane of the equator of Jupiter, which is also very nearly the plane of the

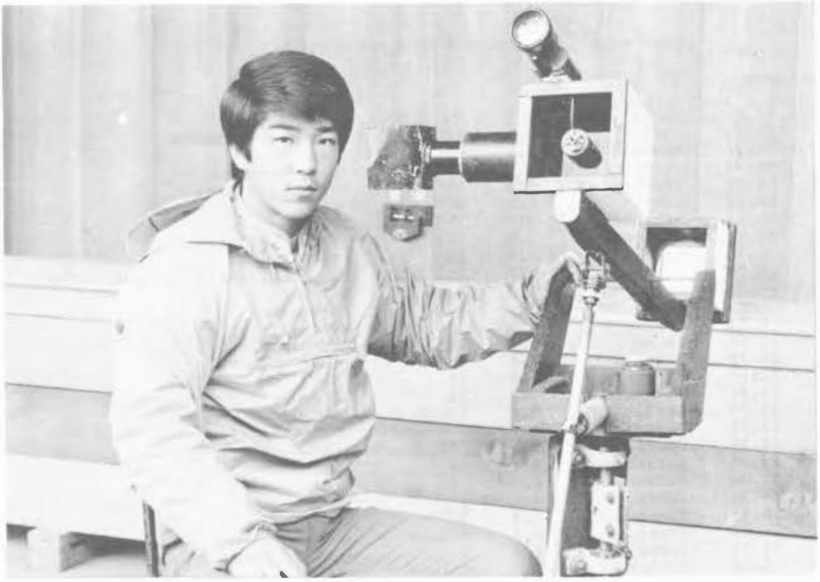

Figure 70. Mr. Kenji Toba, the discoverer of Comet Toba 1971a, and his home-made 11-cm. altazimuth reflector, with 28X. He is a student of economics at Komazawa University and is a member of the Cometary Observation Network of Japan. This Network was founded in 1967 and has been directed by Mr. Akira Kamo of Wakayama City. Most of the Japanese comet discoveries in recent years are by members of this Network. There are nearly 500 members, who are banded together by frequent circulars and a telephone network. Photograph contributed by Mr. Takeshi Sato.

Figure 71 (above) and Figure 72 (right). Mr. David Sutherland of Penhook, Virginia observed Comet Toba 1971a with the home-built 12.5-inch reflector shown. He uses the same instrument for comet searches.

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orbits of these satellites. The Earth crosses this plane twice during each revolution of the Giant Planet around the Sun, and hence the mutual phenomena recur at about six-year intervals. The last time was in 1967; and a new series of mutual phenomena will begin on June 6, 1973.

The mutual occultations and eclipses are interesting in themselves. It is also instructive to compare the colors, sizes, and surface brightnesses of superimposed satellites. Actual timing of all contacts should be attempted. We would be especially interested in observed times (first and last contacts, mid-eclipses, and mid-occultations), notes on comparative colors and surface brightnesses of two satellites in contact, on possible optical effects then remarked, and especially in careful descriptions of the phenomena which will indicate how well our telescopes resolve detail on these small discs.

All observers are encouraged to contribute observations of these phenomena to the A.L.P.O. Jupiter Section. Telescopes of all sizes will be able to contribute valuable data to this type of observing program. If you are equipped with apertures larger than 10 inches, you may wish to contribute photoelectric observations. Smaller apertures may be used to make qualitative comparisons of size, color, and albedo of the two satellites.

We give below the mutual phenomena up to October 30, 1973. It will be noted that some of the phenomena cannot be observed in the United States. However, all times are given so that we may have a good observational program with participation on an international basis. The observer should describe each phenomenon observed clearly and in some detail.

Our list below is taken from pages 36-37 of the 1973 Handbook of the British Astronomical Association. Dates and times are given in Universal Time. In the second column E is for Eclipse, O for Occultation. The third column tells us which satellite is being eclipsed or occulted by which other satellite. It will be noted that some eclipses are penumbral only. The last column gives the fraction of the diameter of the eclipsed satellite covered by the umbral shadow of the eclipsing satellite.

Satellite phenomena observations should be submitted to the author for analysis and for future reporting of their results in this Journal. Send observations to:

ALPO Jupiter Recorder
Phillip W. Budine
91 Townsend Street
Walton, New York 13856

Mutual Phenomena of Jupiter's Satellites in 1973

					Eclipse				
			Occultation		Penumbra		Umbra		
Date	E or O	Satellites	Begins	Ends	Begins	Ends	Begins	Ends	Mag.
			h m	h m	h m	h m	h m	h m	
June 6	O	II by I	20 07	20 08	-	-	-	-	-
10	O	II by I	9 10	9 12					
13	O	II by I	22 13	22 15					
17	O	II by I	11 15	11 19					
21	O	II by I	0 18	0 21					
22	O	I by III	12 38	12 49					
24	O	II by I	13 20	13 24					
26	O	IV by III	8 31	9 01					
28	O	II by I	2 22	2 26					
29	O	I by III	4 40	4 48					
29	O	I by III	11 19	11 38					
July 1	O	II by I	15 24	15 28					
5	O	II by I	4 25	4 30					
8	O	II by I	17 27	17 32					
12	O	II by I	6 28	6 33					
15	O	II by I	19 30	19 35					
19	O	II by I	8 31	8 36					
21	O	III by IV	20 03	20 44					
22	O	II by I	21 32	21 38					
26	E	II by I	-	-	10 25	10 29			
26	O	II by I	10 34	10 40					
29	E	II by I	-	-	23 35	23 40			
29	O	II by I	23 36	23 42					
Aug. 2	O	II by I	12 38	12 44					
2	E	II by I	-	-	12 46	12 51	12 48	12 49	0.04

Date	E or O	Satellites	Occultation Begins	Occultation Ends	Eclipse Penumbra Begins	Eclipse Penumbra Ends	Eclipse Umbra Begins	Eclipse Umbra Ends	Mag.
			h m	h m	h m	h m	h m	h m	
Aug. 6	O	II by I	1 40	1 46					
6	E	II by I			1 57	2 04	1 59	2 02	0.16
9	O	II by I	14 42	14 49					
9	E	II by I			15 09	15 16	15 10	15 14	0.28
13	O	II by I	3 46	3 53					
13	E	II by I			4 22	4 30	4 23	4 28	0.40
16	O	II by I	16 49	16 56					
16	E	II by I			17 35	17 43	17 36	17 42	0.52
20	O	II by I	5 54	6 01					
20	E	II by I			6 49	6 58	6 50	6 57	0.63
23	O	II by I	18 59	19 06					
23	E	II by I			20 04	20 14	20 05	20 12	0.75
27	O	II by I	8 05	8 13					
27	E	II by I			9 21	9 31	9 22	9 30	0.80
30	O	II by I	21 11	21 20					
30	E	II by I			22 38	22 49	22 40	22 48	0.81
Sept. 3	O	II by I	10 20	10 29					
3	E	II by I			11 58	12 11	12 00	12 09	0.77
6	O	II by I	23 29	23 38					
7	E	II by I			1 20	1 34	1 22	1 32	0.69
7	E	II by I			13 14	13 38	13 19	13 34	0.13
9	E	II by III			7 44	8 35	7 49	8 30	0.73
9	E	III by IV			16 07	17 12			
9	E	II by III			21 33	22 11	21 38	22 06	Total
10	E	III by IV			11 28	12 15			
10	O	II by I	12 40	12 50					
10	E	II by I			14 46	15 01	14 48	15 00	0.62
12	E	III by I			7 27	7 36			
14	O	II by I	1 53	2 04					
14	E	II by I			4 16	4 34	4 18	4 32	0.56
16	E	II by III			5 07	5 51	5 12	5 45	0.41
16	O	II by III	11 27	12 24					
16	O	II by III	19 55	20 45					
17	E	II by III			2 40	3 05	2 43	3 02	0.99
17	O	II by I	15 08	15 20					
17	E	II by I			17 55	18 19	17 58	18 16	0.52
19	E	III by I			11 45	12 13	11 52	12 06	0.13
19	E	III by I			16 39	17 13	16 45	17 07	0.24
21	O	II by I	4 26	4 39					
21	E	II by I			7 52	8 36	7 56	8 31	0.52
21	E	II by I			11 00	11 56	11 05	11 52	0.82
23	O	II by III	9 00	9 26					
24	O	II by III	1 32	1 55					
24	E	II by III			7 03	7 23	7 06	7 20	Total
24	O	II by I	17 48	18 04					
28	O	II by I	7 16	7 35					14:42 (I))
28	O	II by I	14 22	14 51	(Occulted by Jupiter until 14:43 (II))				
Oct. 1	O	II by III	5 58	6 13					
1	E	II by III			11 06	11 23	11 09	11 20	Total
1	O	II by I	20 56	21 24					
2	O	II by I	1 52	2 28					
4	E	IV by III			11 18	12 27	11 31	12 15	0.29
5	E	IV by III			17 18	18 06	17 31	17 53	0.15

Date	E or O	Satellites	Occultation Begins	Occultation Ends	Eclipse Penumbra Begins	Eclipse Penumbra Ends	Eclipse Umbra Begins	Eclipse Umbra Ends	Mag.
Oct. 7	E	I by III			16 15	16 19			
8	O	II by III	10 02	10 12					
8	E	II by III			14 58	15 13	15 00	15 11	Total
11	E	I by II			3 33	3 35			
14	E	I by II			16 39	16 42			
14	E	I by III			19 01	19 07			
15	O	II by III	13 55	14 01					
15	E	II by III			18 41	18 55	18 44	18 53	Total
18	E	I by II			5 45	5 49			
18	E	III by I			21 11	21 15			
21	E	I by II			18 52	18 56			
21	E	I by III			21 50	21 57	21 52	21 54	0.14
22	O	II by III	17 43	17 44					
22	E	II by III			22 19	22 32	22 22	22 30	0.90
25	E	I by II			7 58	8 02	8 00	8 01	0.04
26	E	III by I			0 00	0 05			
27	E	III by IV			16 43	17 11			
28	E	I by II			21 05	21 09	21 06	21 08	0.15
28	E	I by IV			23 14	23 21			
29	E	I by III			0 42	0 50	0 44	0 48	0.46
29	E	III by IV			11 50	13 02	12 00	12 52	0.57
30	E	II by III			1 53	2 05	1 55	2 03	0.76

COMET FUJIKAWA, 1969d

By: J. E. Bortle, A.L.P.O. Comets Section

This fairly bright comet was under observation by A.L.P.O. Comets Section members for a relatively short time, some five weeks. It was the third comet discovered by Mr. Shigehisa Fujikawa of Onohara, Kagawa, Japan, being found on August 12.7, 1969. Mr. Fujikawa was an independent discoverer of both 1968a and 1968c and probably spends more time comet hunting than any other observer in the world (he has since also discovered Comet 1970a). At discovery, Fujikawa called his comet magnitude 11 and noted that it had neither a condensation or tail. The comet was under observation from the middle of August until late in September, 1969 as it rapidly increased in brightness from magnitude 9 to 7.

The comet's distance from the Earth changed little during the time it was under observation because of the orientation of its orbit. The comet passed perihelion on October 12 at a heliocentric distance of slightly more than three quarters of an astronomical unit. Orbital elements published by Dr. B. G. Marsden and used in the following study were:

T = 1969, October 12.4480	ω = 299°.030
e = 1.0000 (parabola)	Ω = 191°.687
q = 0.77392 A.U.	i = 8°.932

Reports were received from:

J. Bortle, Mount Vernon, N. Y.
D. Conger, Elizabeth, W. Va.
V. Matchett, New Zealand
T. Middlebrook, Nacogdoches, Tex.
M. Miller, Orosi, Calif.
D. Milon, Cambridge, Mass.
W. Pacholka, Lakewood, Calif.
W. Wooten, De Funiak Springs, Fla.

Though at first described as completely diffuse, Comet Fujikawa rapidly became more condensed as it approached the Sun. When last observed on September 22, its degree of condensation was judged as high as 6-7 (on a scale of 0, very diffuse, to 9, stellar). Throughout the period of observation the coma diameter remained relatively unchanged at approximately 125,000 miles. Only J. Bortle and D. Milon observed any tail. It was first noted on September 10 with a position angle of 275° and was last seen on September 21 when it had grown to 20' and had a P.A. of 290°. Judging from the visual observations plus a few photographs, it would appear that that the tail was of Bredichin Type I (straight,

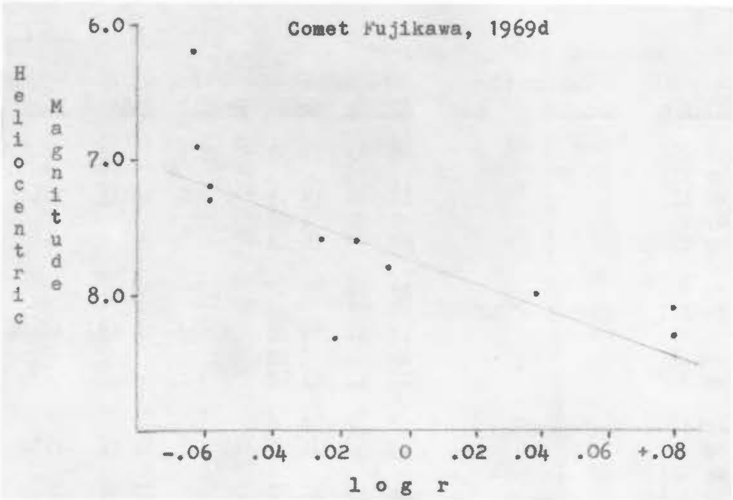

Figure 73. Photometric graph of coma brightness of Comet Fujikawa 1969d. The dots are the individual observations in Table I made by A.L.P.O. Comets Section members. Graph prepared and contributed by J. E. Bortle. The least squares line which best fits the 11 observations is shown.

Table I. Comet Fujikawa 1969d Visual Magnitude Estimates.

Date	U.T.	Observer	Aperture (inches)	Magnitude	
1969, Aug.	24.35	Bortle	6	9.2	a
	24.35	Bortle	2	9.0	a
Sept.	8.52	Pacholka	8	8.7	b
	10.38	Bortle	2	8.5	a
	12.38	Bortle	2	8.3	a
	13.40	Wooten	6	9.0	a
	14.38	Bortle	2	8.3	a
	21.39	Bortle	2	7.9	a
	21.45	Middlebrook	8	8	-
	22.40	Conger	2	7.6	b
	22.51	Miller	6	6.9	a

a. AAVSO charts.
b. Smithsonian Astrophysical Observatory Star Catalog.

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narrow gas tail) and was about one million miles long. J. Bortle and W. Wooten were the only observers to report a stellar nucleus, the former on August 24 and latter on September 13, 1969, both calling it magnitude 11.

Total or Coma Magnitude

Observations were reduced without correction for aperture. Dr. N. T. Bobrovnikoff's aperture correction formula has been found to be of dubious value when applied to observations made with reflectors or for mixed (refractor and reflector) observations in recent A.L.P.O. studies. In the present study, use of the formula would have significantly increased the probable error in the magnitude formula. Eleven observations were reduced to heliocentric values, and the least squares line best fitting the observations was determined. The resulting magnitude formula was:

$$m = 7.70 + 9.37 \log r, \ n = 3.75,$$

where m is the heliocentric magnitude, 7.70 is the absolute magnitude, r is the distance from the Sun in astronomical units, and n is an exponent showing how the comet's brightness varied with changing r. [See also the discussion on pages 69 and 70.] Comet Fujikawa was somewhat fainter than the average comet, but its rate of variation in brightness with heliocentric distance was about average.

BOOK REVIEWS

Challenge of the Stars, by Patrick Moore and David A. Hardy, Rand McNally and Co., Box 7600, Chicago, Illinois, 60680, 1972. 62 pages. Price $6.95. Large format - $9\frac{1}{2}$" x $13\frac{1}{4}$".

Reviewed by J. Russell Smith

Patrick Moore is well known throughout the world as a fluent astronomical author, and the artist co-author is recognized as one of outstanding ability in the astronomical field. In this book they have combined their talents to give us an imaginative journey into the universe.

The authors lead the reader from a Moon base to a base on Mars and then on to explore the Solar System and the distant stars. The text is made more realistic by the many full page astronomical paintings which are based on present knowledge and theories. These paintings, plus the smaller ones throughout the book, not only make it more attractive; but they inspire the imagination.

The volume is actually well illustrated basic elementary astronomy, and it can be recommended for anyone interested in the subject.

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Ion Propulsion - Technology and Applications, by George R. Brewer, Gordon and Breach Science Publishers, New York, N. Y., 1970. 534 pages. Price $45.00.

Reviewed by Julius L. Benton, Jr.

The author of this fairly expensive volume, who is on the staff at Hughes Research Laboratories in Malibu, California, has rather successfully attempted to introduce the new and relatively unfamiliar technology of ion propulsion to students of advanced propulsion and to engineers. Those who possess a moderately good working knowledge of the calculus should find the material interesting and enlightening.

Chapter 1 is essentially a brief survey of the various kinds of electrical propulsion thrusters, performance comparisons, an historical perspective, and finally an introduction to ion propulsion as a new technology. The following chapter, "Ion Propulsion Missions", deals with a variety of missions for which ion propulsion shows definite advantages. Chapter 3, "The Elements of an Ion Propulsion System", discusses the general performance parameters of an ion propulsion system, serving as a prelude to a more detailed treatment in subsequent chapters. The source of ions, which is shown to exert a vital and fundamental influence on thruster performance and overall lifetime, is presented in detail in Chapter 4, "The Ion Source". A reasonably coherent description of the design of an ion accelerator, which extracts ions from the source and "structures" them into a desired beam for ejection from the vehicle, is the principal topic of Chapter 5, "Ion Beam Accelerator Design". Chapter 6, "Power and Control Subsystems", is not only concerned with a status report on the prime power systems, chiefly solar cells and nuclear electric power devices, but also with the power conditioner design, which accepts the power input from the primary source and can vary and control it in a way as is required by the thruster. Chapter 7 is concerned with the final main subsystem, which is the propellant feed and control mechanism. A discussion of system efficiency and durability, together with performance limiting factors, is the subject of Chapter 8. The techniques and nearly unique difficulties of testing the ion propulsion systems are considered in Chapter 9. Ion propulsion systems as applied to the attitude control and station keeping of a synchronous satellite and to unmanned interplanetary spacecraft form the basis of a discussion in Chapters 10 and 11. Lastly, in Chapter 12, the future possibilities which can be envisioned for ion propulsion systems are presented.

Thoughout the book there are numerous diagrams, tables, graphical presentations, and illustrations to aid in the reader's understanding of the concepts developed. As was noted earlier, the book is principally aimed at the specialist who may wish to become familiar with the field of ion propulsion in order to apply it. Such an audience is likely to include propulsion system and space vehicle designers, as well as students who may be pursuing a future in the field. The book may be a little too technical for the non-specialist, and certainly the price is prohibitive to many. Nonetheless, I recommend it for anyone who has some background in higher mathematics and physics and who is sufficiently interested and patient to attempt a progressive understanding of the basic concepts described.

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1973 Celestial Calendar and Handbook, by Chas. F. Johnson, Jr. Published by the author at Box 388, Middletown, Md. 21769. 40 pages, price $1.50, postpaid in the U.S.A., Canada, or Mexico.

Reviewed by Harry Cochran

Mr. Johnson clearly states the purpose of the 1973 edition of his Celestial Calendar and Handbook: "Our aim is always to offer the selected material in a form that will be as practical as possible for everyone, beginner as well as more experienced observer". He then suggests several reliable references for those who desire detailed technical information. Included in the 40 pages are many approved charts, tables, and predictions that will accommodate the varied interests to be expected of observers. Thoughtful consideration of the beginner is quite noticeable throughout the booklet. For example, pages 37 and 38 list seventeen recommendations that concern record keeping and viewing activities, along with appropriate directions. If any one section serves to meet the approval of everyone, including the occasional and curious viewer, it would be the calendar of predicted events.

I feel safe in saying that the Celestial Calendar and Handbook, priced at $1.50, was deliberately compiled to inspire and motivate the beginner to progressive celestial investigation as well as to provide dependable data for the more experienced observer.

ANNOUNCEMENTS

Mars Section Newsletter. An informal newsletter, the Martian Chronicle '71 (MC '71), was so favorably received and was so successful in keeping active Mars observers informed about ALPO Mars Section activities and 1971 Martian observational aspects that a current Martian Chronicle '73 (MC '73) will be published. The MC '73 will appear as communication appears worthwhile during the current last favorable near-perihelion apparition of Mars of this decade. The new service is available at no cost to those who will send to the Mars Recorder, Mr. C. F. Capen, 10 self-addressed, stamped envelopes (8¢ surface or 11¢ airmail) of letter size, 9.4 by 4 inches. Since observers in foreign countries cannot obtain U. S. postage stamps, they can obtain this service for a minimum rate of $2.50, a charge necessary in order partly to cover cost and air mail postage. It is also planned to send to subscribers to Martian Chronicle '73 various observational aids and graphic ephemerides.

New Address for Lunar Recorder Jamieson. Mr. Harry D. Jamieson now has this address: Box 30163, Middleburg Heights, Ohio 44130. All correspondence and all observations contributed to any of Mr. Jamieson's Lunar Section programs should be mailed to the new address given above.

Handbook and Observing Forms for the A.L.P.O. Mercury Section. On December 16, 1972, Mercury Recorder Richard G. Hodgson wrote that he expected to have available by February 1, 1973 An Observer's Guide to the Planet Mercury. It totals 20 to 25 pages, and the cost is $2.50 postpaid. Mr. Hodgson also reports that he regrets that in the future he must charge $1.00 (postpaid) for a set of 20 Mercury observing forms. With increasing costs, and particularly higher postal costs, our staff members cannot properly be expected to pay for the observing aids which members request. We are sure that contributing ALPO members will understand and will coöperate.

A New A.L.P.O. Section: Minor Planets. After some discussion in recent months, the Director has appointed Reverend Richard G. Hodgson, Dordt College, Sioux Center, Iowa 51250 to be Recorder for a new Minor Planets Section. On February 9, 1973 the Minor Planets Recorder wrote in part as follows: ". . . I would be happy to receive any minor planet observations made by A.L.P.O. members. If their correspondence requires an answer, or an acknowledgement is desired, a stamped, self-addressed envelope or postcard should be included. Photographs and positional measures are desired, as are studies of rotation based upon a series of brightness observations. For the latter photoelectric photometry is to be preferred, but careful estimates obtained visually using variable star techniques may also be of value, particularly if conducted over as long a period as possible.

"I wish particularly to know about those who wish to join the Section who have observational equipment. They should let me know what instrumentation they have available. I am planning to begin publication of a Minor Planet Bulletin on a bimonthly basis, beginning with March. This will provide ephemerides of planets of interest for future observation, and will report observations of Section members. (Findings of more general interest will, of course, be recommended for publication in J.A.L.P.O. as well.) The cost of this

Minor Planet Bulletin will be $2.00 a year for addresses in U.S. and Canada, and $3.00 for addresses overseas."

The Lunar and Planetary Training Program: New Assistant and News Notes. Mr. José Olivarez, Director, Hutchinson Planetarium, 1300 North Plum, Hutchinson, Kansas 67501 has joined Mr. Richard J. Wessling as his Assistant in the Training Program. Because of the increased number of students now enrolled in the Training Program, the addition of Mr. Olivarez to the staff is most welcome. He is a very experienced observer of Jupiter and the Moon. When we add to this background his profession as a Planetarium Director and instructor, we see that the Training Program and its students will surely benefit. Prospective members for the Training Program should continue to direct their inquiries to Mr. Wessling. Some will be referred to Mr. Olivarez as appears appropriate.

We congratulate these recent graduates of the Training Program: Frank des Lauriers, Peter Reinert, and Alain Porter. They have proven themselves and are to be considered "qualified" observers. Mr. Wessling is pleased with the recent growth of interest in this project.

The Novice Observers Handbook can now be purchased for $1.00 from Mr. Wessling. This handbook and the expansion of the staff mean that the Training Program can now provide higher quality and faster service to enrolled ALPO members. Both Recorders encourage our readers to take advantage of these services and will welcome your inquiries.

Help Given by Harry Jamieson. In recent months Mr. Harry Jamieson has given us considerable assistance in answering routine correspondence--some of it in truth by no means routine. He has also twice polled the staff on questions of policies. We are grateful for these efforts.

1973 ALPO Convention. This meeting will be held along with the Astronomical League National Convention at Omaha, Nebraska on August 1-5, 1973. More details will appear in our next issue. Papers on suitable subjects by qualified members are heartily invited. Indeed, it is already time to begin planning your paper; it should be mailed to the Editor of this journal. You are also urged to contribute drawings, photographs, charts, and other good display items to the ALPO Exhibit at Omaha. For the third consecutive year our Exhibits Chairman is Mr. Harry D. Jamieson, Box 30163, Middleburg Heights, Ohio 44130. Plan your summer vacation now so as to be with us at Omaha for an astronomically delightful five days!

Venus Section Material. Dr. Julius L. Benton, our Venus Recorder, writes that he can now furnish a complete set of observing forms and a new introductory brochure about Venus for a price of $2.00. The planet reaches superior conjunction on April 9, 1973 and will soon be observable in the evening sky.

Addition to Lunar Section Staff. Mr. Roy C. Parish, Jr., 208 Birch St., Milton, Florida 32570 has been appointed an Assistant Lunar Recorder. He will help Lunar Recorder Jamieson in a special study of the famous twin craterlets, Messier and W. H. Pickering, located on the Mare Fecunditatis, and in vertical studies of other lunar features. Helpful results can be obtained with very modest telescopes. Interested readers are urged to write to Mr. Parish, whom we warmly welcome to our lunar staff.

Reorganization of Jupiter Section: Who Does What. After a substantial amount of correspondence and phone calls among Paul K. Mackal, Phillip W. Budine, and the Director, it has been decided that Messrs. Mackal and Budine shall henceforth be joint co-Recorders for Jupiter. Observers of the Giant Planet should note the following division of duties and should submit observations and correspondence as is indicated. Mr. Mackal will be in charge of full disc drawings, intensity and color estimates, strip sketches, reduction of latitude measurements, research projects in the new Jupiter Handbook, and miscellaneous verbal reports. He will also handle all routine or general Section correspondence. Mr. Budine will be in charge of central meridian transits and their reduction to yield rotation periods, satellite observations, and correspondence relating to the new bound Jupiter Bulletin. The two Recorders will jointly handle Jupiter photographs and Section publicity. Observers may obtain forms for C.M. transits or section drawings from Phil Budine; forms for full disc drawings and Jupiter Section Manuals are available from Paul Mackal. Jupiter Section files of full disc drawings over the period 1961-73 may be studied by qualified research workers at the home of Mr. Mackal. Files of C.M. transits and strip sectional sketches are similarly available at the home of Mr. Budine. It may be best to submit all observational data to Recorder Mackal first.

The following ex officio assistants are helping the Jupiter Section in a variety of ways: Wynn K. Wacker, J. Horvath, Ron Doel, and Walter H. Haas. We are grateful for their interest and assistance.

Sustaining Members and Sponsors. The persons in these special classes of membership as of March 24, 1973 are listed below. Sponsors pay $25 per year; Sustaining Members, $10 per year. The balance above the normal rate is employed to assist the ALPO in suitable ways. We thank all these colleagues for their generous help.

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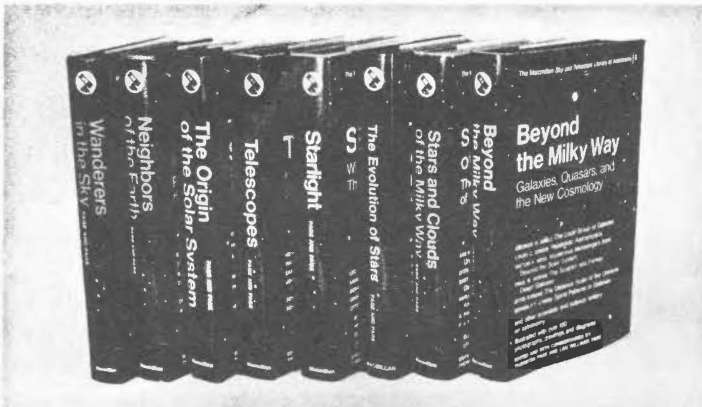

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