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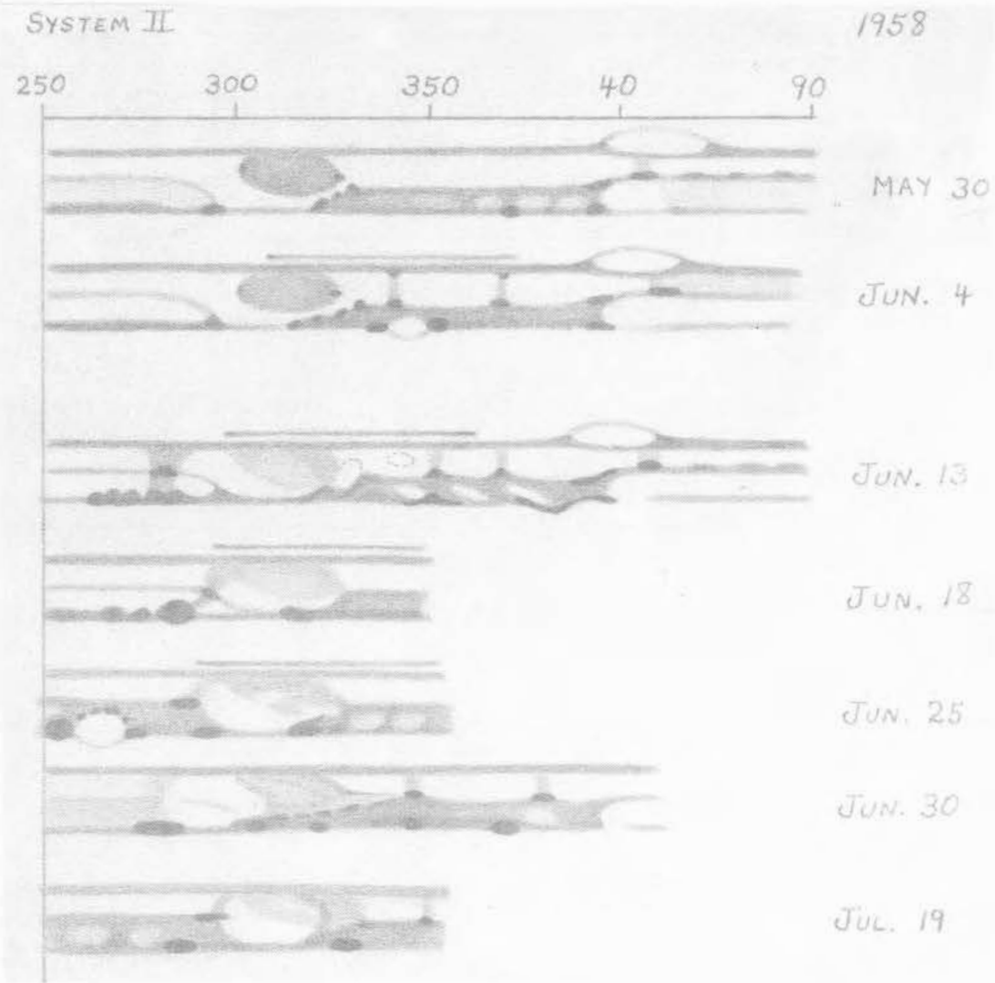


THE STROLLING ASTRONOMER
1835 Evans Place
Las Cruces, New Mexico

Latitudinal Strip Sketches of Jupiter to show Involvement of Red Spot Region in South Equatorial Belt Disturbance of 1958. Observations by Elmer J. Reese with a 6-inch Reflector at 240X. Sketches show S.E.B., S. Trop. Z, and S. Temp. B.

In This Issue

ANNOUNCEMENTS

Prices of Recent Issues. The varying size of recent issues of The Strolling Astronomer has naturally caused some confusion. Single price issues are as follows:

Tenth Anniversary Issue (Jan. - June, 1957), 72 pages	$1.50
Second A. L. P. O. Convention Issue (July-Oct., 1957), 48 pages	$1.25
Jan. - Mar., 1958 Issue, 36 pages	$1.00
Other 1954-1958 Issues	$0.70

Meeting of Meteoritical Society. This society will hold its annual meeting at and near Winslow, Arizona on August 30-September 1, 1958. There will be sessions for papers in the dining room of La Posada Hotel on the morning and afternoon of August 31 and on the afternoon of September 1. A visit to the famous Barringer Meteorite Crater is planned for the morning of September 1. There are many other places of interest, both scientific and scenic, in the vicinity of Winslow, e.g., the Lowell Observatory and the Naval Observatory at Flagstaff, the Grand Canyon, The Museum of Northern Arizona, and the Petrified Forest, among others. Meetings of the Meteoritical Society are open to both members and non-members, and the membership itself includes both amateur and professional scientists. Those desiring further information may write to the Editor. Winslow will be crowded over the Labor Day weekend so that it will be wise to make reservations early. We are confident that you will find the meeting of this society both enjoyable and informative.

New Address for Mercury Recorder. Mr. Owen C. Ranck writes that his address is now 112 Broadway, Milton, Penna. All observations of Mercury should be sent to him at this changed address, beginning immediately.

THE 1956-1957 APPARITION OF JUPITER

by

Henry P. Squyres and Elmer J. Reese

This report concludes all the work done on Jupiter by the A. L. P. O. during the 1956-1957 apparition.

The following list covers all the people who contributed drawings, notes, color estimates, and photographs during the apparition. There were forty-seven observers who contributed a total of 541 observations. Transit observations are not included on this list:

Observer	Telescope	Number of Observations	Location
L. Abbey	6" refl.	10	Decatur, Georgia
R.M. Adams	4.3" refl.	2	Neosho, Missouri
S. Almen	6" refl.	13	Topeka, Kansas
S. Bieda	8" refl.	1	San Jose, Calif.
R. Berg	4" refr.	7	Dyer, Indiana
P. Budine	3" refr.	3	Binghamton, N.Y.

Observer	Telescope	Number of Observations	Location
T. R. Cave, Jr.	12" refl.	4	Long Beach, Calif.
T. Cragg	12" refl.	5	Inglewood, Calif.
J. Crosetti	4" refr.	1	Glendale, Calif.
D. Delgrande	8" refl.	1	San Jose, Calif.
J. Eastman	6" refl.	4	Manhattan Beach, Calif.
P.R. Glaser	6" refl.	17	Menomonee Falls, Wisc.
E. Gilmore	4" refr.	1	Allentown, Penna.
J. W. Goodman	8" refl.	13	New York, N.Y.
D. Greenwood	4" refr.	4	Glendale, Calif.
W. H. Haas	12.5" refl.	written report	Las Cruces, New Mexico
W.K. Hartmann	8" refl., 13" refr.	29	New Kensington, Pa.
A. K. Herring	12.5" refl.	14	South Gate, Calif.
C. Huckins	5" refr.	3	Port Washington, N. Y.
L. T. Johnson	16" refl.	132	Welcome, Maryland
J. Kaltenhauser	6" refl.	8	Lindstrom, Minnesota
M. Kaiser	6" refl.	12	Keokuk, Iowa
W. Kunkel	5" refr.	3	Berkeley, Calif.
F. Loehde	12.5" refl.	7	Edmonton, Alberta, Canada
D. MacPherson	12.5" refl.	1	Edmonton, Alberta, Canada
F. Manasek	6" refl.	5	New York, N. Y.
J. Mandrusiak	12.5" refl.	1	Edmonton, Alberta, Canada
C. Martens	6" refl.	11	Charles City, Iowa
Richard McLaughlin	10" refl.	3	New Kensington, Pa.
Robert McLaughlin	10" refl.	3	New Kensington, Pa.
J. Miller	6" refl.	21	Beverly Hills, Calif.
T. Osawa	6" refl.	17	Osaka, Japan
F.J. Price	6" refl.	1	New York, N. Y.
O.C. Ranck	4" refr.	31	Milton, Pa.
E.J. Reese	6" refl.	2	Uniontown, Pa.
K. Rimstad	8" refl.	1	Detroit, Michigan
L. J. Robinson	10" refl.	31	Sylmor, Calif.
T. Sato	6" refl.	21	Hiroshima, Japan
H. T. Sherman	8" refl.	3	St. Paul, Minnesota
S. Sinotte	6" refl.	22	Keokuk, Iowa
C. J. Smith	9.5" refr.	8	Oakland, Calif.
H. P. Squyres	6"&12" refls.	10	El Monte, Calif.
J. E. Starbird	6" refl.	31	Topeka, Kansas
G. Steelman	4" refr.	8	Glendale, Calif.
F. Suler	8" refl.	6	Holloman AFB, New Mexico
T. Waineo	8" refl.	3	Detroit, Michigan
W. R. Weaverling	6" refl.	7	Dyer, Indiana

The Red Spot Area: The Red Spot remained dark and was the most conspicuous object on Jupiter during the apparition. Figure 1 shows the Red Spot as seen by Mr. Sato. The major axis of the Red Spot was observed to be tilted by 13^{o} in a south-preceding north-following direction by most of the observers during the whole apparition. Many observers reported seeing a dark red border around the edge of the Red Spot. It is the Recorder's opinion that the dark border may be just an optical effect due to the contrast between the Red Spot and the lighter area around the Red Spot. Robert and Richard McLaughlin observed a very bright white spot in the STB somewhat like the variable white spot Mr. Cave saw in the STB near the Red Spot. Their observation was made on March 31, 1957 near 5^{h} 17^{m} UT. This date is only a little over a month after Cave's observation

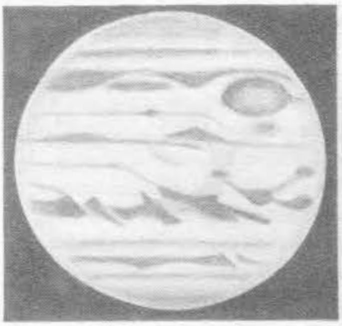


FIGURE 1. JUPITER
Takeshi Sato
6-inch refl. 224x, 336x.
May 16, 1957. $10^H 40^M$, u.t.
C.M.$_1$ = 296°. C.M.$_2$ = 272°.

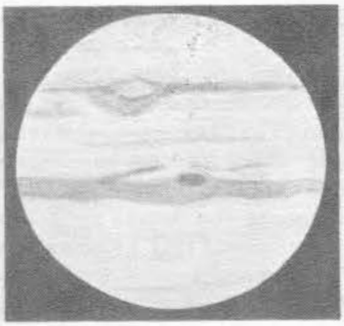


FIGURE 2. JUPITER
P. R. Glaser
6-inch refl. 231x.
May 28, 1957. $2^H 15^M$, u.t.
C.M.$_1$ = 82°. C.M.$_2$ = 329°.

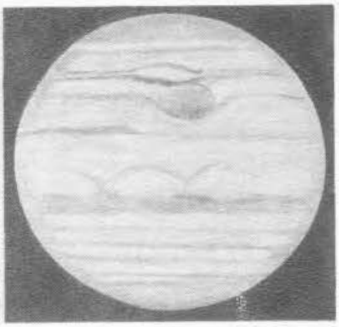


FIGURE 3. JUPITER
Chester J. Smith
9.5-inch refr. 225x.
June 18, 1957. $4^H 3^M$, u.t.
C.M.$_1$ = 220°. C.M.$_2$ = 307°.

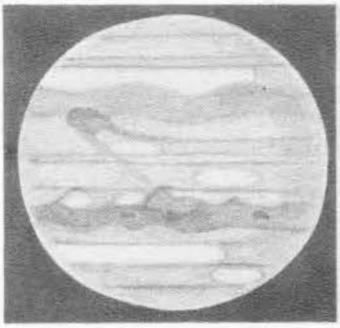


FIGURE 4. JUPITER
L. J. Robinson
10-inch refl. 163x, 286x.
April 13, 1957. $3^H 25^M$, u.t.
C.M.$_1$ = 220°. C.M.$_2$ = 90°.
Green filter used.

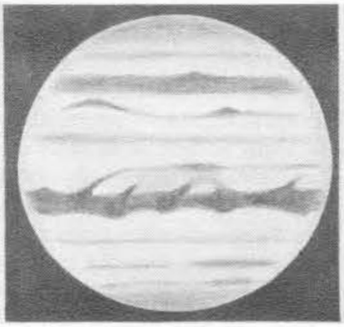


FIGURE 5. JUPITER
Takeshi Sato
6-inch refl. 224x.
April 11, 1957. $12^H 5^M$, u.t.
C.M.$_1$ = 221°. C.M.$_2$ = 104°.

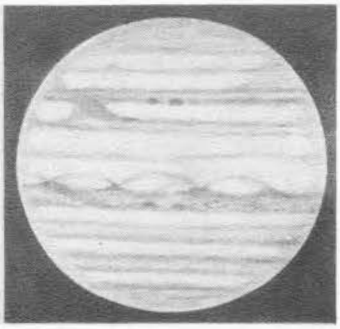


FIGURE 6. JUPITER
Chester J. Smith
9.5-inch refr. 225x.
May 26, 1957. $3^H 50^M$, u.t.
C.M.$_1$ = 184°. C.M.$_2$ = 86°.

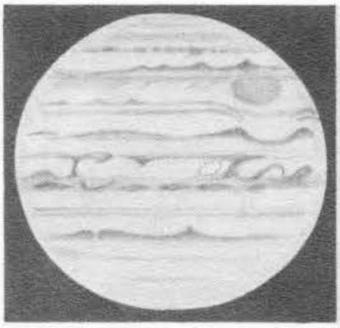


FIGURE 7. JUPITER
Thomas Cragg
12-inch refl. 260x.
April 9, 1957. $5^H 0^M$, u.t.
C.M.$_1$ = 6°. C.M.$_2$ = 266°.

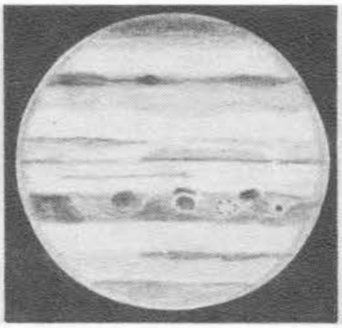


FIGURE 8. JUPITER
Phillip W. Budine
3-inch refr. 171x
March 14, 1957 $3^H 15^M$, u.t.
C.M.$_1$ = 154°. C.M.$_2$ = 253°.

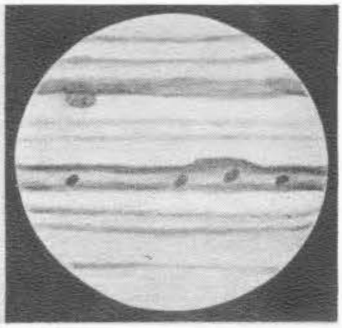


FIGURE 9. JUPITER
Owen C. Ranck
4-inch refr. 150x.
March 5, 1957 $3^H 20^M$, u.t.
C.M.$_1$ = 175°. C.M.$_2$ = 342°.

(Str. A., Vol 11, Nos. 1-6, pp. 17 & 19). The McLaughlin object was located near 50° longitude in System II.

The South Tropical Zone Disturbance: This area was the most conspicuous object observed on Jupiter except for the Red Spot during the 1956-1957 apparition. Alex Smith, who is the Director of the Radio Observatory at the University of Florida, has ruled out all other spots except the South Tropical Zone Disturbance as radio sources. Observers should watch this area closely during 1958 and try to make as many transit observations of this area as possible in order that the optical transit positions can be checked against radio transit positions. It has been found that the radio rotation period for System II is about 11.8 seconds shorter than the optical rotation period for System II. Figures 4, 5, and 6 show this Disturbance.

Belts: The North Equatorial Belt was the most conspicuous belt on Jupiter during the 1956-1957 apparition. In order of their decreasing conspicuousness, the belts usually recorded were: N.E.B., S.T.B., S.S.S.T.B., N.N.T.B., $S.E.B._s$, $S.E.B._n$, N.N.N.T.B., S.S.T.B., N.T.B., E.B., and the N. Trop. Z. Band.

The N.E.B. and the S.T.B. had many festoons. Dark spots and white markings were also very common in these belts. Figures 7, 8, and 9 show some general views of the Giant Planet during the 1956-57 apparition. Figure 10 shows seven excellent photographs of Jupiter taken by Mr. L. T. Johnson with his 16" reflector. The Red Spot can be seen easily in all the photographs. On the original prints the $S.E.B._n$ shows faintly, and the N. T. B. is just barely visible.

Rotation Periods, 1956-57: We received a total of only 560 transits for the apparition - not nearly enough to assure adequate coverage of the various atmospheric currents. However, reliable rotation periods were obtained for the South Temperate Current, the Disturbance in the South Tropical Zone, and the Red Spot. The mean rotation period found for objects on the south edge of the North Equatorial Belt is fairly reliable; however, more transits would have made individual identifications more certain, and would have greatly increased the number of objects appearing in the table.

In the tables which follow, the first column gives an identifying number or letter to each object. The second column indicates whether the object was dark (D) or bright (W) and whether the preceding (p), center (c) or following (f) end was being observed. The third column gives the first and last dates of observation; the fourth column, the longitudes on those dates. The fifth column gives the longitude at opposition, March 17, 1957. The last column indicates the number of degrees in longitude that the marking drifts in 30 days.

S. S. Temperate Current (SSTB), System II

No.	Mark	Limiting Dates	Limiting L.	L.	Transits	Drift in 30d.
1	Df	Feb. 21-Apr. 1	62°-27°	41°	4	-26°.9

Rotation Period $9^h\ 55^m\ 4^s$

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

No.	Mark	Limiting Dates	Limiting L.	L.	Transits	Drift in 30d
D	Wp	Nov. 4-Jun. 16	88°-294°	357°	15	-20°.6
2	Wc	Nov. 4-Jun. 16	99 -306	9	10	-20.5
E	Wf	Nov. 4-Jun. 16	110-318	21	15	-20.4
4	Wp	Feb. 14-May 2	58-7	38	7	-19.9
F	Wp	Nov. 15-May 17	296-146	198	12	-24.5
6	Wc	Nov. 15-Apr. 21	305-180	209	7	-23.9
A	Wf	Nov. 15-May 1	316-184	218	11	-23.7
B	Wp	Dec. 19-May 1	320-203	243	11	-26.4
C	Wf	Nov. 4-May 1	15-225	264	12	-25.3
10	Wf	Mar. 3-Apr. 21	179-140	168	4	-24.0

Mean drift in 30 days -22°.8
Mean rotation period $9^h\ 55^m\ 9^s.4$

The three bright bays along the south edge of the STB continue to be well-defined features. The drift of BC in decreasing longitude was accelerated near the end of the previous apparition. Though slackening somewhat, the motion of BC in decreasing longitude continued to exceed that of FA or DE throughout the present apparition. By early May BC had approached to within 20° of FA. FA was in conjunction with the Red Spot on November 20, 1956. BC and DE were in conjunction with the Red Spot on January 16, 1957 and June 12, 1957 respectively. Figure 2 shows DE before this conjunction; Figure 3, after conjunction.

S. Tropical Zone Disturbance, System II

No.	Mark	Limiting Dates	Limiting L.	L.	Transits	Drift in 30d
1	Dp	Mar. 17-Jul. 6	79° - 26°	79°	9	-14°.3
2	Dc	Mar. 17-Jul. 6	90 - 33	90	8	-15.4
3	Df	Mar. 17-Jul. 6	102-41	102	11	-16.5

Mean drift in 30 days -15°.4
Mean rotation period $9^h\ 55^m\ 20^s$

The STrZ Disturbance, which first appeared early in the previous apparition, was again seen. The Disturbance was not well observed prior to the date of opposition, but from March 17 to July 6, 1957 it was seen as a dark hump along the north edge of the STB. During that interval it gradually faded and decreased in length from 23° to 15°. The SEBs, which was very faint during the apparition, was deflected south of its normal latitude into the preceding and following ends of the Disturbance. The Disturbance was remarkably similar in appearance to the S. Tropical Streak of 1946-7 during March and April, 1947. The rotation period of the Disturbamce was about 10 seconds shorter than it was during the previous apparition. Its mean period from September 19, 1955 to July 6, 1957 was $9^h\ 55^m 27^s$. The Disturbance was no longer visible when Jupiter arrived in the early morning sky late in 1957.

Red Spot, System II

No.	Mark	Limiting Dates	Limiting L.	L.	Transits	Drift in 30d.
1	Dp	Nov. 15-Jul. 3	286° - 296°	291°	24	+1°.3

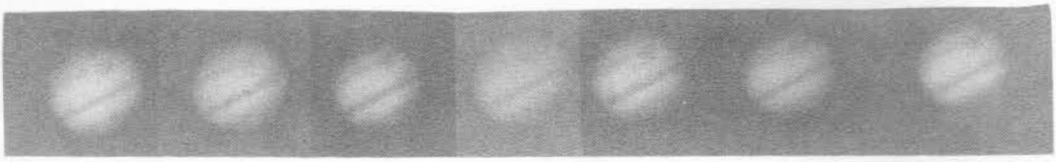


Figure 10. Photographs of Jupiter by Lyle T. Johnson with a 16-Inch Reflector on April 26, 1957 at $4^h\ 34^m$, U.T. No filter. ½ second exposure.

Developed for 25 mins. in Neofin Red. 7x enlargement. $CM_1 = 155.^\circ CM_2 = 286^\circ$. Note Red Spot in upper right.

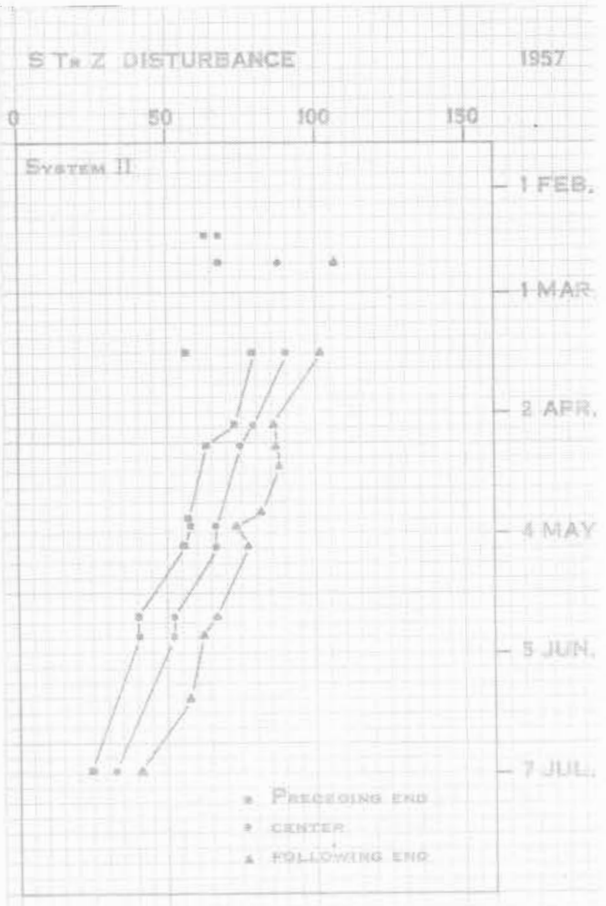


Figure 11. Rotation - drift of a South Tropical Zone Disturbance on Jupiter in 1957.

No.	Mark	Limiting Dates	Limiting L.	L.	Transits	Drift in 30d.
2	Dc	Nov. 15- Jul. 3	300° - 310°	305°	24	$+1.^\circ3$
3	Df	Nov. 15- Jul. 8	314 - 324	319	23	+1.3

Mean drift in 30 days $+1.^\circ3$
Mean rotation period $9^h\ 55^m\ 42.^s4$

S. edge SEBn, System II

No.	Mark	Limiting Dates	Limiting L.	L.	Transits	Drift in 30d.
1	Dc	Nov. 15-Jun. 16	278°-286°	282°	15	+1°.1

Rotation period $9^h\ 55^m\ 42^s.1$

A dark thickening along the south edge of the SEBn near longitude 282° persisted throughout the apparition. Since this dark feature remained fixed relative to the Red Spot, it seems probable that it marked the north-preceding shoulder of the otherwise invisible Red Spot Hollow.

North Equatorial Current (S. edge NEB), System I

No.	Mark	Limiting Dates	Limiting L.	L.	Transits	Drift in 30d.
1	Dc	Nov. 4-May 30	32° - 24°	27°	10	-1°.2
2	Dc	Nov. 4-May 23	53 - 55	55	5	+0.3
3	Dc	Nov. 4-Apr. 3	79 - 87	86	8	+1.6
4	Dc	Nov. 4-May 1	105 - 116	114	7	+1.9
5	Dc	Dec. 4-May 31	150 - 146	147	10	-0.7
6	Dc	Nov. 12-May 31	182 - 185	184	9	+0.5
7	Dc	Nov. 12-May 17	227 - 222	224	10	-0.8
8	Dc	Nov. 17-May 13	280 - 285	285	7	+0.8
9	Dc	Nov. 15-May 23	349 - 349	349	7	0.0

Mean drift in 30 days +0°.3
Mean rotation period $9^h\ 50^m\ 30^s.4$

Note by Editor. The discussion of rotation-periods in this paper is the work of Mr. Reese. The rest of the paper is the work of Mr. Squyres.

A QUANTITATIVE APPROACH TO THE PROBLEM OF THE CUSP CAPS OF VENUS

by James C. Bartlett, Jr.

Among the many vexing problems of that most vexatious of all planets - Venus - perhaps the most subtle is this: Are there really bright caps at the apparent poles, or are there not? We here refer to the poles of the disc, which may or may not correspond to the poles of rotation. If we could decisively determine the existence of bright cusp caps, always 180° apart on the disc, then we could also say with confidence that they must mark the poles of rotation; and this in turn would automatically answer one of the more important open questions, namely the question of the planet' s inclination.

Now to the casual reader it may seem that nothing should be easier to determine than the existence or non-existence of conspicuous, bright caps at the poles of a planet which at times assumes an apparent diameter in excess of 60'' of arc. Reduced to practice, however, the matter becomes extremely difficult. There are several reasons why this is so, but by far the most important is the extraordinarily high albedo of the planet. This quantity -0.59 - means that for every 100 units of sunlight falling upon the planet almost 60 are reflected back into space. Few substances are brighter, though among them is snow when pure;

but even snow is not so much brighter as to be conspicuous against a background having a mean albedo equal to that of Venus.

For this reason the apparent polar caps of Venus can never be truly conspicuous, and indeed on the average must be frequently close to the albedo of the planet and often equal to it. Hence they are extremely difficult to define upon the bright disc and deception is correspondingly easy. Add to this the fact that on the average the Venusian caps are of about the same whiteness as the rest of the disc and the difficulty of observing them becomes clear.

There are other factors which also make for difficulty, chief of which is the unalterable fact that Venus is an interior planet. Now this means that when the disc is very nearly full the planet is not only very close to the sun but also at its greatest distance from us. Thus at the time when we can see most of the disc its apparent diameter is only some 10" of arc; moreover it is so unfavorably placed for observation that only those in superior locations can do anything with it.

Conversely when the planet reaches its maximum apparent diameter of some 60" of arc it is then close to inferior conjunction; the dark side is then turned earthward and the area of surface still in sunlight is reduced to a thread-like crescent. For all practical purposes therefore we are limited to the time between superior conjunction and greatest elongation east (during an evening apparition) for our best views of the cusp caps. They are often conspicuous - or relatively so - near and at dichotomy; but once dichotomy has been passed the cusp area illuminated by the sun becomes progressively smaller, and as the angle of incidence of the solar rays becomes lower and lower the thin cusps often take on a dusky hue from want of light. During a morning apparition the reverse is true.

Notwithstanding these insurmountable difficulties there is a continous and persistent report of bright caps at the poles of the disc; so many and from such diverse sources that one may question whether all can be chargeable to error or illusion. Moreover, such reports have also come down to us from the past and from astronomers of the highest standing armed with unquestionably good instruments. Finally it must be said that the writer has observed the caps when filter and other tests strongly confirmed their objective existence; and I do not think it too much to say that any one who has seen them at their brightest could not seriously doubt their real presence.

The question is whether the scattered impressions of many observers can be brought together into some order of relationship which will be statistically significant. Unfortunately direct correlation is seldom possible; not only because of the inherent delicacy of the phenomena, but because truly parallel observations are extremely rare if ever obtained. Almost always some factor will vary - it may be time; it may be the seeing; it may be the transparency; but always something to render two observations of the same date something less than truly parallel. Now these factors would not be important in observations of the Martian caps; because when visible they are always so conspicuous by their contrast against the red-and-green disc as to be easily seen by all who chance to observe the planet. Not so the apparent polar caps of Venus, for reasons outlined above; and so these factors are critically important in observations of Venus and unfortunately weigh heavily against the chances of truly parallel observations.

But in one sense this difficulty is a blessing in disguise; for if in spite of such difficulties a good order of agreement is found among several scattered observers, then we have a rather strong indication of the objective existence of the Venusian caps - or so it seems to me.

Having at hand material going back to 1944 (my own observations) fortified by many observations by A. L. P. O. observers between the years 1951-56, a good basis for a statistical survey existed. What this survey yielded will become apparent later on; but sufficient now to say that the following tables were constructed from a mass of 830 observations covering the period 1944-1956. Of this total, 221 observations were by the writer; 158 by O. C. Ranck; and the remaining 451 by many and various A. L. P. O. observers. It must be said at once that the reductions of these numerous observations was by no means easy, and it is quite probable that here and there some error of interpretation may have been made; but I think that such errors as may exist are far too few to seriously affect the final results. Such errors would have been caused by insufficient data in the observations. Unfortunately some observers contributed little more than a sketch, with little or no annotation. In all such cases judgement had to be guided by the details of the drawing. In cases where the cusp bands plainly delimited the caps this was not difficult; but in cases where there was no annotation to show that bright caps had been visible on a disc or crescent lacking cusp bands, the observations had to be rejected. Had it not been for this the total of 830 observations would have been considerably larger.

Many of the drawings however, especially those of O.C. Ranck, carried definite notations as to the relative brightness of the caps. Others, by means of symbols explained in the text of the observation, showed plainly whether the caps were brighter than the rest of the disc. Therefore it is felt that the 830 observations selected yield trustworthy data, to the extent that they are entirely honest reports of the phenomena as they appeared to the several observers.

The difficulties attending mere brightness estimates were not, of course, experienced in regard to such positive factors as the dark cusp bands and the two terminator indentations at the north and south cusps respectively. These features are plainly evident in the drawings, so that even without annotation their existence or non-existence to any given observer can easily be ascertained.

O. C. Ranck and the writer are the only observers represented in this group who had sufficiently long and consecutive series of observations from which long-term comparisons could be made. For this reason the observational series of these two observers have in some instances been considered separately, and then compared one to the other and both to the data obtained from the remaining observers. The observations of Ranck are greatly enhanced in value by the fact that this assiduous observer frequently reported the planet completely around its orbit, from superior conjunction back to superior conjunction.

Finally it may be observed that all figures, including percentages, have been rounded off to avoid troublesome fractions. Hence if a percentage figure appears to be off a point or two such is the reason; but in no case will there be found any discrepancies capable of affecting the final results to any significant degree.

In addition to O. C. Ranck, I am indebted to the following observers whose work made this survey possible: Leonard Abbey, Jr; R. M. Adams; D. P. Avigliano; Ray Berg; R. M. Baum; Lee Bellot; Phil Cluff; Thomas Cragg; Charles M. Cyrus; W. H. Haas; W. K. Hartmann; Lyle T. Johnson; A. P. Lenham; A. Longton; Eugene A. Lizotte; Charles P. Martens; David D. Meisel; Richard Miller; Patrick Moore; T. Osawa; Cecil Post; Tsuneo Saheki; C. J. Smith; C. B. Stephenson; H. P. Squyres; J. E. Thrusell; Frank Vaughn; Howard Le Vaux; Brian Warner; William Weaverling; John A. Westfall; René A. Wurgel.

These 32 observers contributed 451 useable observations among them, and many of the observations were of very high quality. All were sufficiently good to enable positive conclusions to be drawn.

We may now consider the primary phenomenon, ie., the visibility or invisibility of the cusp caps in relation to the total number of observations. The tables will be taken in descending order of the number of individual observations, for which reason the writer begs indulgence for heading the list.

Table 1

interval	no. observations	observer
1944-1956	221	Bartlett

S. cap alone visible	32	14%
N. cap along visible	12	5%
Both caps visible	103	46%
Both caps invisible	74	35%
	221	100%

Table 2

interval	no. observations	observer
1951-56	158	O.C. Ranck

S. cap alone visible	16	10%
N. cap alone visible	18	12%
Both caps visible	64	40%
Both caps invisible	60	38%
	158	100%

Table 3

interval	no. observations	observers
1951-56	451	all others

S. cap alone visible	49	11%
N. cap alone visible	25	6%
Both caps visible	128	29%
Both caps invisible	249	54%
	451	100%

Table 4

interval	no. observations	observers
1944-56	830	all observers

S. cap alone visible	97	11%
N. cap alone visible	55	7%
Both caps visible	295	35%
Both caps invisible	383	47%
	830	100%

A number of interesting comparisons immediately emerge from the above tables, not the least of which is the close correspondence in percentage figures as between O.C. Ranck and the writer notwithstanding a considerable difference in the total number of observations. Further significance may be seen in the fact that Ranck's observations cover morning apparitions also, whereas those of the writer do not. These two observers agree that both caps were visible more often than either alone, and both agree that one or both caps were visible more often than they were invisible. These two observers show only one significant disagreement, and that is in relation to observations during which only one cap was seen. To the writer, the lone cap was most often the southern one; but O.C. Ranck found solo appearances about equally divided between either cap with a slight edge for the northern cap. This may be related to the greater number of Bartlett observations over a longer period of time.

Taking Table 3 we find that the 32 other observers also agree to the following: That both caps together were more often visible than either alone; that in solo appearances the south cap was more often visible than the north cap (which agrees with Bartlett but not with Ranck); and that one or both caps were more often visible than invisible.

Table 4 represents a combination of all observers' reports. It will be seen from this table that in 830 observations, over a period of 12 years, either one or both caps were visible 447 times. Reduced to percentage this is a little more than 53% - call it 54% - or slightly in excess of half of the total number of observations. Now this percentage is rather suggestive, inasmuch as we might expect relatively easy visibility for only about half of the time between one conjunction and the opposite.

The relation of visibility to phase is of great interest. The 830 observations agree that the caps are visible, at one time or another, over the entire orbit of the planet; though after dichotomy in an evening apparition, and before dichotomy in a morning apparition, their appearances are less than between elongation and superior conjunction. This, of course, is only what one might expect.

The following tables represent the earliest and the latest appearances of the caps, as reported by several observers, in relation to phase; as expressed by the quantity k based upon the table of the Illuminated Disk of Venus in The American Ephemeris and Nautical Almanac. The values for k on intermediate dates are interpolations.

Earliest appearance of one or both

cusp caps as related to k between

Superior Conjunction and G. E. E.

k	date	observer
0.982	March 17, 1954	O.C. Ranck
0.946	Sept. 2, 1952	T. Cragg
0.933	April 24, 1954	Eugene Lizotte
0.930	Nov. 27, 1955	W. H. Haas
0.918	May 4, 1954	D. P. Avigliano
0.889	March 9, 1951	J.C. Bartlett
0.842	January 13, 1956	Richard Miller
0.835	April 1, 1951	R. M. Baum
0.801	Jan. 29, 1957	Frank Vaughn
0.799	June 20, 1954	Patrick Moore
0.776	April 21, 1951	T. Osawa
0.719	Feb. 25, 1956	Brian Warner
0.701	March 1, 1956	D. D. Meisel

Latest appearance of one or both cusp caps as related to k between G.E.E. and Inferior Conjunction

k	date	observer
0.206	March 16, 1953	Patrick Moore
0.196	May 26, 1956	Ray Berg
0.178	March 19, 1953	J. C. Bartlett
0.172	March 20, 1953	A.P. Lenham
0.157	May 29, 1956	D.D. Meisel
0.149	March 23, 1953	J. E. Thrussell
0.077	June 7, 1956	O.C. Ranck
0.069	June 8, 1956	Charles Martens

Earliest appearance of one or both cusp caps as related to k between Inferior Conjunction and G. E. W.

k	date	observer
0.153	Sept. 21, 1951	Tsuneo Saheki
0.174	July 18, 1956	O.C. Ranck

Latest appearance of one or both cusp caps as related to k between G. E. W. and Superior Conjunction

k	date	observer
0.875	Oct. 5, 1953	H.P. Squyres
0.970	Nov. 30, 1953	T. Cragg

It must be clearly understood that the above are maximum and minimum figures, and do not represent all of the appearances of the caps reported for any given quarter of the planet's apparition; though it is apparent that the easiest visibility lies between Superior Conjunction and either elongation. The few figures for the morning apparitions mean only that many fewer morning observations were available.

What these tables show definitely is the general visibility of the caps in all parts of the planet's orbit. Their easier visibility between Superior Conjunction and either elongation is to be explained partly by their greater illuminated area, and perhaps equally by a more consistent appearance of delimiting cusp bands.

We may now inquire as to the gross characteristics of the caps as reported by the several observers.

Table 5

Cusp caps related to relative size

period	S. cap larger	both caps equal	N. cap larger	observer
1944-56	100	28	19	Bartlett

Total observations 147

Table 6

Cusp caps related to relative size

period	S. cap larger	both caps equal	N. cap larger	observer
1951-56	36	33	28	Ranck

Total observations 98

Table 7

Cusp caps related to relative size

period	S. cap larger	both caps equal	N. cap larger	observers
1951-56	125	33	44	all others

Total observations 202

From the above tables it will be clear that all observers found the south cap to be most often the larger of the two, the north cap least often the larger of the two; though O.C. Ranck found the least relative difference among the three categories. Again this may be related to the greater number of all observations as compared to Ranck.

We have now arrived at the following point. If the cusp caps are purely illusionary, then the illusion appears to be both persistent and generally consistent for 34 different observers using different apertures, different qualities of instruments, and observing under widely different conditions. To this writer such a possibility seems much less likely than the probability that real phenomena have been observed.

Finally it may be noticed that the caps are not consistently represented by mere featureless areas of greater than average brightness, but often structural details are reported. Figures 12 and 13 are from R.M. Baum for the south cap, showing deformation of outline and internal, nodular structures, presumably "star points". Figure 14 for the south cap is from D.P. Avigliano. Figures 15 and 16 are from the writer's observations, showing apparent deformations in the outline of the south cap. Consistent with the easier visibility and generally larger size of the south cap is the fact that most observations of structural detail relate to this cap, though O.C. Ranck occasionally shows divisions in the north cap.

Having now examined the affirmative evidence for the existence of true, apparent polar caps on Venus, it is necessary to consider the negative. This takes the form of dusky caps; not merely dull caps but caps which appear to exhibit actual shading relative to the rest of the disc. Such appearances are not difficult to explain close to Inferior Conjunction; but the difficulty is to explain them between Superior Conjunction and either elongation. Before evaluating the following tables it is necessary to understand the apparent characteristics of the dusky polar areas. To begin, the term "cap" and "cusp" become interchangeable near Inferior Conjunction, so that for observations close to this point reference is to dusky tips of the horns of the crescent. At points between Superior Conjunction and either elongation the apparent polar areas may be completely shaded, or they may exhibit only a partial shading. When completely shaded the appearance is of a distinct, dusky cap as in Figure 17 from O.C. Ranck. At other times the cap area is only partly affected; sometimes involving no more than a dark shading to the polar limb, as in Figure 18 from the writer; sometimes involving a definite fraction of the whole cap area. It may be said that the dusky caps are neither as frequent nor as consistent as to form and area as the bright caps. The following tables give the relation to phase as expressed by the quantity k.

Table 8

Relation of dusky caps to phase expressed as k

South cap only

k	date	observer
0.812	Nov. 11, 1944	Bartlett
0.810	Nov. 12, 1944	Bartlett
0.773	Nov. 26, 1944	Bartlett
0.717	Dec. 15, 1944	Bartlett
0.700	Dec. 20, 1944	Bartlett
0.196	March 17, 1953	Bartlett
0.178	March 19, 1953	Bartlett
0.169	March 20, 1953	Bartlett

Both caps

k	date	observer
0.713	Dec. 16, 1944	Bartlett
0.160	March 21, 1953	Bartlett
0.149	March 22, 1953	Bartlett
0.131	March 24, 1953	Bartlett
0.079	March 31, 1953	Bartlett

Total observations of Venus	221
Dusky caps observed	13

Table 9

Relation of dusky caps to phase expressed as k

South cap only

k	date	observer
0.865	Oct. 1. 1953	Ranck
0.851	Oct. 23, 1952	Ranck
0.653	Oct. 3, 1956	Ranck
0.588	Jan. 16, 1953	Ranck

Figure 12. S. Cusp Cap of Venus showing small, nodular features probably "star points". January 18, 1953, 17h 47m U.T. R.M. Baum

Figure 13. S. Cusp Cap of Venus showing deformation of the limb outline of the cap. May 29, 1951, 18h - 19h 40m U.T. R.M. Baum

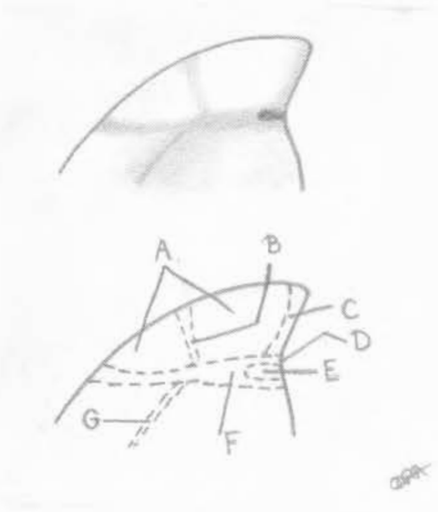


Figure 14. S. Cusp of Venus.
A-very bright white areas
B-Schiaparelli Vallis (?)
C-Shaded terminator edge
D-Terminator indentation
E-Very dark notch
F-South Cusp Band
G-Dark streak
Aug. 2 to Aug 30 U.T. dates, 1954
D.P. Avigliano

Figure 15. S. Cusp Cap of Venus showing limb deformation Aug. 5, 1951. 0h36m U.T. 3.5 in. reflector, 100x S-5 T-5 James C. Bartlett, Jr.

Figure 16. S. Cusp Cap of Venus showing irregular outline. Sept. 5, 1954 0h6m U.T. 3.5 in. refl., 100x S-2 T-5 James C. Bartlett, Jr.

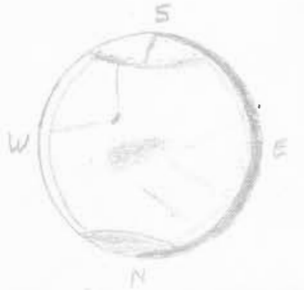


Figure 17. Venus showing dusky north cap. Apr. 4, 1954. 23h41m U.T. 6 in. reflector, 112.5x. S-4 T-3 O.C. Ranck

Figure 18. Venus showing dusky S. limb. Nov. 26, 1944. 22h30m U.T. 3-in. refractor, 75x. Definition fair; transparency not recorded. James C. Bartlett, Jr.

South cap only

k	date	observer
0.413	Feb. 18, 1953	Ranck
0.273	July 29, 1956	Ranck

North cap only

k	date	observer
0.983	Mar. 16, 1954	Ranck
0.982	Mar. 17, 1954	Ranck
0.964	April 4, 1954	Ranck
0.958	April 9, 1954	Ranck
0.888	May 18, 1954	Ranck
0.853	June 1, 1954	Ranck
0.445	August 22, 1956	Ranck

Both caps

k	date	observer
0.589	August 16, 1954	Ranck
0.384	Feb. 22, 1953	Ranck
0.300	Oct. 14, 1951	Ranck
0.285	Oct. 12, 1951	Ranck
0.162	Sept. 28, 1951	Ranck
0.108	May 3, 1953	Ranck
0.079	March 31, 1953	Ranck

Total observations of Venus	158
Dusky caps observed	20

On September 24, 1951, Lee Bellot observed both caps to be dusky; and on March 17, 1956, D.D. Meisel observed the same. On February 21, 1956, and again on March 5, 1956, D.D. Meisel observed the north cap only to be dusky. It is probable that a considerable number of observations from the other observers should have been included; but unfortunately the observations were not clear, neither in text nor in figure, as to a specific shading of the polar areas and so were unable to qualify.

The salient fact to be gleaned from the above tables is that the dusky caps, like the bright caps, may be seen in all parts of the planet's orbit.

It is also worthy of note that of the 13 observations of dusky caps, made by the writer, 6 are for the gibbous phase; and of the 20 reported by O.C. Ranck no less than 11 are for the gibbous phase. It may also be noticed that Ranck's percentage of such observations is considerably higher than the writer's. This may be an effect of morning observations, frequent in the work of O.C. Ranck but totally lacking in the work of the writer.

In comparison to the bright caps we have the following.

Table 10

Total Venus Observations	Bright caps	Dusky caps
221	147	13

period - 1944 through 1956 observer - Bartlett

Table 11

Total Venus Observations	Bright caps	Dusky caps
158	98	20

period - 1951 through 1956 observer - O.C. Ranck

The interpretation of the dusky caps poses a serious dilemma. If we insist that the bright caps cannot be illusionary, I do not see that we can reject the dusky caps on the same ground; yet the existence of such dusky caps, or dusky areas within the apparent polar surfaces, is not compatible with the assumed nature of the bright caps.

A physical explanation for dusky polar caps is not difficult to find. One has only to visualize partial clearing, from time to time, of polar haze and cloud. That such clearings would take place now and then is almost certain; and if such clearings exposed to view a land or water surface beneath, not sharply as with Mars, but dimly through the dense Venusian atmosphere, the appearance would be of a shaded area.

But in that case what becomes of the assumed polar snows? Whither would they have gone? And whence would they return?

It must be understood that if the bright caps of Venus are true polar caps, their interpretation as snow and ice accumulations (assuming water on the surface and in the lower atmosphere as vapor) is entirely consistent with the geometry of the situation. For if these caps indeed mark the poles of rotation, then the inclination is close to zero. For the sake of convenience assume it to be zero. Then the sun, as seen simultaneously from both poles of Venus, would forever be on the polar horizon. This circumstance, if not modified by local conditions, would account for glaciation of both poles; but it is important to notice that polar caps so induced would be permanent. The only change to be expected would be a steady but very slow growth to be measured in millenia; but hardly a decline and never a seasonal decline as with the earth and Mars. The only possible seasonal effect would result from the eccentricity, which is so small -0.007 - that the planet's orbit is practically a circle.

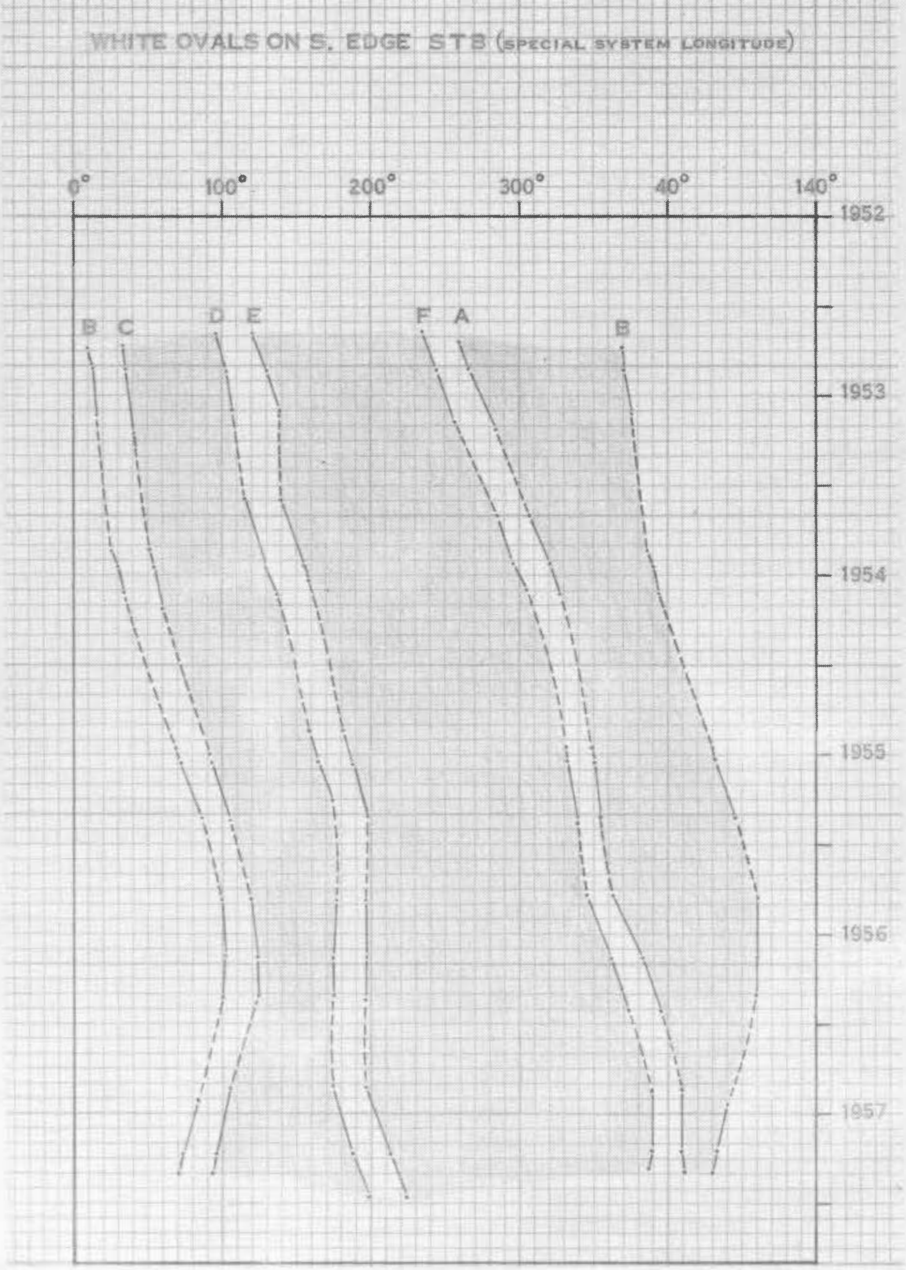
Now permanent polar caps would agree perfectly with the fact that the bright caps are visible in all parts of the orbit; and that they are so visible is strongly attested by the 830 observations herein considered. Apparent variations in size, as when the north cap may become larger than the south cap, need not trouble us; for such variations are almost certainly only apparent. They are easily explained by local variations in the cloudiness or translucency of the atmosphere. This is made clear by the lack of any rigid relation to phase, whereas were they effects of the angle of illumination then we should expect to find such variations repeated for any given value of k. Such demonstrably is not the case.

None the less the incommensurability of this view of the caps with the existence of dusky caps remains. All that can be said on the basis of our present survey is that the evidence for the existence of permanent, bright caps, always 180° apart on the disc, and generally visible in all parts of the orbit, is strong. How this is to be reconciled to the fewer but equally important observations of dusky caps is not clear at the present though not entirely hopeless. For instance, it is conceivable that dusky shadings at the poles might result from the shadows of higher clouds thrown upon layers of lower ones.

In a subsequent paper, forming a sequel to this, we shall consider the statistical relations of certain auxiliary phenomena common to the apparent poles of Venus; which relations will be based upon the same 830 observations reviewed above.

ADDITIONAL NOTES ON THE LONG-ENDURING SECTIONS OF THE SOUTH TEMPERATE ZONE OF JUPITER

Figure 19. Graph constructed by Elmer J. Reese. Refer to text on page 55.



On October 17, 1957, Mr. Elmer J. Reese wrote in part as follows:

"You may recall my graph of the long-enduring white ovals in Jupiter's S.Te. Z. drawn for a special system of longitude (<u>Str. A.</u>, Vol. 8, pg. 16, 1954). Figure 19 is a continuation of this earlier graph and shows not only the positions at each opposition but also the first and last observed positions during each apparition. The dotted lines represent the unobserved drift when Jupiter was near conjunction with the sun.

"The special system of longitude is based on an arbitrary rotation period of $9^{h}\ 55^{m}\ 7^{s}.8$ and has a daily drift of $-0^{\circ}.800$ relative to System II. The longitude of a marking at any given time can be changed from System II to the special system by the following formula:

$$\text{Long.}_{s} = \text{Long.}_{II} + 0^{\circ}.8\ (t-2434325)$$

where t is the Julian day number at the given time.

"The following table gives the average rotation period of the three white ovals between oppositions:

Interval	Rotation Period
Dec. 13, 1953-Jan. 15, 1955	$9^{h}\ 55^{m}\ 11^{s}.4$
Jan. 15, 1955-Feb. 16, 1956	10.1
Feb. 16, 1956-Mar. 17, 1957	8.3

"The mean lengths of the white ovals on the dates of opposition were:

Year	Length
1940	93°
1941	86
1943	68
1944	62
1945	57
1946	54
1947	41
1948	46
1949	33
1950	29
1951	27
1952	26
1953	25
1955	22
1956	22
1957	22

"The white areas seem to repel each other when their meanderings bring them close together; hence an actual coalescence seems improbable. Features FA and BC (Figure 19) slowly approached each other in 1956-57. It will be interesting to see what becomes of them in 1958". Mr. Reese continued to observe these features carefully in 1958, and FA and BC did not coalesce.

The Editor has often wondered whether the Julian day system employed by Mr. Reese in the formula above could not be advantageously used more widely in studies of Jupiter to give a convenient, continuous time system.

A PROPOSED A.L.P.O. LUNAR MISSILE SURVEY: WORKMEN WANTED

by Walter H. Haas

With all this talk of "shooting the Moon", we should like to urge that A.L.P.O'ers. organize a systematic survey of the lunar surface to watch for lunar missiles and their after-effects. We did indeed carry out such a project on and near November 7, 1957, as reported in Str. A., Vol. 11, pp. 128-133, 1957. However, we now have in mind a regular, sustained patrol by a large number of participating observers scattered over the whole world. The idea may come a bit late, it is true; and perhaps Man will have landed a missile on the lunar surface before these words are published. Anyhow, the survey must be organized very soon.

Unfortunately, we cannot say exactly what we should search for. Hints may be given in the press and over the radio while a Moon-aimed missile is in flight, at least for U.S. missiles. Neither have we solved the problem of quickly alerting our worldwide membership when it is known or suspected that lunar missiles have been launched. We hope that they will act quickly if news reaches them from other sources. A lunar missile will cause an impact-flash when it strikes the lunar surface, probably easily observable on the dark side of the Moon and possibly visible in the sunlit portions. The detection of this flash will be a hit-and-miss affair, depending upon being at the telescope at the time. The detection of impact-craters, powder-stains, and the like will require a subsequent careful examination of the lunar surface and may indeed demand close familiarity with the natural lunar features. Excellent photographs would sometimes be helpful. It will be pointless, unless possibly for a very few observers with considerable experience, to examine the whole Moon. Such searches must necessarily be cursory and superficial.

We hence propose to divide the lunar surface into small sections for the purposes of this survey and to assign each observer a section. The obvious method of division is the sections of the Wilkins map. Therefore, we invite all interested persons to write to:

Walter H. Haas
1835 Evans Place
Las Cruces, New Mexico

in order to be registered in the A.L.P.O. Lunar Missile Survey and to be assigned a section of the Wilkins map. If you wish to study a particular section of the Moon, we shall certainly try to give you your preference; but first comers will be served first. As soon as your assignment is given, begin at once to become very familiar with this part of the Moon by frequent study, drawings of selected formations, and the like.

We ideally require for this project a large number of participating observers, 100 to 200 or even more. The assistance of those outside of the United States is especially important in order to realize complete time-coverage of the Moon. We make no instrumental specifications, though as usual those with the larger apertures have the greater opportunities. It is useless to register in the project unless you can observe the Moon fairly often - say several hours a week as an extreme minimum. If you can give the Moon that much time, we need your help and thank you very much for your assistance.

It is planned to send bulletins and forms to observers registering in the A.L.P.O. Lunar Missile Survey.

An important by-product might well be some very useful lunar research. If we can build up an effective group of observers each thoroughly conversant with one Wilkins map section, selenology may make surprising advances. This worthy goal will take time - so may we hear from you soon?

COMET AREND-ROLAND (1956 h)

by David D. Meisel

(Paper read at the Second A. L. P. O. Convention, September 2, 1957.)

Introduction

Now that Comet Arend-Roland has come and gone, it seems that some type of report should be forthcoming. Although it will be some time before all the photographs are measured and the data reduced, the writer feels that some of the deductions from the many observations that were received should be made known now. For clarity, the report is divided into three parts. Part I is composed mostly of commentaries deduced from graphs, which were compiled from the observations made by ALPO members. Part II deals with specific details such as the double nucleus, jets, and the anomalous tail. Then it deals with some of the physical aspects of the comet such as structure, size, and details of composition and formation. A number of illustrations are provided in an attempt to convey more meaning than is possible without a lengthy text. Part III is a summary of conclusions reached by the writer. No proof of the statements is given, due to length limitation. Unless otherwise indicated, the words "the comet" refer to Arend-Roland.

Part I

When the comet was discovered in November, 1956, it possessed a tail, coma, and central condensation, which at that time was indiscernible from a nucleus. It seems, however, that right after perihelion passage the most condensed part of the comet moved from around the nucleus (in concentric fashion) to a slightly more sunward position, and a flaring parabolic shape, from the nucleus. This effect was not all optical (see Part II). Thus for an interval of 15 days (April 21-May 6, 1957) the nucleus was a plain and discrete body, not just a bright spot in the coma. Though before perihelion passage this feature when observed was always very small (1''-45'' of arc), after perihelion it had, as was observed by Loehde, a diameter of at least 80'' of arc and a magnitude of +1.9 on April 21-22, 1957. On the following nights the size of the nucleus varied, first getting smaller and then larger as its magnitude decreased and the coma became more concentric to it. The nucleus faded rapidly after perihelion, even more than its gain before perihelion. It seems that the nucleus decreased in size rapidly until it became elongated on or near May 4, 1957. Observations by Cave, Herring, and Squyres indicate that the nucleus may have been double on the 4th of May. Likewise, Meisel's observations on the 5th and later show double nuclei, the second or rearward component of which became large and elongated. This same feature may be the bright tailward extension in Pfleumer's photographs and may be responsible for the straight tail segment in Farrell's photograph of June 17, 1957. Here we have an apparent case of a nucleus giving off material into the tail and showing a definite expansion or ejection of material from a comet's nucleus or central parts.

As has already been noted, the coma and central condensation were nearly always concentric before perihelion, while after perihelion the coma had undergone drastic and swift changes. On the 21st of April it was parabolic-shaped, the condensation located along the leading edge of the coma rather than the nucleus. Then as the week progressed, material started to coagulate around the nucleus (Fig. 20).

Although the central condensation returned to the nucleus, the coma as a whole remained in the parabolic shape.

Even as early as January 29, 1957, a halo of a sort was observed concentric to the coma. It seems that later observations indicated not one but two halos around Arend-Roland, one concentric to the nucleus and one concentric to the coma-tail in a parabolic shape. Also around the anomalous tail a "ghost" halo was photographed and observed on several nights by many observers. A more detailed analysis of these "halos" will appear in Part II.

Though separated from the coma-structure during the pre-perihelion period the tail and coma seemed to be united after perihelion. Thus in order to show the change in the "spread" of the tail as well as the length, the writer chose to graph the difference of the position angles of the two sides of the tail (i. e. the subtended angle). Two divisions of the tail were visible, one associated with the fainter halos and one associated with the coma. In addition to this detail, many fine jet structures appeared in the tail and coma. Of particular note was the change of tail shape from straight-sided to curved on one side and straight on the other. Part of this effect was probably due to perspective. (The earth was in the plane of the comet's orbit at the time of the symmetry of the sides.) Figure 21 is a composite drawing of the comet as it appeared on April 25, 1957, taken from 20 observations and photographs. The parts are labeled for further reference.

Perhaps the most striking feature of Arend-Roland was its sun-pointed anomalous tail. This tail was first seen by Loehde on the 21st of April, 1957 as a short "beard". It was last recorded by photographs on the 29th of April.

From this very short summary of the observations, we next pass to Part II to discuss the conclusions. The reader will note that no mention has been made of the magnitude of the comet. Only a few magnitude estimates were made by ALPO members. These show a wide variation. For this reason, no discussion of stellar magnitude is given in this article. A graph of the estimates made by Meisel is given with no claim to absolute accuracy (Figure 22). The exact values will not be known until all the photographs have been evaluated or more estimates are received. For a discussion of magnitude estimates in general, see Reference 5.

Part II

Much of the difficulty encountered in cometary astronomy could be done away with if the observer possessed two things. One of these, a uniform definition of magnitude, will not be discussed here. (For more information, see Reference 1). The other is a way to get dimensional views of the comet in space. This, however, is impossible because of our fixture to the earth. Knowing the position of the earth relative to the comet, we shall attempt to make a series of drawings showing two views of the comet from observations over a two month period. These drawings are analogous to correcting planetary drawings for phase. Because the earth passed through the plane of the comet's orbit, we find that we have a definite viewpoint from which our deductions may be drawn.

Figure 23 shows the comet as it may have appeared from two directions on various dates. These are the one perpendicular to the comet's orbit and the other in the plane of the comet's orbit. The process of obtaining the correct view is complicated and will not be discussed. The scale is found as a function of angular size and distance.

One feature of these drawings is the double nucleus. Although seen by several observers, its exact position and position angle were hard to determine in terms of our reference frame. Thus its position in Figure 23 is not absolutely certain. This feature came into view after the anomalous tail disappeared, and

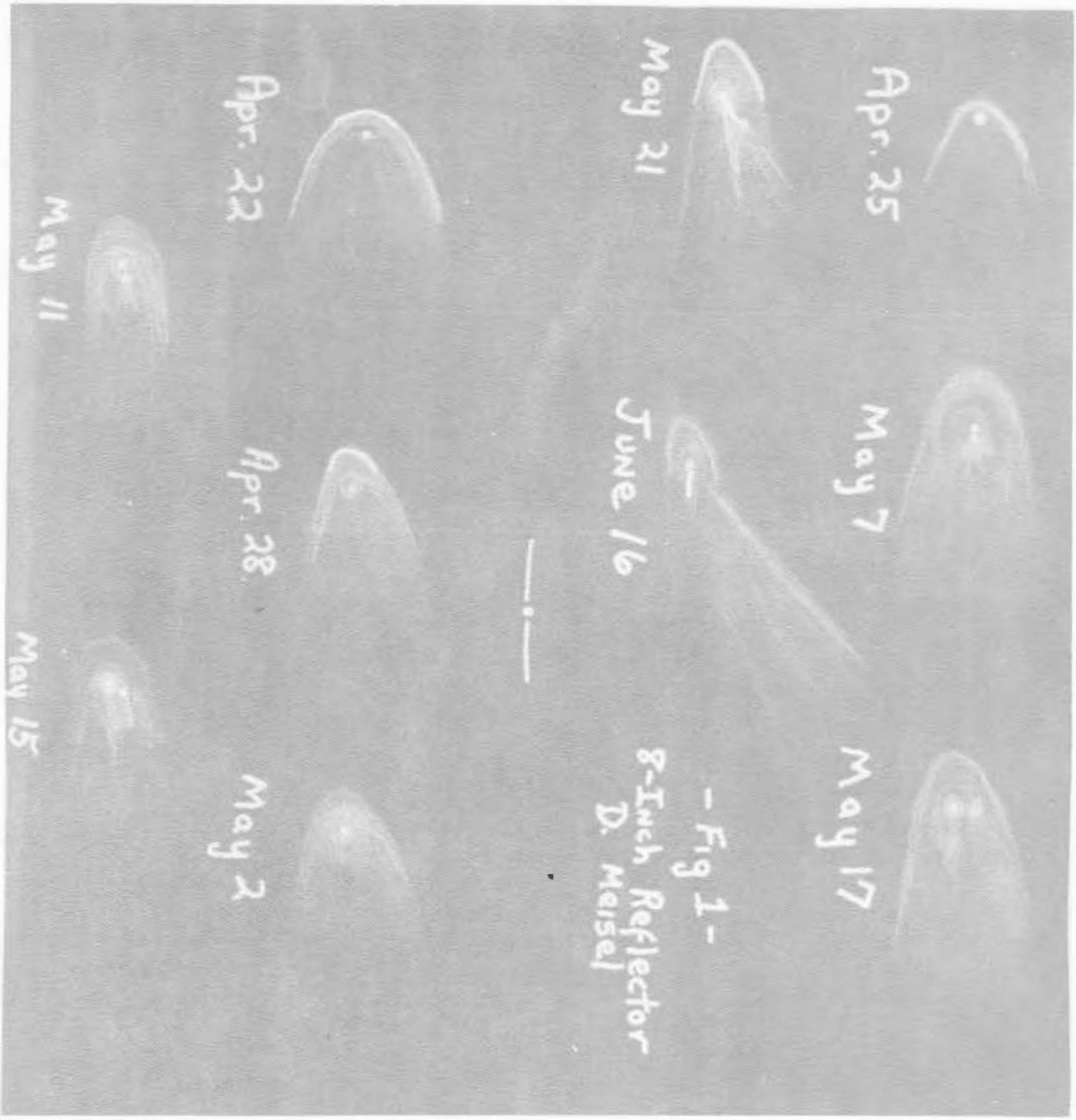


Figure 20. Some telescopic views in 1957 of coma and nucleus of Comet Arend-Roland. Contributed by David D. Meisel.

changed position and apparent position angle to such an extent that on May 17 the line joining the nuclei was at right angles to the axis of the tail. Later observations and photographs indicate that the two nuclei, after division, became the centers of a major and minor coma condensation, each having jets streaming from them.

At this point we should trace the evolution of the comet's structure from its discovery on Nov. 6, 1956 to its eventual disappearance. However, before proceeding any further, it is necessary to pause to describe a method for finding the degree and direction of ionization in any comet's parts. This step is necessary to the interpretation of some of the features seen and photographed.

Many recent studies in astrophysics depend on polarimetric observations. One of the basic assumptions in these studies is that the axis of polarization of the emission light in gaseous nebulae is perpendicular to its magnetic field which, in turn, determines the direction of motion of the negatively charged particles (see Reference 2). Using this postulate, the writer has experimented with applying this

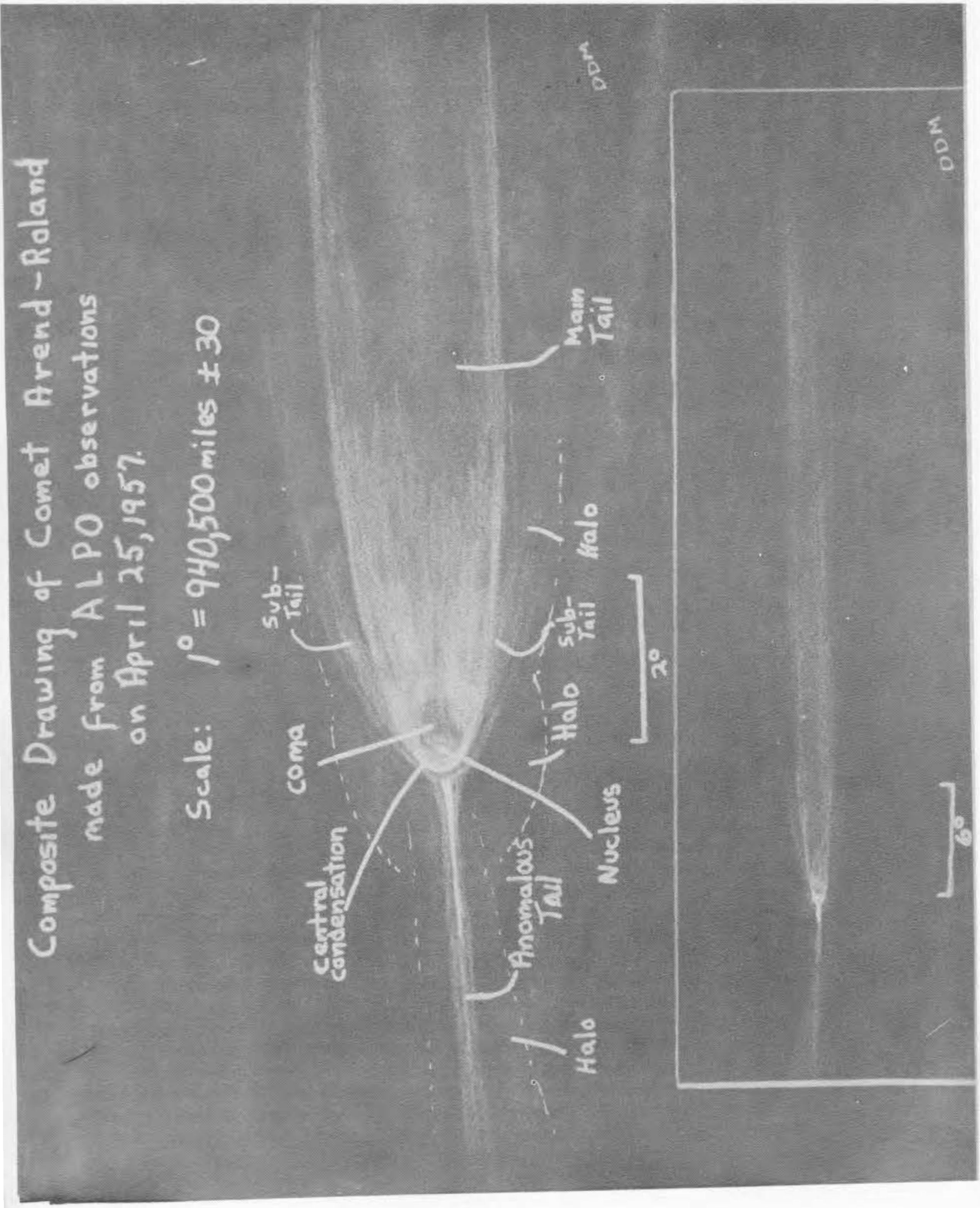


Figure 21. Composite by David D. Meisel.

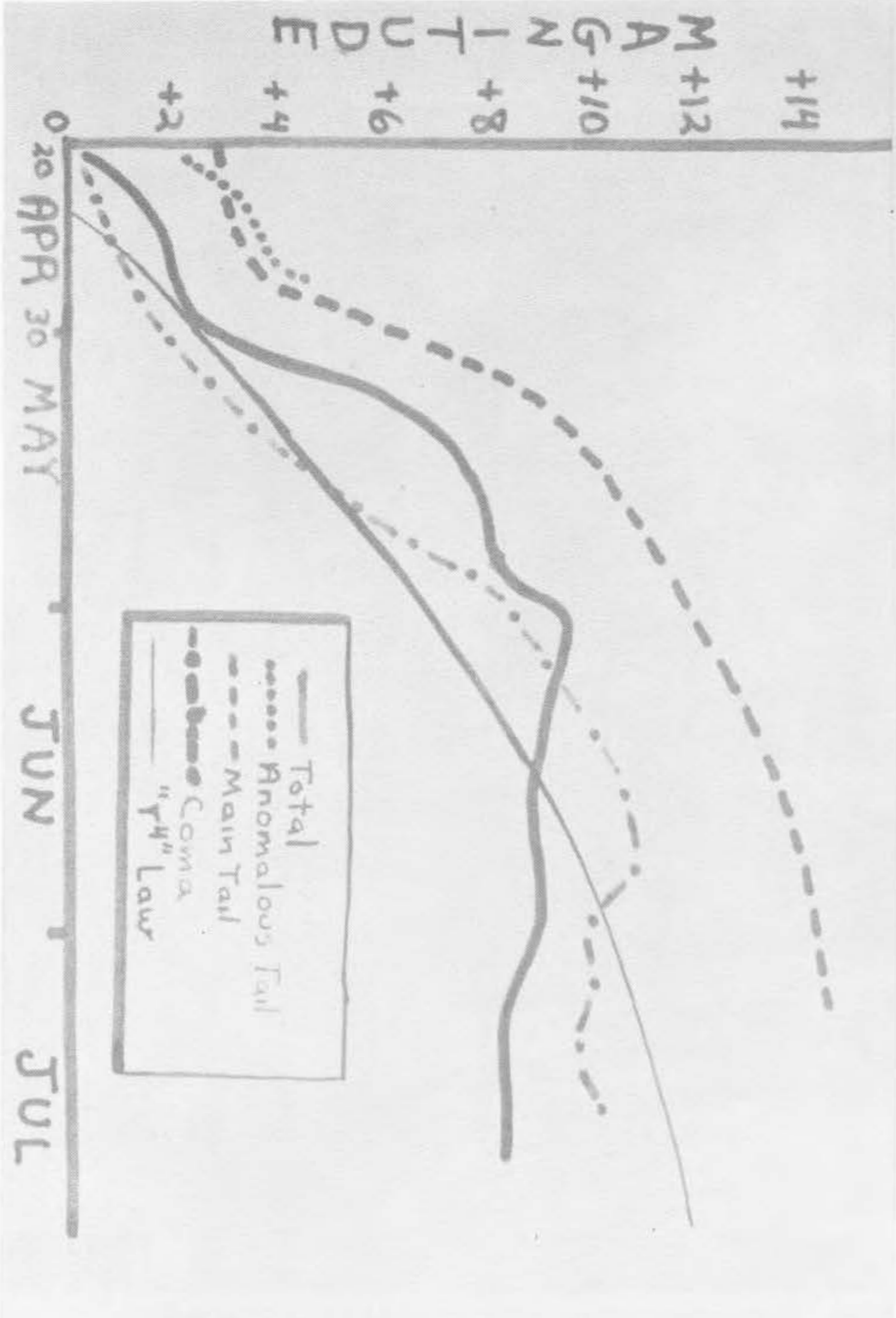


Figure 22. Variations in stellar magnitude of Comet Arend-Roland in 1957, according to observations of David D. Meisel.

method to cometary studies. The results are that the visual tail composed of positive ions (as proved by the spectroscope) is surrounded at all times by a sheath of negative particles of a much fainter integral brightness (found by polarization). On the basis of measures by the writer, it is possible to postulate the nature of various features of Arend-Roland on the basis of electric charge. (Positive signs indicate a need for electrons, and negative signs indicate a surplus of electrons.) Figure 24

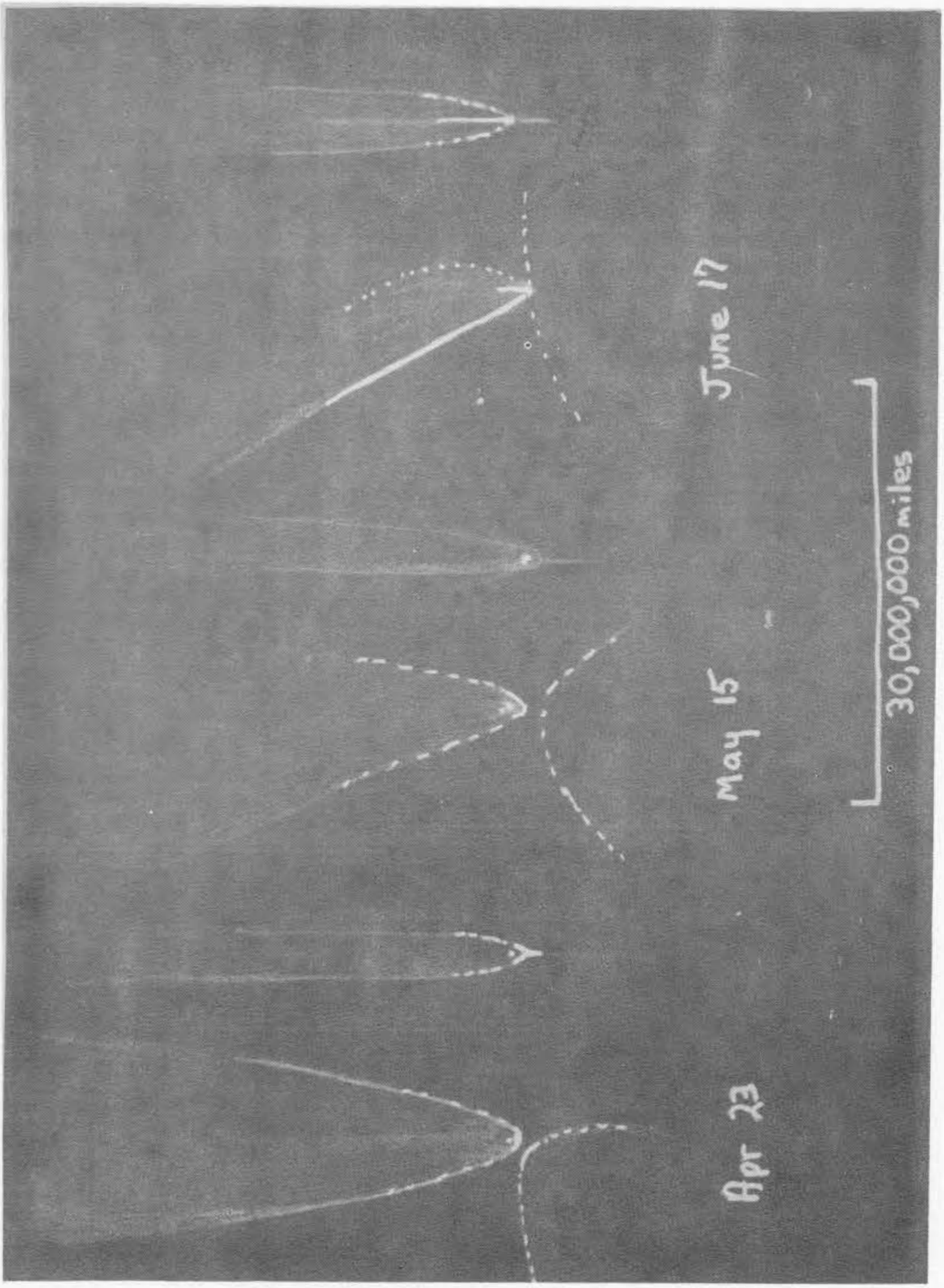


Figure 23. Perspective views of Comet Arend-Roland on three dates in 1957. Left: as seen perpendicular to plane of orbit. Right: as seen in plane of orbit. Refer to text of article about Comet Arend-Roland in this issue.

diagrams the parts of the comet with the respective charges and direction of motion indicated. The motion is relative to the nucleus nearer to the center of the coma. The diagram is based on observations made on April 25 and May 2, 1957.

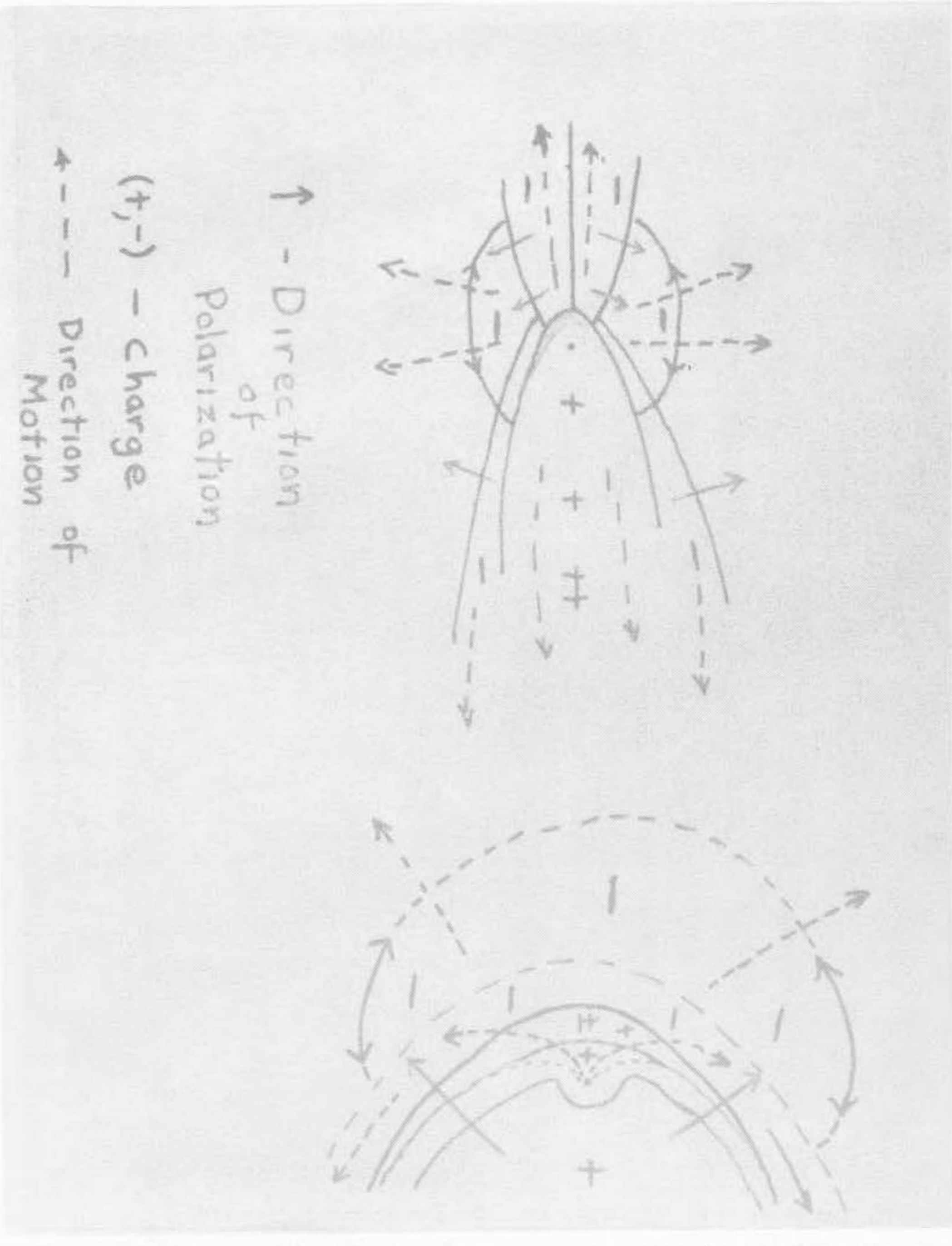


Figure 24. Suggested distribution of positive and negative ions in Comet Arend-Roland, according to David D. Meisel. See article about this comet in this issue.

Rather than giving a lengthy text on the evolution of Arend-Roland, the writer has chosen to present a drawing (Figure 25) which gives a day-to-day account of the comet's history as indicated by ALPO observations. One point that has not been mentioned is the peculiar yellow tint to the coma during the period April 21-22, 1957. This color was first observed by Loehde on the 21st. Although no positive proof is on hand to substantiate the opinion, the writer would imagine that the tint was due to metallic sodium dust heated to incandescence. The color of the coma then returned to its normal bluish-white after the comet got far enough away from the sun to prevent this heating. The presence of sodium in comets is further substantiated by the

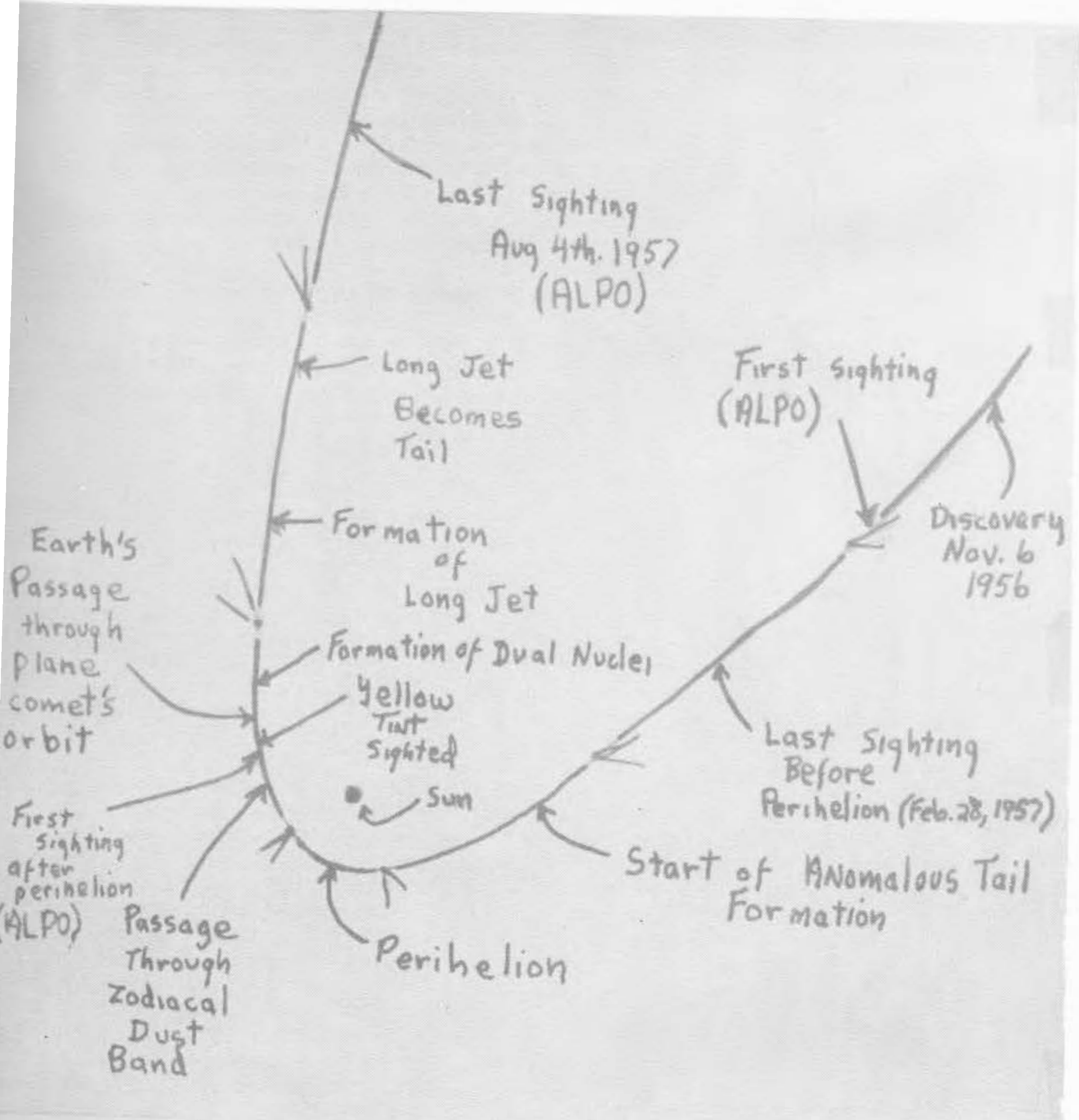


Figure 25. The story of Comet Arend-Roland. See article in this issue.

fact that Perseid meteor spectra contain, in many cases, many lines of metallic sodium. This sodium also may combine with ionized oxygen in a comet's tail to produce very long jets independent of the tail structure. No definite conclusions can be reached at this time concerning Arend-Roland because of the lack of the proper spectrograms.

Assuming that the comet was, as indicated by its orbit, a "new" comet, its evolution before perihelion was merely a period of adjustment. In this period the comet had to find a stable mode of existence if it were to survive to perihelion passage. If the comet had been unstable, it would have disintegrated after perihelion. By being stable both electrically and chemically, the comet enjoyed a fairly "quiet" passage. Of interest was the fact that a non-luminous segment of the tail was detected by the radio telescope to be drifting toward the earth. That this feature emitted radio waves seems to indicate the validity of the writer's opinions concerning polarimetric observations and electric charges pertaining to cometary research. Also of interest was the segmenting of the comet's tail after increased solar activity on April 25-27, 1957. The attraction between positive and negative ions may be the mechanism for holding a comet together and preventing rapid dispersion because of solar action. It would be interesting to see if this effect can be duplicated in the laboratory. It seems also that if this action is going on, much dust would be attracted to the comet's orbit. This is important to the analysis of the halos.

When the ALPO observations were corrected for "phase", the nature of the forward tail became evident. Giving a detailed account in a magazine article, Dr. Fred Whipple has explained it geometrically (see Reference 3). It is then our purpose not to prove or disprove the conclusions in that article but rather to elaborate on the creation of such a feature. Let us analyze and summarize what is immediately known about the forward tail.

(a) The forward tail was probably composed mainly of residual dust rather than all gas as is suggested by the tail's lack of polarization in the shorter wavelengths of light. Some gas, however, may have been occluded on the dust, thus giving rise to a gaseous spectrum.

(b) This dust was of rather large size in comparison to the average material in a comet, meteoroids of the nucleus excepted. Although of rather low density, as demonstrated by its transparency at large orbital inclinations, the dust, unless of a fairly good size, would have dimmed rather than occulted bright stars while passing in front of them, as was observed when seen edge on. Another indication of size is the fact that solar radiation had little effect on these particles, as they were apparently streaming sun-ward.

(c) Because of their size, these particles obtained and retained higher angular momenta than the rest of the comet at time of perihelion, excepting the nucleus, Thus only a fraction of the energy required to free this material at any other point in its orbit is used to start this material sun-ward. Also at perihelion the effect of gravitational attraction is near to zero in the comet while the sun's attraction is greatest. In addition to the energy of motion obtained in freefall, the internal energy of the comet is at its greatest due to ionization by solar radiation. The momenta of this dust is also aided by reactions like those described above.

(d) The tilt of the axis of the forward tail was probably caused by "friction" with the zodiacal dust band as the comet crossed the plane of the earth's orbit. This interference provided resistance to the leading edge of the forward tail, causing this edge to move toward the center of the tail, while the trailing edge did not change its orientation in space. This action changed the direction of the axis of the tail as well as the shape.

It is the writer's opinion that the forward tail formed by a delicate balance of the effects mentioned above in such a way as to make this feature appear as was viewed, also that this trailing of dust is normal for comets moving in parabolic orbits. No doubt it has been noticed that most of the changes in tail structure, both luminous and non-luminous, occur in the plane of the comet's orbit. This would seem to indicate that centrifugal force plays a part in the distribution of cometary materials, also in the shaping of a comet, tending to flatten it in the plane of its orbit.

As for the main tail, its curved leading edge was probably caused by friction with the finer interstellar gas falling into the sun while it diffused through the coarser material of the Zodiacal Band without too much change.

The nucleus of the comet, after undergoing much change before perihelion, finally split into two pieces, one of which was stable and remained at or near the center of the coma and one which was unstable and disintegrating, throwing out many jets in the process. The coma of the comet, however, retained its parabolic shape though seemingly tilted to the axis of the tail, as was photographed by Farrell on June 17. When the earth moved out of the plane of the comet's orbit and the comet receded from both the sun and the earth, the halos disappeared or became indistinct against the brighter background of the rest of the comet. Actually all of the so-called halos of Arend-Roland were not really halos but instead sheaths of material surrounding the brighter parts. They were classed only as halos because of their difference of polarization-axis-orientation from other parts of the comet. True halos are separated from the rest of a comet by a dark interspace. This does not mean that the nature of the halos is not the same whether separated or not.

Part III

Using the observations of other ALPO members as well as personal observations, the writer has reached tentative conclusions concerning not only Comet Arend-Roland but other comets as well. The conclusions are as follows:

(1) The nucleus, center of a comet's gravitational and magnetic fields as exhibited by tail rotation and polarization measurements, is probably a mass of solid meteoroids with super-cooled compressed gases occluded on them. The gases exist in a state of compression because of magnetic cooling and conduction, the exact process being beyond the scope of this paper. The nucleus seems to be held together by electrostatic forces as demonstrated by the apparent infall of material around the nucleus as the comet recedes from the sun. Gravitational forces would seem to contribute little to this effect while the rate of change in diameter of the central condensation around the nucleus is too rapid for thermal contraction to account for all of it. The distribution of material away from a nucleus is due to expansion of material as it is heated by the sun and the glowing nuclear material. The material does not disperse completely because of static attraction counteracting the thermal attraction.

(2) Magnetic eddy currents in the coma may produce pseudo-nuclei which last only for a limited time, though producing jets by particle acceleration. This effect may have caused the double nucleus of Comet Arend-Roland, though the minor component lasted too long to be just an eddy current without some nuclear material (dust, meteoroids) to prevent rapid dispersion.

(3) The coma is a shell of turbulent material surrounding the nucleus. Unlike the nucleus which seems to have a high negative charge due to the abundance of solid material which takes up free electrons (hence the negative charge), the coma seems to have an abundance of positively ionized gas and fine dust. However, because the nucleus is negative, the total charge on the head of a comet is slightly negative. Thus gas from the coma that gains enough energy to free itself is thrown back into a tail. The number of ions that are able to be free is relatively small at any one time, hence the lower density of the tail than the coma. The tail of a comet is then composed of positive ions with neutral or slightly charged dust that is swept along or pushed by sun-light. The positive gas has enough velocity to free itself from any influence of the comet proper. The ions' positive charge tends to disperse the tail, making it spread outward before gaining enough electrons to become neutral gas, which floats on out into space. A convergent tail is caused by a surplus of negative ions that have been accelerated in the direction of the tail. It is usually surrounded by a sheath, of slightly luminous neutral material thrown out as the positive ions are de-ionized.

(4) Jets can be caused by radical and ion reactions, particle accelerations, dust collisions, or a combination of any of the three.

(5) Halos are caused by collisions between freed electrons and infall dust,

which is attracted by the positive charged ions, producing a slight glow making the features visible.

(6) Forward tails are formed by large solid particles that are ejected in a manner or combination of effects as described in Part II. Thus a comet may gather fine dust and neutral gas by infall while ejecting larger particles and ionized gas in a manner which causes tails. Thus because of the low relative albedo, neither kind of tail should be visible except when viewed through almost its greatest extent. The main tail is visible at most times because of its emission light as produced by ionization. The coma shines by both emission and reflected light so that it is the brightest in comparison to its relative density of all parts of a comet.

(7) The tendency for most comets toward stability is to replace the large dust and meteoroids with more easily ionized fine dust; that of low potential material with that of higher potential material and that of low density gas with that of fairly high density gas. After enough successive trips to the sun, the nucleus breaks up, leaving meteoroids behind in the orbit. The comet then becomes a floating gas and dust cloud, gradually dispersing by thermal expansion and ionization as the negative charge producer and retainer is left in an orbit.

(8) Thus a comet can only remain stable if the total charge is near zero. If it becomes negative it will collect positive ionized gas and start going back to zero charge. If the charge becomes positive it tends to rob the nucleus of some of its binding charge and the comet heads toward disruption. A comet in deep space will have a neutral or slightly negative charge; a comet near the sun has a positive charge due to ionization, at least very near perihelion. A comet's stability depends on its percentage composition of gas, meteoroids and metallic dust, and type of elements present in each. Just what percentage and type of composition is not known.

It may be said that this list is not exhaustive or absolute. This study should provide a fruitful field for any enterprising amateur who is willing to spend the time to seriously study those "celestial Van de Graff generators" called comets.

Acknowledgements

The writer would like to thank Walter H. Haas for patience and time so unselfishly given to the production of this paper by private encouragement and communication. The writer would also like to thank the following ALPO observers for their work on Comet Arend-Roland, without which this paper could not have existed:

A.C. Larrieu, Frank Suler, Hans Pfleumer, Frank Loehde, C.F. Capen, B.A. Smith, John Farrell, Mike Kaiser, Walter Barber, Beaufort Ragland, Owen Ranck, Robert Farmer, Robert and Richard McLaughlin, Frank Nicolazza, William Hartmann, Tom Cave, Alika Herring, Henry Squyres, and Stephen Sinotte.

In addition he thanks James Nigh, Fred Villinger, John Monahan, and other Fairmont, W. Va., amateurs for the use of their various instruments for public as well as private observations of Arend-Roland.

References

1. Observational Astronomy for Amateurs - J.B. Sidgwick, page 252, paragraph (f).

2. Scientific American - March 1957, pp. 52-60.

3. Sky and Telescope - July 1957, pp. 426-428.

4. Sky and Telescope - July 1957, pp. 412-417.

5. Strolling Astronomer - September - October 1956, pp. 116-121.

6. Various standard texts on astronomy and physics.

BOOK REVIEWS

Atlas of the Sky, by Vincent de Callataÿ. St. Martin's Press, 103 Park Avenue, New York 17. 1958. 157 pages. $12.50. Reviewed by Charles A. Haas.

This book is very valuable to the person who wishes to familiarize himself with the heavenly bodies. It also contains much information for the advanced amateur or even professional. It is written in simple terms. Numerous star maps are used to present the material. There are 36 plates showing the stars as white dots on a dark background and including all stars down to magnitude 5.5. Under each plate objects of interest are fully discussed, and information is given about how to locate these bodies. There is much valuable information throughout the text and a set of valuable astronomical photographs at the end.

The table of contents is very well arranged so that the reader can easily find a subject in which he is interested. The book is well arranged and is made to endure usage. The book is an asset to anyone interested in stellar astronomy.

The Encyclopedia of Radio and Television. Philosophical Library, New York, 1958. Second Edition. Reviewed by W. Richard G. Duane and John M. Sharp.

Despite an ever-growing trend toward specialization, scientists in widely diversified fields have of late found electronic instrumentation increasingly valuable in their research. The modern astronomer, for example, makes use of such electronic devices as photo-electric star magnitude comparators, radio telescopes, special timing devices and servo-operated telescope controls. A recent article in the *Scientific American* describing a home made electronic meteor counting system points up the fact that even the amateur astronomer is making use of electronic techniques. If one considers mathematics the "hand maiden of the sciences", electronics may properly be called "the scientist's handyman"!

Obviously, a specialist in astronomy cannot be expected to make himself familiar with all phases of electronics; but if he wishes to employ the latest techniques in his field, he must be able to understand the use of electronic equipment. Accordingly, he needs a reference source to assist him in understanding terminology relative to electronic equipment in his field.

This book, then, is such a reference source. It is a dictionary rather than a textbook; the specialist in electronics would find it too elementary to be of value to him, while the tyro would find it too advanced. However, for the scientist who has had some contact with electronics, the definitions are clear, concise and to the point. The American reader should be cautioned that since the book was authored in Britain, certain terms (for example, "valve" for "tube") differ from usage in this country. This should cause little difficulty, since these terms are not numerous.

The diagrams are clear and sufficiently abundant to illuminate the text. The style is neither pedantic nor condescending.

It is regrettable that transistors and other semi-conductors were not covered more fully in so recent a publication as this. The reviewers feel that the organization of this book could be improved if the "recent developments" were incorporated in the normal alphabetical sequence of the main text rather than as an appendix at the end of the volume.

The reviewers believe that this book would be of some value to the scientist interested in the electronic instrumentation of his field.

ASTRONOMICAL LEAGUE - A. L. P. O. CONVENTION

by William E. Shawcross

The Association of Lunar and Planetary Observers convened with the Astronomical League at Cornell University, Ithaca, New York, on July 4-6, 1958. It was the third convention of the A. L. P. O., the 12th of the Astronomical League. Of the approximately 150 people attending, 34 were A. L. P. O. members.

Registration began Thursday afternoon, July 3, while exhibits were set up. The A. L. P. O. display was one of the most colorful, and David D. Meisel, Comets Recorder, deserves much credit for this fine exhibit. Friday and Saturday had a full schedule of papers, and the first A. L. P. O. session was held Saturday morning from 11 to 12 noon, under the chairmanship of Grace C. Scholz. Here was heard Walter H. Haas' "Lunar Colongitude: Why, What, How, and When", read by William H. Glenn of the New York AAA Observing Group. Ernst Both presented his paper "Introduction to Selenomorphology", and Leonard B. Abbey, Jr. read Patrick Moore's "Some Suggestions Regarding Lunar Domes".

Saturday evening, like all the other evenings, was cloudy, so A. L. P. O. members met informally in the lounges of Dormitory 4 (convention headquarters) for discussions lasting into the small hours, just as they had done on Thursday and Friday nights. The discussions centered on observing problems and results; they were sparked by the presence of our Mercury Recorder, Comets Recorder, Uranus-Neptune and Assistant Mars Recorder, and our Foreign Language Co-ordinator.

Sunday morning from 9:30 to 11:30 marked the second A. L. P. O. session. William K. Hartmann discussed "Drawing the Moon and Planets", Owen C. Ranck gave the report of A. L. P. O. Mercury observations, and David D. Meisel discussed the A. L. P. O. cometary research program. A. C. Larrieu's paper on the French selenographer C. M. Gaudibert was read; Phillip W. Budine spoke on "Intensities and Colors of Jovian Features"; "Some Changing Aspects of Mars in 1956" by Joel W. Goodman was heard. The session closed with Walter H. Haas' A. L. P. O. progress report.

The convention ended at 12 noon on Sunday; apart from the inclement weather which prevented any observing, all present had an interesting and profitable three days at Cornell.

Lengthy Postscript by Editor. It should be added that it was Mr. Shawcross who read Mr. Larrieu's paper.

The Editor was delighted and touched to receive the following telegram from Ithaca on July 5: "Best wishes from the A. L. P. O. members at Convention. Leonard Abbey, Ed Bailey, Ernst Both, Tommy Brooke, Phil Budine, Ed Gilmore, Bill Glenn, Joel Goodman, Bill Hartmann, Henry Kepler, Emil Klein, John Krewalk, Charles Le Roy, Dick Luce, Russ Maag, Allan Mackintosh, Dave Meisel, Hal Metzger, Owen Ranck, John Reed, Minick Rushton, John Schlauch, Grace Scholz, Bill Shawcross, Eugene Spiess, Armand Spitz, Joe Sullivan, Hoy Walls, Bob Wright, Tim Wyngaard, Mark Zillman". I wish to thank the senders of this telegram very much for their courtesy and thoughtfulness.

I also want to thank Grace Scholz for acting as Chairman of the A. L. P. O. Convention, David Meisel and his helpers for setting up the exhibit, all speakers and readers of papers, Bill Shawcross for this article, George Keene, the Astronomical League Program Chairman, the officers of the League, and all others who helped in any way.

Figure 26. Some of the A. L. P. O. members at Third A. L. P. O. Convention at Ithaca, New York on July 5 and 6, 1958. Left to right: Hal Metzger, William K. Hartmann, Mark Zillman, Owen C. Ranck, David D. Meisel, William E. Shawcross, Leonard B. Abbey, Jr., and Ernst Both.

Figure 27. Informal scene at Astronomical League - A. L. P. O. Convention. Center foreground, left to right: David D. Meisel, Ernst Both, and William K. Hartmann. Right rear: Chandler H. Holton, President of the Astronomical League.

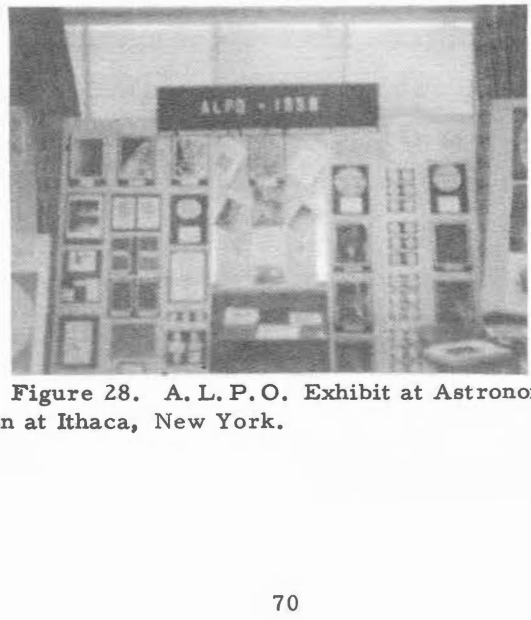


Figure 28. A. L. P. O. Exhibit at Astronomical League-A. L. P. O. Convention at Ithaca, New York.

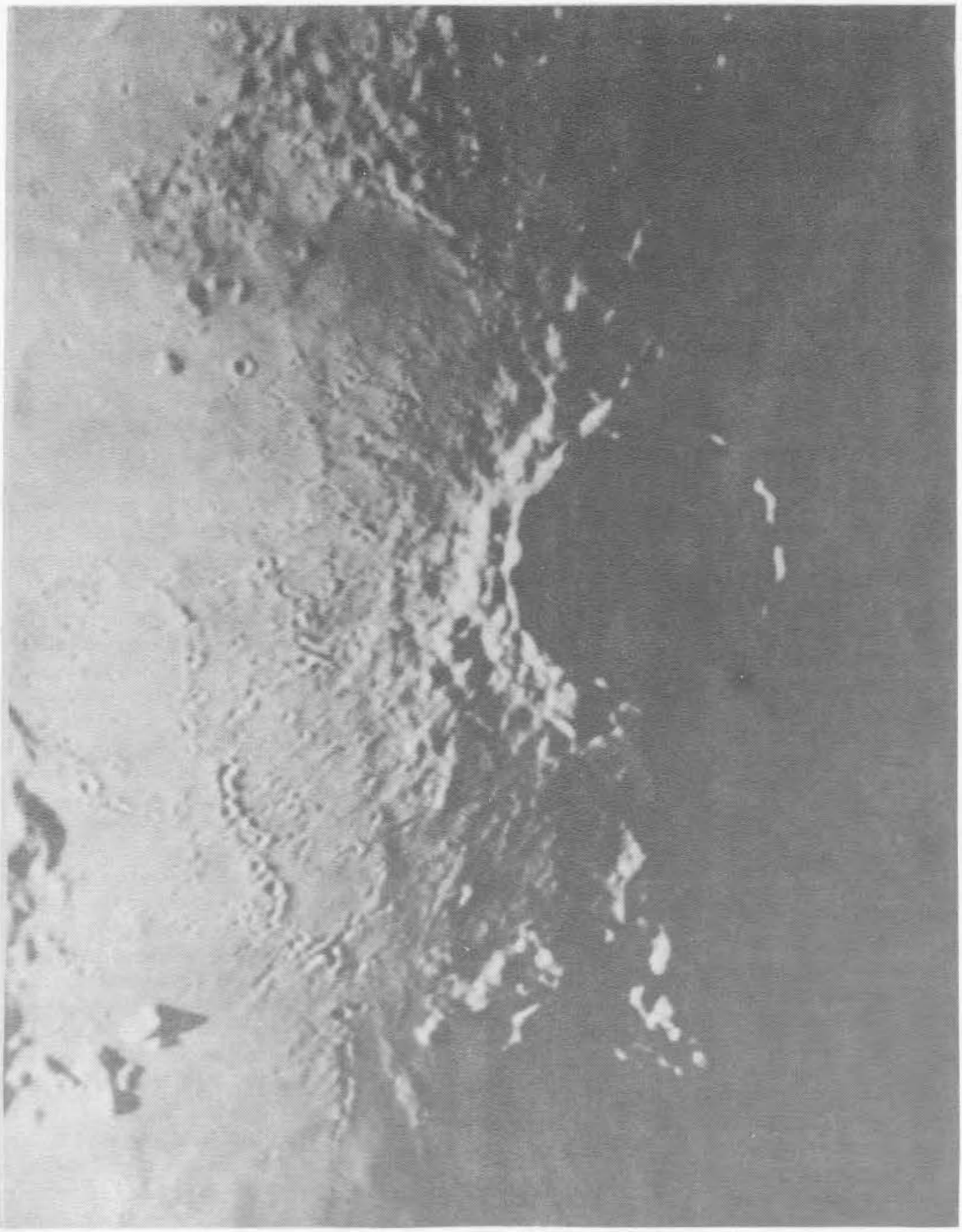


Figure 29. Ring-Plain Copernicus on sunrise terminator. Photograph by Dr. Dinsmore Alter with Mt.. Wilson 60-inch reflector, Cassegrain focus, and 40-inch diaphragm. November 12, 1956, $4^h\ 4^m$, U.T. 1-N plate, Pyrex 7-69 filter. Exposure 3.5 seconds. Colongitude = $20\overset{\circ}{.}2$.

OBSERVATIONS AND COMMENTS

Copernicus. We invite our readers to study Dr. Dinsmore Alter's excellent photograph of Capernicus on pg. 71. Although we do not know how successfully the finest detail on the print kindly supplied by Dr. Alter will reproduce, we are sure that earnest lunarians will find much to study here. We especially invite attention to the radial ridges and to the rows of crater-pits, surely not the result of random meteoritic impacts. Many of the features shown are visible only under extremely low solar lighting. Observers should enjoy comparing the telescopic aspect of this part of the Moon to the photograph, naturally when the solar lighting is very similar.

Comets Section Materials. This issue is accompanied by several loose sheets of material kindly supplied by the Comets Recorder, Mr. David D. Meisel, 800 8th St., Fairmont, West Virginia. These pages should be self-explanatory. Readers are invited to look over these sheets, and everyone interested in comets should fill out the application form and mail it to Mr. Meisel. We thank you for your cooperation.

The Red Spot Region and the S. E. B. Disturbance of Jupiter. Readers may enjoy studying the latitudinal strip sketches of Jupiter by Elmer J. Reese on the front cover of this issue, showing the involvement of the Red Spot region in the great South Equatorial Belt Disturbance of 1958. The method of strip sketches may itself be worth a few lines, for the rapid rotation of Jupiter (six degrees of longitude in only ten minutes) makes drawing the full disc rather difficult because of time limitations. Here one instead limits attention to a portion of the Giant Planet; Mr. Reese has here shown the South Equatorial Belt, the South Tropical Zone, and the South Temperate Belt. In this method the sketch can be gradually extended in the direction of increasing longitude on a given night as the rotation of the planet brings new markings into view; longitudes of markings can often be fixed by central meridian transits, which can and should be simultaneously observed while the sketching is going on. Sometimes sketches can be made from observations on two different dates, though one must then be wary of possible changes in the interim on the surface of Jupiter.

These sketches may be regarded as a chronological supplement to those in Figure 13 on pg. 35 of our January-March, 1958 issue. Identification of features in the South Equatorial Belt is rather difficult because of rapid changes and because of large drifts of the order of several degrees per day in System II, in the direction of increasing longitude for the south component of the S. E. B. and in the direction of decreasing longitude for the north component. On July 7 Mr. Reese wrote in part as follows: "Near the middle of June, I, too, observed the Red Spot to be apparently displaced toward the following shoulder of the developing Hollow. The drift of the Red Spot in longitude has been almost perfectly linear since early Nov., 1957. It would seem that the momentum of the advancing dusky matter in the SEB temporarily overcame the Red Spot's repelling action.

"The Red Spot began to fade on June 8. The leader of the retrograding spots on the S. E. B.$_s$ arrived at the preceding shoulder of the Red Spot Bay on June 15. On June 30 there were indications that the Red Spot region was about to change its aspect. In a fair view on July 7 at 2^{h}12^m, U. T. the Red Spot appeared quite faint but still the 'Spot' and not the 'Hollow'." It will be noted that Reese's July 19 sketch shows the Hollow very well developed, an observation confirmed independently by Haas on July 21.

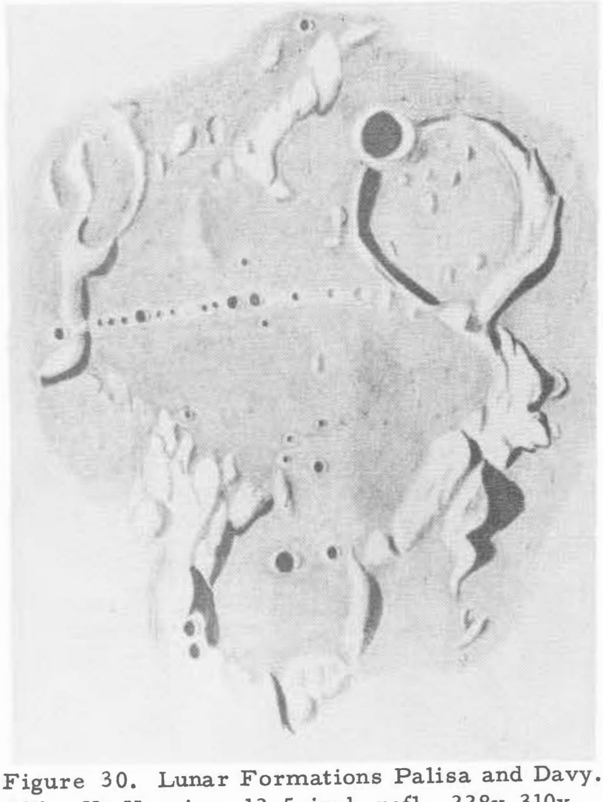


Figure 30. Lunar Formations Palisa and Davy. Alika K. Herring. 12.5-inch refl. 228x-310x. May 27, 1958. 4^{h}15^m, U. T. Colong. = 16°.7. Note chain of 14 craterlets across rectangular walled plain between Palisa and Davy.

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