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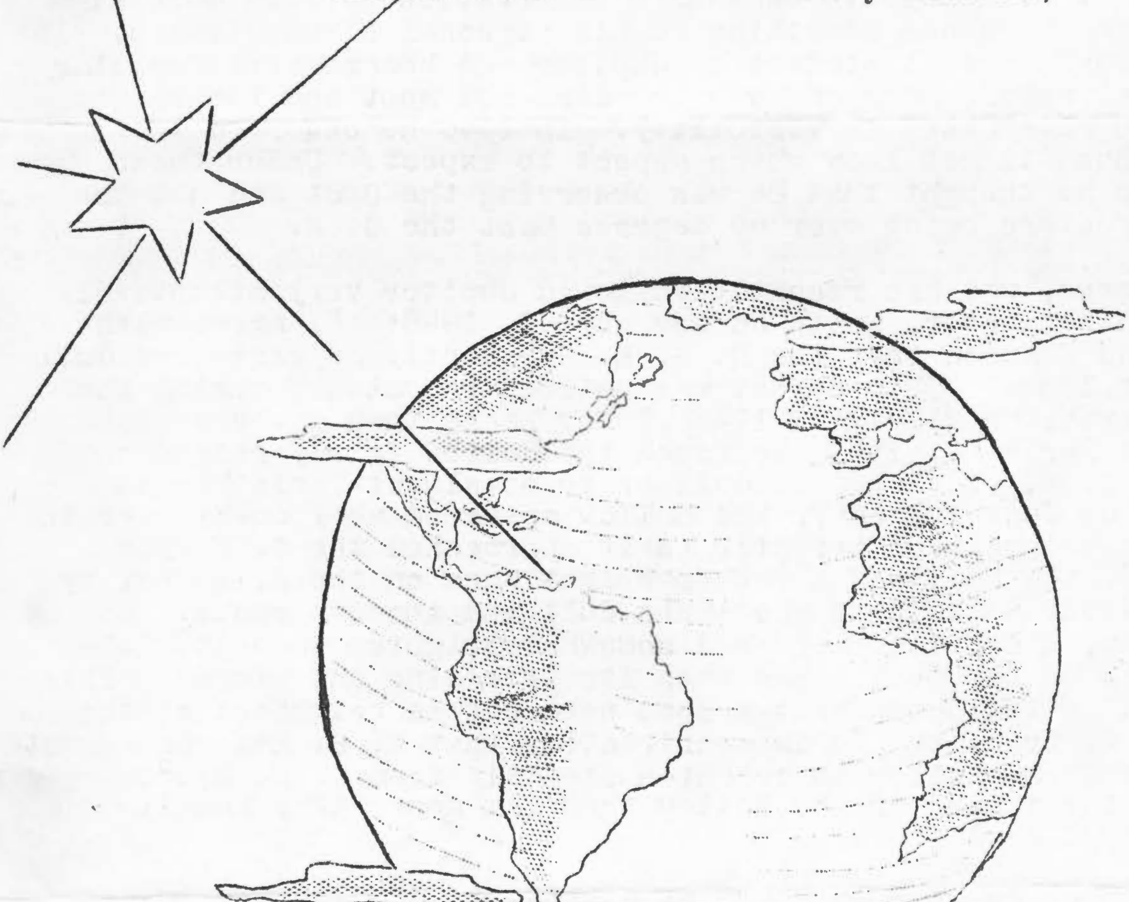

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THE BRIGHT AND DUSKY RED SPOT HOLLOW

Up until a few months ago we innocently supposed that one could speak about the brightness or darkness (only relative, of course) of a mark on Jupiter without much reference to its distance from the central meridian. Alas, the planetarian's life has grown more complex in this respect! On pp. 3 and 4 of our November, 1948, issue we described how the Red Spot Hollow, which in 1948 always looked bright near the C. M., appeared dusky when well off the C. M. to C. B. Stephenson and to H. M. Johnson. Johnson's observation derives more significance when one knows something of his personal circumstances. In 1937-41 he was an ardent student of Jupiter and became very familiar with the usual appearances of both the dark Red Spot and the bright Hollow, which alternated in visibility. In 1948 he observed very little and thus did not know which aspect to expect. Under these circumstances he thought that he was observing the Spot and not the Hollow, the feature being over 60 degrees past the C. M.

E. J. Reese, who has recently followed Jupiter very attentively with a 6-inch reflector, wrote on November 7, 1948: "I agree with Stephenson and Johnson that the R. S. H. frequently appears very dull when near the limbs. This effect was noticed repeatedly during the last two apparitions [1947 and 1948]." Mr. Reese then gives some examples. On March 20, 1947, he found the Hollow fairly bright on the C. M. at C. M. 226°* but so dull as to be almost invisible at C. M. 279°. On June 10, 1947, the Hollow appeared very dusky near the east limb but became much brighter as it approached the C. M. On April 4, 1948, the Hollow was rather bright when on the C. M. but by C. M. 272° (about 45 degrees past) was dull and inconspicuous. On August 3, 1948, the Hollow appeared somewhat brighter when its following end was on the C. M. than when its preceding end was on. This last observation indicates that a spot need not be brightest at the moment of C. M. transit. It is confirmatory that W. H. Haas on August 10, 1948, found the Hollow to brighten steadily from C. M. 210° to C. M. 250°. The center of the Hollow then lay near 232°, and its length was about 24 degrees.

A drawing of Jupiter by Meyer at Stuttgart, Germany, on August 11, 1948, at C. M. 269° shows the Hollow bright, not dusky. Yet Stephenson on August 30, 1948, at C. M. 264°, and with the Hollow hence somewhat closer to the C. M. than for Meyer, found it so dusky that he at once falsely took it for a shaded area elsewhere in the zone.

J. C. Bartlett of Baltimore, Maryland, has written at considerable length about the problem being discussed. His observations, all in 1948, are with a 3.5-inch reflector. On August 3 at C. M. 209° he found the Hollow "very prominent and much brighter than the South Tropical Zone." At C. M. 290° on that date the Hollow was still seen "with some difficulty"; there is no mention of duskiness. On August 25 at C. M. 234° Bartlett found the Hollow rather bright, in fact brighter than the Equatorial Zone. By C. M. 278° it was noticeably dimmer, though still white and not dusky. At C. M. 200° on August 27 the Hollow was "white and equal to the Equatorial Zone in brightness."

*All longitudes in this article are by System II

On August 28 at C. M. 299°, and thus when about 67 degrees past the C. M., the Hollow was "bright." We should mention here that Stephenson and Johnson observed duskiness at C. M. 294° on July 8. Bartlett on November 14 at C. M. 201° found the Hollow "white and much brighter than any other marking save the Equatorial Zone." On November 21 at C. M. 168° the Hollow was surprisingly dull, being about 66 degrees short of the C. M. It was scarcely brighter than the South Tropical and South Temperate Zones. Bartlett considered it "certainly much duller than I have seen it in comparable positions."

Now a careful study of these records plus the ones given on pp. 3 and 4 of our November, 1948, issue leaves little doubt that the brightness of the Hollow when its center was more than 30 degrees from the C. M. fluctuated considerably in 1948. The only alternative is to suppose that observers cannot tell whether the Hollow is brighter or darker than the South Tropical Zone--a notion hardly plausible. Though the brightness of the Hollow when near the C. M. varied to an easily observable extent, it appears unlikely that it varied as much as the observations well off the C. M. show.

Dr. Bartlett in correspondence offers an explanation of the Hollow's curious behaviour interesting enough to deserve quoting at length:

"Since the Hollow is not a fixed feature, there does not seem to be any reason why it may not have a vertical motion as well as a motion in longitude, the vertical motion being perpendicular to the planet's surface and consequently at an angle to the line of sight when the Hollow is near the limb. Indeed, if the Hollow is in any sense a floating feature, as its movements seem to indicate (understanding this to mean floating in an atmosphere), it seems certain that it must have at least some small vertical oscillation. If you have ever watched a half-submerged log floating in the sea you will see at once what I mean.

"If this be true, then at times of maximum emergence from the surrounding vapors and clouds, the Hollow might well appear bright up to and on the limb for the same reason that the faculae appear bright on the limbs of the sun. On the other hand, when it is partially submerged, we might reasonably expect a decided absorption as the Hollow neared the limb and so a corresponding diminution in brightness. Indeed, on well-known optical principles, if absorption were greater than for a feature at a higher level, the Hollow would tend to appear darker and so be translated by the eye to a dusky feature.

"It seems to me that a good line of observation is indicated here; namely, a consistent and prolonged study of the Hollow in positions very close to the limb using the Equatorial Zone as comparison, i. e., the center of the E. Z. [Unfortunately, the E. Z. may vary in brightness. Perhaps the Hollow should instead be compared to several zones. Also, one might assign an intensity-number on some arbitrary scale. None of these methods are absolute.--W. H. H.] If now it were found that the Hollow showed constant differences in relative brightness as compared with the central meridian on the equator, when the Hollow itself was on or very near to the limb, one would establish a variation in the intrinsic brightness of the Hollow itself. This, of course, would not in itself establish a vertical oscillation as the cause of the differences, though it would strongly support such a view. I give this theory for what it may be worth."

We welcome correspondence on Dr. Bartlett's interpretation of the changes.

THE TWIN CRATERLETS IN PLATO

The dark-floored walled plain Plato has probably received more study from lunarians than any other region on the moon's surface. Its students include such eminent observers as W. R. Birt, A. S. Williams, W. H. Pickering, G. and V. Fournier, P. Fauth, and H. P. Wilkins. Of the dozens of bright spots which have been mapped upon the floor, perhaps six to ten are within the reach of ordinary-sized telescopes of good quality. These spots are seen as crater-pits when Plato is near the terminator and as white spots when the solar illumination is higher. They are more conspicuous in small instruments under the latter condition. The easiest craterlet (or spot) is ordinarily one near the center of Plato. If we now proceed from this craterlet in a north-northeast (lunar) direction and stop about half way to the edge of Plato, we find at this place a pair of small craterlets, which are the subject of this article.

According to measurements reported by W. H. Pickering on pp. 179-182 of Volume 32 of Harvard Annals, the southwest member of the pair has a diameter of 4200 feet and is hence larger than the northeast member, which measures only 3000 feet. The height of the walls of the northeast crater above the exterior plain was found to be 150 feet, and the depth of the southwest crater was determined from its interior shadow to be 500 feet. More recently, E. J. Reese has estimated that the distance between the centers of the craterlets is about 1" and is certainly less than the separation of the components of the double star Pi Aquilae. Norton's Atlas informs us that the latter value was 1".4 in 1937 and changes little. At the average distance of the moon 1" corresponds to 6000 feet, if foreshortening is not involved. If we combine Pickering's diameters and Reese's separation, we have that the rims of the craterlets are only 2400 feet apart, a value probably too small because of neglected foreshortening.

It is not easy to divide the twin craterlets with small telescopes. In fact, optics of high quality and favorable atmospheric conditions are required. Usually, the craterlets are seen merged into a single white spot. Their separate visibility is a good test for apertures of, say, six to ten inches.

The immediate cause of this article is a communication from E. K. White. His 7-inch reflector afforded him a fine view of Plato with fairly good seeing near 4^h 30^m on October 14, 1948 (Universal Time here and later). Although Plato was then 37 degrees of longitude past the sunrise terminator, Mr. White could clearly see the floor craterlets as pits. "The northern pair was especially noted with 300X, and I was surprised to find the eastern craterlet about 4/3 times as large as its western companion. This is the first time I saw the eastern one larger." We should state here that Mr. White has made dozens of observations of Plato from 1942 to the present. The same observer later found the twin craterlets "about equal in size" when observing "two days before last quarter" and thus probably near 13^h on October 23, 1948. At that time Plato was 29 degrees from the sunset terminator. Perhaps the view was not so good as on October 14.

Our readers might be interested in a few other observations of the twin craterlets. There can be no question of a complete discussion of all known data here; that would require a huge amount of space. On September 11, 1947, E. J. Reese wrote that he had resolved the double craterlet only twice, on March 6 and September 1, 1947. The component spots were small and almost identical, but perhaps the northeast one was slightly the larger. Going further back, we have that in 1943-5 W. H. Haas often examined Plato with an 18-inch refractor, sometimes enjoying views good enough to show crescent-shaped internal shadows in the craterlets when Plato was several days from the terminator. Haas' observations, even more than Reese's, emphasize the identity of the craterlets; he never once recorded a difference in size, and only once did he comment on a distinct difference in brightness. (The east craterlet was clearly the brighter near 8^h on November 1, 1944). A map of Plato for the years 1938-43 constructed by the late S. M. Green of the British Astronomical Association from his drawings and observations shows the west craterlet distinctly the larger, the very opposite of White's 1948 observation but in accord with Pickering's 1892 measures. A drawing by G. P. B. Hallowes on September 18, 1915, which is reproduced on pg. 244 of W. Goodacre's Moon, shows the twin craterlets apparently very much alike. Finally, during B. A. A. surveys of Plato in 1869-72 and again in 1879-82 the southwest craterlet was considerably more conspicuous than the northeast one; it was necessarily then larger or brighter than its neighbor, perhaps both.

Naturally, we can hardly seriously suppose that either of our twin craterlets actually varies in size. But with objects so near the limit of resolving-power, the observed size, as distinguished from the true size that a surveyor on the moon's surface could determine, must be influenced greatly by such matters as the brightness of the walls and the darkness of the floor of Plato adjacent to the craterlet. That marked changes in the visibility of the craterlets not dependent upon the solar lighting or libration do occur has been the opinion of almost all first-rank observers of Plato. For example, the craterlet ranking sixth in conspicuousness in 1870 was completely invisible in a larger telescope in 1892, though searched for and though dozens of spots were mapped. (W. H. Pickering, The Moon, pg. 40, 1904). Again, the Fourniers in 1907 and 1909 usually found a craterlet in the southeastern quadrant of Plato to be second in ease of visibility, the twin craterlets coming next. However, on January 21, 1910, the twins were seen larger than the southeastern craterlet and certainly were more conspicuous than in other lunations at similar solar lighting. The seeing was not unusually good and cannot explain their prominence; only four craterlets were visible on the floor of Plato. (R. Jarry-Desloges, Observations des Surfaces Planétaires, Fascicule II, pp. 209-210, 1911.) In 1943-5 W. H. Haas with an 18-inch refractor usually found the southeastern craterlet mentioned above to rank second in conspicuousness. In fairly good seeing on October 3 and 28, 1947, it was comparatively inconspicuous with a 6-inch reflector, being harder to see than the (merged) twins. The best views showed it unexpectedly tiny and comparatively brilliant; it was brighter than the central craterlet, which it was dimmer than in 1943-5. One will note that a craterlet really tiny and brilliant would be more readily seen so with the larger telescope.

The editor recommends the careful study of these twin craterlets to ambitious observers. We reiterate earlier warnings: the telescope must be good, and preferably large; and only nights with good seeing can be used. Granting these conditions, it should be possible to make very accurate comparisons of the two twins as regards size, brightness, general conspicuousness (a combined effect of both), depth, etc. The study would require little time and might well become fascinating.

CONCERNING THE RING C PUZZLE

In the autumn of 1947 the dark apparent projection of Ring C, the Crape Ring, against the ball of Saturn was found so extremely narrow by a number of observers that W. H. Haas was convinced that a remarkable narrowing must have occurred (The Strolling Astronomer, Volume 1, No. 9, pg. 1, and No. 10, pg. 2, 1947). E. E. Hare more cautiously suggested that the Crape Band seen was not really the projection of Ring C at all but was instead its shadow. He explained the darkness of the Band as caused by the dispersal of sunlight by diffraction as it passed twice through the Crape Ring (The Strolling Astronomer, Volume 2, No. 3, pg. 1, 1948). It seems curious that if the Crape Band is really the shadow of the Crape Ring, its consequent sizeable variations in width each year (due to the changing positions of the sun, the earth, and Saturn) should be so completely unknown to astronomers. Perhaps it is merely one more example of the remarkable ability of observers not to see what they are not looking for. On November 2, 1948, E. J. Reese sent us an important and valuable discussion of this Ring C problem. We regret lacking facilities to reproduce the graphs which illustrate his argument. Mr. Reese has employed very largely his own observations so that the results will be somewhat tentative on that account. He set for himself two objectives: (1) To determine whether Ring C narrowed near the 1947 conjunction of Saturn. (2) To determine the nature of the Crape Band seen upon the ball adjacent to the inner edge of the brilliant Ring B. To realize these goals Reese plotted a curve P of the width at the central meridian of the planet of the projection of a Crape Ring 10,000 miles wide. The width of this projection will naturally vary as the tilt of the axis of the planet toward the earth changes. He also plotted a curve S of the width at the C. M. of either the shadow of a Ring C 10,000 miles across or else of the combined shadows of Rings C and B when the latter shadow was not entirely occulted by B itself. During the 1947-8 apparition prior to February 7, 1948, and hence in the autumn of 1947, the sun was farther south of the ring-plane than the earth and hence threw shadows northward. Therefore, the darkness of the C projection was increased by the shadow of C except in a southern band. After February 7 shadows were thrown southward; and the south part of the shadow of C was now seen directly, while the C projection covered parts of the shadows of C and B.

One's problem is now to compare observed widths with curves P and S. The width of the Crape Band can sometimes be compared to that of the shadow of Ring A on the ball, lying just north of the rings (if earth and sun are south of rings). Its width can always be compared to that of Cassini's Division at the ansae. Any other feature of known width, such as the Ring B projection at the C. M., may also be used. Now a substantial systematic error is introduced into the observations by irradiation, which causes the dark Band to be seen too narrow. Reese and E. E. Hare therefore compared the widths of Ring A and Cassini's Division and thus obtained about 2400 miles for the latter from the known width of A. The difference between this number and the 2900 miles given by some authorities was imputed to irradiation. Assuming that the Crape Band would be affected by irradiation by the the same amount as Cassini's, Reese corrected all estimates of the Band by 0".12.

Astronomers have usually thought, it seems, that the Crape Band is the dark particles of Ring C seen projected against the bright surface of the planet. If so, the observed widths would follow curve P. They unquestionably do not. Indeed, the most cursory inspection of reported widths of the Band in our past issues will show that it was unmistakably wider in the spring of 1948 than in the autumn of 1947 (note geometric conditions above).

Reese suggests an alternate interpretation. He proposes that the particles of Ring C have an average albedo similar to that of the Equatorial Zone so that they are invisible against it. The darkness of Ring C at the ansae would result from low ring density, and the darkness of the Crape Band would result from penumbral shadows cast by the particles. Under these conditions the observed widths must follow curve S. Reese's own observations show them doing so, and he may be supported by the work of E. K. White and D. R. Monger.

Hare's diffraction explanation of the darkness of the Band (see above) requires that the observed widths follow curve S when shadows are thrown northward (both earth and sun being south of the ring-plane) and curve P when they are thrown southward. A few observations by E. E. Hare, R. Missert, and W. H. Haas known to Reese appear to conform to this behavior.

It will evidently require <u>precise</u> observations to differentiate between various possible interpretations of the Crape Band. The problem may well be too difficult for simple visual estimates. Micrometric measures of the Crape Band on sufficiently good photographs of Saturn taken at various times in the past would be most helpful.

We see that Reese's second goal has been realized to the extent of showing that the Crape Band is a shadow and not the projection of Ring C. His first goal is more elusive. Although systematic errors hard to evaluate little affect the shape of the curve of observed widths, from which we seek to determine the nature of the Band, they greatly affect the width of Ring C computed from the observed width of the Band. Reese hence thinks now that we cannot be positive that Ring C was abnormally narrow in the autumn of 1947, and the editor shares this opinion. Nevertheless, the table below may be of interest. Column I is the estimated width of Ring C as observed at the ansae. Column II is its width computed from the observed width of the Crape Band on the assumption that this Band is the shadow of C, or of C and part of B. Column III is the same quantity when the correction of 0".12 for irradiation is applied.

Period	I	II	III
October, 1946-May, 1947	9,100 miles	8,900 miles	10,300 miles
September, 1947-January, 1948	7,300	6,600	8,700
February, 1948-June, 1948	8,900	8,200	10,000

It may be significant that results based on two different methods of investigation agree in indicating that the Crape Ring really was narrower than usual late in 1947.

Mr. Reese expresses the hope, which the editor shares, that this discussion will arouse interest in the problem among our readers. He requests them to criticize his efforts and to try to add new ideas. It is thus that we hope to progress.

OBSERVATIONS AND COMMENTS

Note. All dates and times in this periodical are by Universal Time, unless the contrary is explicitly stated.

During January Saturn will be well placed for much of the night as it nears opposition, and Venus will still be conspicuous in the morning twilight. Mercury will be making a fairly favorable appearance in the evening sky. Greatest elongation occurs on January 18, but the planet will be most conspicuous a few days earlier. Uranus is very well placed, having been at opposition on December 20, 1948. On January 15 it will be at right ascension 5 hrs., 49 mins., declination $23^{\circ}.6$ north.

Our readers know of the recent planetary researches of Dr. G. P. Kuiper of the Yerkes Observatory. On December 10 in Chicago H. M. Johnson heard Dr. Kuiper lecture on these studies; we quote the pertinent part of Mr. Johnson's letter: "He spoke principally of Venus and Mars and of Venus gave forth only the new information of an isotope of carbon dioxide in the atmosphere. Most of his work on both planets was in the infra-red spectrum, analyzed by means of a Cashman infra-red sensitive cell available only since the war. The technique with it is to compare the intensity of light as a function of (infra-red) wavelength as received from various parts of a planet with similar curves from various trial substances on earth. Thus he categorically states that the polar caps of Mars are water and not carbon dioxide, and that the desert regions are comparable to a certain igneous rock which does not derive its redness from oxidation like the 'Painted Desert' here. He finds that carbon dioxide in the

Martian atmosphere is double that of the earth, but accepts a Mount Wilson upper limit for oxygen there of 1/600 that in the earth's atmosphere. He disputed Russian results of similar technique (but not going far enough into the infra-red, he says) which found the maria reflecting light like pine trees, stating instead that the maria reflect light more like lower plant life, lichens in particular. But of this he was not sure, except for the contradiction with higher plant life." Dr. Kuiper's observations of the polar caps in 1948 were presumably of the north cap only and in its spring season.

About Saturn we cannot add a great deal to the reports in our last issue. On December 19 W. H. Haas observed the planet with his 6-inch reflector for the first time since last July. He noted: "The South Equatorial Belt impresses me as less conspicuous than in 1947-8. If it is not single, its components are, I think, harder to divide than in 1947-8. Along its north edge one again sees delicate irregularities suitable for transit-work in good seeing." On December 25 he found the South Polar Band more conspicuous than the S. E. B. Haas thus confirms Cragg and White about the comparative faintness and near-singleness of the S. E. B. Moreover, Cragg in four drawings with a 6-inch reflector from November 23 to December 1, all obviously good views, showed the S. E. B. doubled only once. On December 19, 21, and 25 Haas found an inconspicuous and diffuse South Polar Belt and a still less conspicuous North Temperate Belt. Cragg in addition recorded a North North Temperate Belt, mentioned in our December issue, and a South South Temperate Belt (identification?). The last-named was thin and faint and lay just north of a narrow bright zone in middle southern latitudes. This zone Cragg saw on the four dates that he observed. (It appears to coincide with a zone often drawn by Reese in 1946-8.) Cragg's drawing at $13^h 40^m$ on December 1 shows both this zone and the adjacent South South Temperate Belt apparently greatly disturbed. On December 19, 21, and 25 Haas found the Equatorial Zone brighter in its north half than in its south half. He was unable to see any difference in brightness between the North Tropical Zone and the ball north of the North Temperate Belt (see December issue). A small bright South Polar Cap was easily visible to Cragg from November 23 to December 1; a North Cap was large on December 1, absent on the other dates.

Cragg continues to have much success in perceiving interesting small details on the ball. These include: (1) Limb bright spots in high southern latitudes on November 23 and December 1. (Haas noted a number of such spots at various latitudes in December.) (2) Long bright clouds in the North Tropical Zone on several dates. (3) A peculiar bulge in an Equatorial Zone bright cloud on November 29 and December 1. The bulge would have been on the central meridian near $14^h 40^m$ on December 1. By measures of his original drawings Cragg deduced a rotation period of $10^h 12^m \pm 2^m$. This value agrees very well with the $10^h 14^m$ for equatorial features determined a number of times in the past. (4) A large white spot in the north part of the E. Z. on the C. M. at $13^h 40^m$ on December 1. (5) A small gray spot just north of the shadow of the rings and perhaps 10 degrees past the C. M. at the time just mentioned. (6) A small bright spot at the same latitude perhaps 10 degrees short of the C. M. at 13^h 40^m on November 23. (7) The following end of a darker section of the South South Temperate Belt near the C. M. at 13^h 10^m on November 30. Any additional observations of these objects will be welcome and useful and may allow determining some Saturnian rotation-periods.

Ring B remains clearly dimmer than the E. Z., though Cragg opines that the difference in brightness apparently grew less from November 23 to December 1.

The Ring C projection--or, rather, the Crape Band--was completely invisible to Haas in fairly good seeing on December 19 and 21. On the later date he noted: "I think that [the Band] would be visible if it were as much as 1/3 as wide as the conspicuous shadow of the rings; I am confident that it would be if it were ½ as wide as that shadow." On November 10 M. B. B. Heath wrote that he had found the Crape Band "very narrow" and gray.

T. Cragg made four drawings of Venus with a 6-inch reflector between November 23 and December 1, inclusive; and W. H. Haas observed the planet on December 19. Cragg's drawings again exhibit an extreme instability of Venusian features and again show belt-like dark streaks. Cragg recorded a south cusp-cap on November 29 and December 1 but not on November 23 or 30. On November 30, in fact, a gray shading covered the south cusp--an aspect rarely seen. Both observers saw bright areas upon the terminator; these gave it a whitened appearance. At 14^h 5^m on November 23 Cragg perceived a small indentation in the terminator slightly north of its center where a dusky band touched it. One is reminded of terminator-irregularities noted in March-May, 1948, by several different observers.

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