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THE BRIGHT SOUTHERN COMET, 1947 *n*

LELAND E. CUNNINGHAM
Students' Observatory
University of California, Berkeley

The brightest comet in two decades appeared suddenly in the southern sky on the evening of December 8, 1947. Although the reports presently available are not particularly authentic, it appears probable that the comet was independently noticed that evening by thousands of people in New Zealand, Australia, South Africa, and South America. Newspaper reports state that the comet was observed the same evening at several astronomical observatories in the southern hemisphere.

Long ago astronomers established an elaborate system for the telegraphic interchange of information about newly discovered comets, unusual minor planets, novae, and other astronomical phenomena of note. This system is now partially supported by the International Astronomical Union, in which Commission 6 is devoted solely to this work. A Central Bureau is maintained at the University Observatory, Copenhagen, and distributing points are located at several other observatories throughout the world. The Harvard College Observatory acts in this capacity for the North American continent. It would seem surprising, at first sight, that despite this elaborate system no early telegraphic reports of the new comet were originated by the southern observatories. It was quite natural, however, for them to reason that no one would need a telegram to call his attention to what was probably the most conspicuous object in the heavens! Of course, the fallacy in this reasoning is the fact that the comet would not necessarily be conspicuous to every observer within whose reach it might possibly lie. Moreover, it might suddenly appear to other observers, and catch them unprepared to observe it. This might even be true for observers in the southern hemisphere who had been experiencing cloudy weather.

The first news of the new comet reached northern observatories through press and radio reports on the afternoon of December 9. They quoted Dr. John Jackson, H.M. Astronomer, Cape of Good Hope, as saying that the comet was very much brighter than Halley's; and Dr. Richard Woolley, Commonwealth Solar Observatory, Canberra, Australia, as saying that the earth might pass through the tail in a few days. No position was given, nor any suggestion whether it was a morning, evening, or daylight comet.

In view of these reports, it seemed quite possible the comet might be visible in daylight, or might quickly become visible in the northern hemisphere. Since in either event it might present the first opportunity to employ on a really bright comet the several observational techniques that have been developed since the last bright one, it seemed very important to learn more about the comet at once. Therefore, I tried to reach South Africa by radiotelephone, but no circuits were available for several days; an attempt to reach South America was equally unsuccessful. Finally, contact was made by radiotelephone with I. L. Thomsen, Carter Observatory, Wellington, New Zealand, who reported cloudy weather, but who supplied the first information concerning the comet's position. The ship *Arbutus*, at sea between Australia and New Zealand, had measured the comet's bearing and altitude, and the reduction of this observation showed that the comet was in the evening sky about 15° east and 12° south of the sun; the report indicated it might have been as bright as magnitude —2. This information was telegraphed to Harvard and to Copenhagen for distribution.[1] Arrangements were made with Thomsen to cable additional positions, if obtained, and a request for additional data was made to the Union Observatory, Johannesburg, South Africa. While awaiting information about its motion, we searched diligently for the comet in daylight and in strong twilight, but without success.

No further information was received until December 11, when reports began to pour in. The Associated Press reported a position by Woolley;[2] Dr. W. H. van den Bos, Union Observatory, cabled approximate positions obtained December 9 and 10; and the Harvard bureau distributed an approximate position

[1] *Harvard Announcement Card,* No. 863; *Union Astronomique Internationale Circulaire,* No. 1121.

[2] *H.A.C.,* No. 863; *U.A.I.C.,* Nos. 1121, 1122.

obtained December 9 by Dr. J. S. Paraskevopoulos, Boyden Station, Harvard Observatory, Bloemfontein, South Africa, and one obtained December 10 by Dr. Jorge Bobone, Observatorio Astronómico de Córdoba, Córdoba, Argentina, which was the first accurately measured position received.[3] The check word in the telegram transmitting the latter position showed there was an error in the message, but all efforts to obtain a correction have so far failed.

The positions available were insufficient for an orbit determination, but they served accurately to indicate the comet's daily motion, and so its position for the next few days could be predicted with confidence. This was done, and the results were telegraphed directly to the Lowell and McDonald Observatories, since their southerly location and instrumental equipment indicated their probable urgent need for an approximate ephemeris, and to the Harvard Observatory for further distribution, if deemed desirable.[4] This effort was well rewarded, since observers at the McDonald Observatory did indeed pick up the comet on the evening of December 14, and were able to observe its spectrum in the infrared![5]

Numerous additional accurate and approximate positions[6] were received on December 12, 13, and 14; they ranged in time from December 9.4 to 14.4 U.T. Although there were thirteen positions available extending over five days, several attempts to determine the comet's orbit were unsuccessful for three reasons. First, the small perihelion distance and the considerable interval since perihelion passage made the orbital elements unusually sensitive to small errors of observation. Second, the positions were somewhat inconsistent, as might be expected from the difficult observing conditions. Third, Bobone's position was rather a key one; it was hoped that the telegraphic error had been made in the check word, as is most often the case, but it is now known that this was not so.

Finally, on the afternoon of December 16 it was decided that while the elements were not accurately known, nevertheless they

[3] *H.A.C.*, No. 863. [4] *H.A.C.*, No. 864.

[5] *H.A.C.*, No. 866. [6] *U.A.I.C.*, No. 1125.

would produce an ephemeris good enough for immediate needs. Accordingly, a short ephemeris was computed and telegraphed to Harvard and Copenhagen along with the elements.[7]

The very next morning *H.A.C.*, No. 865, containing a good orbit by Bobone, was received! This orbit, which was based on positions that *had not been telegraphed, had been available for several days* while long and tedious attempts had been made to determine the orbit and ephemeris, because it was presumed they were urgently desired. Through some unfortunate accident the Harvard bureau had failed to telegraph the orbit to its subscribers, or to the Central Bureau in Copenhagen.

The details of the early communications concerning this comet have been given at length in order to promote a more general understanding of the problems involved, to illustrate the splendid international co-operation that already exists, and to show the need for improvements in astronomical telegrams and their distribution. It is also hoped the example will show that astronomical telegrams are not intended primarily for orbit computers, and especially not to provide them with the material for a competitive struggle amongst themselves, a view which unfortunately seems to have gained some ground. In many cases the orbit computer needs quickly to provide an ephemeris so that the object will not be lost, so that it may be observed physically or for position, and so that plans for its observation may be made in sufficient time to insure proper preparation. The orbit computer would prefer, for his own purposes, not even to start work on an orbit until all the observations had been published. The need of others for ephemerides induces him to struggle with the available data, which is often unnecessarily inadequate.

At discovery the brightness of the comet's head must have been nearly equal to that of the brightest stars in the sky. It faded only slowly, as shown in Figure 1, which is a plot of the 29 estimates of magnitude that have been received so far. The abscissae are the logarithms of r, the comet's distance from the sun. The ordinates are the observed magnitudes, augmented by

[7] *H.A.C.*, No. 867; *U.A.I.C.*, No. 1123.

$-5 \log \rho$, in order to eliminate the effect of the comet's distance, ρ, from the observer. The points to the left of $\log r = -0.21$ represent estimates made in the southern hemisphere, while those to the right represent estimates made from the northern hemisphere; they show some systematic trends, and the scatter

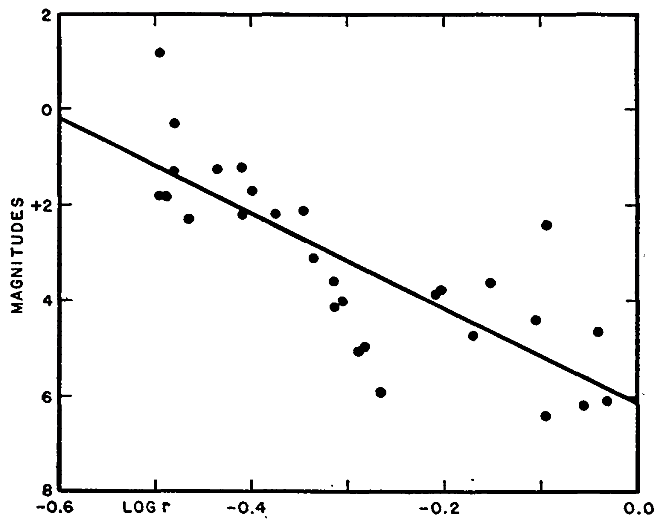

FIG. 1.—Estimated magnitudes of comet 1947 *n*, reduced to unit distance from the earth, plotted against the logarithm of *r*, the comet's distance from the sun.

is large, but not larger than is usual with estimates of a comet's magnitude, especially when the estimates are of the present heterogeneous nature. The straight line represents the result of a least-squares solution for the constants M_o and n in the assumed, empirical law,

$$\text{Magnitude} = M_o + 5 \log \rho + 2.5\, n \log r.$$

M_o is the comet's absolute magnitude (apparent magnitude if placed at one astronomical unit from the sun and from the earth). Its value found from the least-squares solution is $+6.2$, which shows that the comet is not especially bright intrinsically, having been equaled or excelled by four comets in the last two years (Timmers; Jones; Bester, 1946 *k*; and Bester, 1947 *k*). The value of n obtained from the least-squares solution is $+4.0$, which is near the lower limit of the values obtained for other comets.

Reports about the length of the comet's tail near discovery vary considerably, probably due to the conditions of observation rather than to great changes in the comet. The *Arbutus* described the comet as having a long tail pointing up from the horizon, and Paraskevopoulos observed the tail, perhaps photographically, as 25° long. Thomsen was able to trace the tail for about 20° on December 14 and noted that "after the head had set, the tail stretched up in the sky somewhat like a faint auroral ray." An Associated Press dispatch on December 17 reported a photograph by Paraskevopoulos showed two tails, each 20° long and a third 4° or 5° long.

As was the case with the Great Comet of 1882, and several others, the nucleus of 1947 *n* broke up, presumably during its passage through perihelion. The first news of this interesting phenomenon was contained in the Associated Press report of December 17, which further mentioned that Paraskevopoulos' photograph showed the nucleus as double. The observers at the McDonald Observatory independently noticed the duplicity on December 19.[8] Later it was learned that van den Bos had noticed it on the night following discovery, and had measured the nucleus as a double star at every opportunity thereafter.[6] His observations show a gradual increase in the separation between the two nuclei from 6″ on December 10 to 12″ on December 20, and at the same time a decrease in their position angle from 192° to 130°. The apparent separation on December 10 corresponded to a real separation of about 2500 miles, if there was no foreshortening due to the relative positions of the earth and the two nuclei. Even with foreshortening, the separation of the nuclei was probably not greatly different from the diameter of the earth, and at this relatively small separation the gravitational attraction between them should be appreciable. if they possess any significant mass. Perhaps the observations will yield some positive information about the comet's mass, but this is a slim hope; anyway, a careful investigation will be made as soon as all the observations become available.

The relative brightnesses of the two nuclei have undergone remarkable, although not unprecedented, changes.[6,8] When the

[8] *H.A.C.*, No. 869.

duplicity was first noticed by van den Bos on December 10, he estimated the magnitudes of the nuclei as 4.5 and 8.5; on December 14 he estimated 6.0 and 8.5. The next night the two nuclei were of equal brightness! After that date each nucleus gradually faded with some small fluctuations, and with the previously fainter nucleus fading a little faster than the other; on December 20 van den Bos estimated their magnitudes as 9.0 and 10.5. On December 26, Dr. Balfour S. Whitney, University of Oklahoma, found the two nuclei of nearly equal brightness.[9]

The only spectrographic observations so far reported were obtained by Blaauw, Jose, Page, and Swings at the McDonald Observatory.[10] They obtained at least three excellent spectrograms on hypersensitized I N emulsion (infrared), and at least two others covering the range of wave lengths from 3800 to 6700 angstroms. The presence in the comet of iron, nickel, and "large amounts of ammonia" was reported. Iron has definitely been found before in comets, and nickel has been suspected, but the presence of ammonia has not been previously observed. The principal feature of the infrared spectrum, which has never before been obtained for a comet, is a band with a sharp maximum at wave length 7908 angstroms, and probably a secondary maximum near 7869 angstroms; Dr. P. Swings suggests that this is a rotation-vibration band of ammonia. The brief reports by the McDonald observers suggest that they have photographed many new and interesting features of a comet's spectrum, and that the final analysis of the spectra will yield much important information concerning the physical constitution of comets, and will present many difficult problems of identification and theoretical interpretation, as well.

"How could such a bright comet appear so suddenly?" has been asked many times. The answer may be found in Figure 2, which shows portions of the orbits of the earth and comet projected on a plane midway between their respective planes of motion, which are inclined to each other by about 45°; when

[9] *H.A.C.,* No. 871.

[10] *H.A.C.,* Nos. 866, 869, 870; Associated Press.

the comet is above the *Line of Nodes* on the diagram, it is below the ecliptic, and conversely. As the comet approached the vicinity of the sun it was too faint to be discovered (except through the remote chance it would cross the field of a powerful telescope at just the right hour) until perhaps the beginning of October. At that time it was nearly stationary in the constellation of Ophiuchus, and its magnitude, computed with the con-

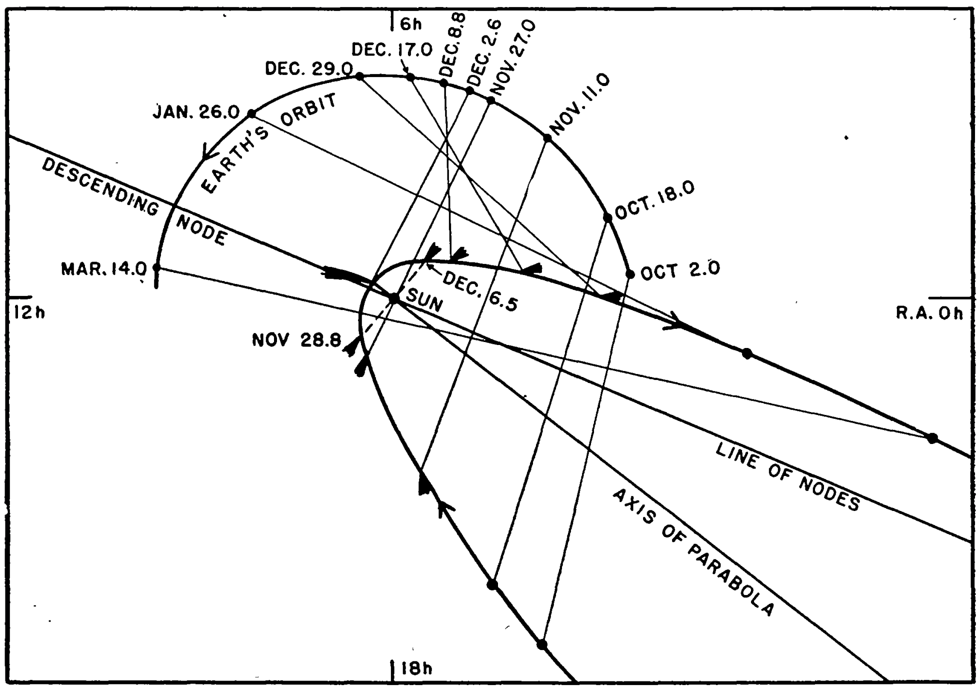

FIG. 2.—Portions of the orbits of comet 1947 *n* and of the earth projected on a plane midway between their planes of motion, which are inclined to each other by about 45°.

stants derived above, was about 10. It was then nearly in quadrature with the sun, and there is a chance that a photograph covering its position was taken at some observatory. It is not at all certain, however, that the comet will have been recorded on such a plate, because the estimate of its brightness has not taken into account the possible increase in brightness produced by the splitting of the nucleus during perihelion passage. It is hoped that photographs covering the region of the comet before perihelion will be found to exist, so that this question may be settled. A prediscovery search ephemeris will be published shortly. After October the comet rapidly approached the sun, so that its discovery was unlikely despite its rapidly increasing brightness. On November 27 it passed the sun on its way from the evening into the morning sky; only five days later it was at perihelion, and at its greatest distance west of the sun, namely, 6°. Its magnitude at that time, computed from the constants derived above, shows it must have been about as bright as Venus, and perhaps could easily have been seen in a telescope, if one had known of its presence. The tail may have extended far out into the morning sky, but it would hardly have been detected accidentally. Three days after perihelion passage the comet was again in conjunction with the sun, and passed into the evening sky. It swung halfway around the sun, 180° of heliocentric longitude, in a bit less than eight days; and it was twice in conjunction with the sun within eight days. Everything considered, discovery did not occur until the time when it was easiest, as is unfortunately so often the case.

Figure 2 shows that the comet was closest to the earth (0.85 astronomical units) near discovery; thereafter its distance rapidly increased. The comet's apparent angular separation from the sun increased at first owing to the motion of the comet, but this was soon counteracted by the earth's motion, which will again bring the comet into conjunction with the sun early in March. The comet will emerge from the vicinity of the sun in May, when it is likely to be of about the fifteenth magnitude,[11] and thereafter easily observed with large telescopes. It should continue to be observable through the following opposition, which will occur about September 1, 1948.

Normally, a comet is named for its discoverer, or, if more than one person discovers a comet independently and almost simultaneously, then three names, at most, may be attached to the comet, according to the present custom, which has been more or less generally accepted. The bright comet 1927 *k* was given the name Skjellerup,[12] after the first of its discoverers to report his find, although it had earlier been observed by at least four

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[11] *H.A.C.*, No. 873.

[12] *A.C.D. Crommelin,* Mem.B.A.A., **26**, Part 2, 1925.

others, one of whom saw it about five days before Skjellerup.[13] On the other hand, the bright comet 1910 *a* has not been given a name, and is listed as having been discovered by "many people."[12] The naming of a comet for its discoverer may be considered partly as a reward for his discovery. Such a discovery is of scientific value only when it is promptly communicated to astronomers throughout the world, so that they can observe the comet. Since the present comet appeared suddenly, and was independently noticed by a great many people within the space of a single day, and especially since the press was the first to announce the discovery, there seems to be no reason to expect that a discoverer's name will be attached to it. Probably the comet will continue to be called 1947 *n*.

January 13, 1948

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[13] *A.C.D. Crommelin,* M.N., **88**, 297, 1928.