The Orbit of the Comet 1927*K*. (Skjellerup).

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There have been many claims to the discovery of this comet, but unfortunately for the claimants, reports were not sent to the nearest observatories till long after the news had appeared in the daily papers. The three first recorded observations were by Skjellerup—a veteran comet searcher late of South Africa—at Melbourne, on December 3.7292 G.M.T., for which the observed position was 16h. 12m. 12s. Right Ascension, and 53° 57′ South Declination; by Rhind at New Plymouth, on December 4.6389, when the position by sextant was 16h. 17m. R.A., and 52° 43′ S. Dec., and by Maristany at La Plata, who gave for its position on December 6.0250 G.M.T. as 16h. 27m. R.A., 50° 00′ S. Dec. It was remarkable that such a brilliant comet as this happened to be, should have been so badly situated for observation; and, indeed, Professor van Biesbroeck[1] considered it to have come very close to fulfilling those geometrical conditions which would have rendered its observation impossible. Apart from this, it was found impossible to make micrometric measures of the position, and so the early observations, with three exceptions, consisted merely of circle readings corrected for index error and refraction. Of the three exceptions mentioned, two were the observations by McIntosh at Auckland with a fourteen-inch reflecting telescope, the other being Rhind's sextant observation. Mr. McIntosh made careful drawings of the position of the comet with respect to a number of small stars (between the 8th and 10th magnitude) in the field. For his observation on December 5.6458 G.M.T., the stars were identified in the Cape Photographic Durchmusterung by Dr. Crommelin[2], who gave for the position of the comet at that time, R.A. = 16h. 27m. 0s., Dec. = — 51° 10′ for the equinox 1927.0; the error of which is not greater than 3 minutes of great circle. The other observation—Dec. 6.6715 G.M.T., was similarly reduced by Dr. Adams, who gave for the position at that time R.A. = 16h. 35m. 35s., Dec. = —49° 14.3′ for the equinox 1928.0. The previous observation reduced to the equinox 1928.0 became R.A. = 16h. 26m. 52s. Dec. = — 51° 9.6′. These were probably the two most reliable early observations, though they were, of course, subject to errors in drawing and in scaling. In general, then, the observations of the comet in 1927 were characterized by the following defects:—

(1) Bad situation.

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(1) van Biesbroeck, Prof. G., "Comet Notes," *Popular Astronomy*, Feb. 1928.

(2) Crommelin, Dr. A. C. D., *B.A.A. Journal*, vol. 38 No. 4, pp. 124-125, 1928.

(2) Impossibility of obtaining micrometric measures. These two defects made it most difficult to compute a really satisfactory orbit for the comet from those observations.

At an early date it was thought that this comet might be the very overdue Comet 1846, IV (De Vico), which was expected to return towards the end of 1921. The elements of the orbit of that comet, as computed by Von Hepperger, were—

$$\left.\begin{aligned} \omega &= 12^\circ\ 53'\ 27'' \\ \Omega &= 77^\circ\ 33'\ 16'' \\ i &= 85^\circ\ 06'\ 27'' \end{aligned}\right\} 1846.0$$

T = 1846, March 5.552 Paris Mean Time,
q = 0.66380
e = 0.96291
Period = 75.7 years.

The similarity of the planes of the orbits of these two comets, as defined by the inclination to the plane of the ecliptic, and by the longitude of the ascending node, is very remarkable, but it will be seen by inspecting the orbits given below for the comet 1927k, that the dissimilarity in other respects is too great to justify any speculations on the probability of an identity between the two comets.

SPECTROSCOPIC OBSERVATIONS.

At the Lowell Observatory, Dr. V. M. Slipher obtained a long series of high dispersion spectrograms of the comet on December 16th, 17th, 18th, and 19th. On the 16th the spectrum of the comet was the solar spectrum only, indicating that the comet was wholly illuminated by reflected sunlight, and none of the usual comet emission bands, e.g., those at λλ 5635, 5165, 4737, 4715, 4698, 8685, 4382, 4371, 4365, 3914, and 3883, could be seen or photographed. On the 17th, the Sodium lines λλ 5895.93, 5889.97 were bright though not strong, but these continued to increase both in brightness and strength as the comet approached perihelion.

From the shift of the Sodium Emmission lines D1, D2, Dr. Slipher concluded a positive radial velocity — i.e., a velocity of recession from the observer—of 60 miles per second for December 19th, which was almost identical with that indicated by the computed orbits, and was thus a highly satisfactory result.

A copy of the spectrogram taken at the Lowell Observatory at midday on December 19th, which Dr. Slipher has been kind enough to send to me, showed the comet spectrum on a sky spectrum background, together with the Sodium and the Iron spark spectra for comparison. The Sodium D lines were very strong and bright.

It is well known that the metallic lines are strengthened, and the carbon bands weakened, as a comet approaches the sun, and this is the most probable explanation of the absence of the usual carbon bands in the spectrum of this comet.

The comet was also photographed there in red light at midday on several occasions.

A new line of research was undertaken by Mr. Lampland, of the Lowell Observatory, who, with the aid of the 42-inch reflecting telescope, and heat-measuring apparatus, was able to observe the heat radiations of the comet. This is the first time that such measurements have been applied to comets.

THE OBSERVATIONS.

Following is a list of the observations of the positions of the Comet 1927k, covering the whole period of its visibility during 1927. There is, however, one serious gap in the catalogue; not a single observation was obtained between December 10.3507 G.M.T. and December 16.2708 G.M.T. It is thus difficult to interpolate with any great accuracy over the intervening period of six days.

The positions from La Plata, Santiago, Bergedorf, Wien, Sonneberg, and Babelsberg are mainly those published in the *Beobachtungs-Zirkular*. Those from Yerkes, Washington, and Whitin are from *Popular Astronomy* and those from Kodaikanal were published in the *Monthly Notices of the Royal Astronomical Society*. For the New Zealand observations I have to thank the observer, Dr. C. E. Adams, Dominion Astronomer, and for additional observations from the Hamburger Sternwarte (Bergedorf), I have to thank the director, Professor Dr. Schorr.

At discovery, the comet's magnitude was estimated at 3 by Skjellerup; that was on December 3rd. On December 6th, Maristany at La Plata gave the magnitude as 2, and by the 7th its magnitude had increased to 1, at which time the tail was about 3 degrees in length. On December 16th, after the comet had passed out of our southern night skies, it was seen with the unaided naked eye by Dr. H. Worner[3] of the Hanover Flugwetterwarte, about 7 degrees north of the sun, and on the following day, it was seen at the Hamburger Sternwarte, Bergedorf[3], about 8 degrees north of the sun, and having a tail about 3 degrees long. The Bergedorf observers estimated the nucleus to have then been of the 1st magnitude. On the 19th, Muller, of the Potsdam Observatory[3], estimated it to be of the 1st magnitude. At the same time, Hoffmeister, of the Sonneberg Observatory[4], estimated it to be of the 1st magnitude, and gave the length of the tail as about 8 degrees. Dr. Crommelin[5] estimated that the greatest magnitude could not have been much less than —10, certainly[6] it was not less than —6. By December 21st, the magnitude had dropped[7] to 2.8, and by the 24th[8] it was down to 3 again and getting fainter.

The following is the catalogue of the observations of the comet during December 1927:—

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(3) *Beobachtungs-Zirkular*, Nr. 43, 1927.
(4) *Boebachtungs-Zirkular* Nr. 44, 1927.
(5) Crommelin, Dr., *Journal, B.A.A.*, vol. 38, Nr. 3, 1928.
(6) *Nature*, 1928, Jan. 21, p. 113.
(7) *Beobachtungs-Zirkular*, Nr. 43, 1927.
(8) Van Biesbroeck, Prof. G., "Comet Notes," *Popular Astronomy*, 1928, February.

COMET 1927k. (Skjellerup)—OBSERVATIONS.

No.	G M T Dec 1927.	Right Ascension H. M. S.	South Declination. ° ′	Place.	Observer.	Remarks
1.	3.7292	16 12 12	53 57	Melbourne	Skjellerup	First recorded position.
2.	4.6389	16 17	52 43	New Plymouth	Rhind	Sextant observation.
3.	5.6458	16 27	51 10	Auckland	McIntosh	Reduced by Dr. Crommelin (1927.0)
4.	6.0250	16 27	50 00	La Plata	Maristany	
5.	6.6715	16 35 35	49 14.3	Auckland	McIntosh	Reduced by Dr. Adams (1928.0).
6.	7.3586	16 41 17	47 48.2	Santiago	Castro	
7.	8.3556	16 49 32	45 34	Wellington	Dr. Adams	9-inch telescope circle readings.
8.	9.3542	16 56 35	43 03	Wellington	Dr. Adams	9-inch telescope circle readings.
9.	10.3507	17 04 11	40 19	Wellington	Dr. Adams	9-inch telescope circle readings.
10.	16.2708	17 37	20 17	Kodaikanal	Chidambara Aiyar	
11.	17.1945	17 43	17 20	Kodaikanal	Chidambara Aiyar	
12.	17.4866	17 40.1	16 35	Bergedorf	Schwassmann and Wachmann	Lippart Astrograph.
13.	17.5096	17 40.2	16 32	Bergedorf	Schwassmann and Wachmann	Lippart Astrograph.
14.	17.6264	17 40.4	16 15	Bergedorf	K. Graff	60 cm. Refractor.
15.	17.923	17 47	15 19	Washington	Burton	
16.	18.2389	17 46	14 43	Kodaikanal	Chidambara Aiyar	
17.	18.6174	17 43.1	14 05	Bergedorf	K. Graff	60 cm. Refractor.
18.	18.6309	17 43.2	14 02	Bergedorf	Kruse	26 cm. Equatorial (2 obs.).
19.	18.954	17 44	13 25	Yerkes	Van Biesbroeck and Morgan	

COMET 1927k. (Skjellerup)—OBSERVATIONS.—Continued.

No.	G M.T. Dec. 1927.	Right Ascension	South Declination.	Place.	Observer.	Remarks.
		H. M. S	° ′			
20.	19.5631	17 45.2	12 40.7	Yerkes	Van Biesbroeck and Morgan	
21.	19.6528	17 40	13 00	Wien	Hepperger	
22.	19.6726	17 45 33	12 35	Sonneberg	Hoffmeister	
23.	20.5512	17 46 58	11 49.5	Yerkes	Van Biesbroeck and Morgan	
24.	20.6324	17 47.2	11 47	Bergedorf	Kruse	26 cm. Equatorial (2 obs.).
25.	20.6496	17 47 11	11 45	Babelsberg	G. Struve	
26.	20.6688	17 47 04	11 48	Sonneberg	Hoffmeister	
27.	20.9492	17 47 41	11 37.7	Yerkes	Van Biesbroeck and Morgan	
28.	21.5474	17 48 43	11 26.8	Yerkes	Van Biesbroeck and Morgan	
29.	21.6354	17 48 55	11 25.5	Babelsberg	G. Struve	
30.	22.5594	17 50 24	11 23.3	Yerkes	Van Biesbroeck and Morgan	
31.	23.5549	17 51 57	11 31.7	Yerkes	Van Biesbroeck and Morgan	
32.	24.532	17 53 50	11 48	Yerkes	Van Biesbroeck	
33.	25.492	17 57	12.1	Whitin Obsy.	Duncan	
34.	27.475	18 00	13.0	Whitin Obsy.	Duncan	

For the purpose of comparing the various orbits which have been suggested, and for investigating with what degree of accuracy they fitted the observations, I plotted these observations, and from the graph so obtained, scaled off approximate positions at 8 day intervals from December 4th to December 28th.

Approximate Positions Scaled from Diagram.

Date.	R.A.	Dec.
December, 1927.		
4.0	16h. 14m.	— 53° 40′
12.0	17h. 15m.	— 35° 30′
20.0	17h. 47m.	— 12° 10′
28.0	18h. 00m.	— 13° 20′

These positions were only approximate, but it should be borne in mind that the original observations were liable to errors of 0.1 minute in right ascension and of 3 or 4 minutes or more in declination.

THE ORBIT.

(*a*) The first orbit published was that by Wood, of Johannesburg, as follows:—

$$\left.\begin{array}{rl} T &= 1927, \text{ Dec. } 1.192 \text{ G.M.T.} \\ \omega &= 323^\circ\ 29' \\ \Omega &= 79^\circ\ 20' \\ i &= 72^\circ\ 10' \\ q &= 0.6058 \end{array}\right\} \quad 1927.0$$

This orbit was necessarily computed from a very short arc, as it was issued from Copenhagen on December 12th. The above elements gave rise to the following Ephemeris:—

Date.	R.A.	Dec.
December, 1927.		
4.0	16h. 14m.	— 53° 50′
10.0	17h. 3m.	— 41° 10′
22.0	18h. 40m.	+ 14° 8′
30.0	19h. 23m.	+ 36° 52′

It will be seen immediately that although the early observations were satisfied by this, the errors soon became exceedingly great.

The next orbit published was by Dawson, of La Plata, who gave the following elements:—

$$\left.\begin{array}{rl} T &= 1927, \text{ Dec. } 18.200 \text{ G.M.T.} \\ \omega &= 20^\circ\ 58' \\ \Omega &= 78^\circ\ 43' \\ i &= 82^\circ\ 41' \\ q &= 0.3230 \end{array}\right\} \quad 1927.0$$

This was also from a short arc, for it was distributed from Copenhagen on December 19th. From these elements, the following Ephemeris was constructed:—

Date.	R.A.	Dec.
December, 1927.		
4.0	16h. 15m.	— 53° 35′
10.0	17h. 3m.	— 41° 21′
20.0	17h. 54m.	— 8° 59′
28.0	18h. 11m.	— 1° 40′

This was a little nearer the truth than the orbit by Wood, but although the early observations were satisfied, the errors were far too great to give a satisfactory agreement with the later observations.

An orbit published about the same date by myself from three observations by Dr. Adams on the 8th, 9th, and 10th December, and which was admittedely in error, was:—

$$\left.\begin{aligned} T &= 1927, \text{ Nov. } 28.403 \text{ G.M.T.} \\ \omega &= 315^\circ\ 47' \\ \Omega &= 80^\circ\ 20' \\ i &= 67^\circ\ 44' \\ q &= 0.5963 \end{aligned}\right\} \quad 1927.0$$

It satisfied the original observations in some measure (e.g., for Dec. 4.0, R.A. 16h. 20m., Dec. = — 53° 1′), but the errors soon became too great.

These three preliminary orbits suffered from three bad faults.

(1) They were computed from short arcs. This is the unavoidable defect of any preliminary orbit.

(2) They differed considerably among themselves, chiefly in—

(a) Date of Perihelion,
(b) Argument of Perihelion,
(c) Perihelion distance.

(3) They entirely failed to represent in any measure the later observations.

(*b*) The next orbit published was by Dr. Crommelin[9] and was a vast improvement on any previous one. His elements were as follows:—

$$\left.\begin{aligned} T &= 1927, \text{ Dec. } 18.61 \text{ G.M.T.} \\ \omega &= 42^\circ\ 56' \\ \Omega &= 81^\circ\ 19' \\ i &= 83^\circ\ 52' \\ q &= 0.1822 \end{aligned}\right\} \quad 1927.0$$

These elements gave the following Ephemeris, which was in very much better agreement with observation than were any of the previously published orbits:—

(9) Crommelin, Dr. A. C. D., *Journal B.A.A.*, vol. 38. Nr. 3.

Date.	R.A.	Dec.
December, 1927.		
4.0	16h. 12m.	— 54° 15′
12.0	17h. 10m.	— 37° 8′
20.0	17h. 45m.	— 12° 32′
28.0	17h. 57m.	— 11° 30′

The greatest weakness about this was the fact that the declinations were too great in the early part, and too small in the latter part. This, however, was the first orbit to represent the whole series of observations with any degree of accuracy at all.

(*c*) As was to be expected, the elements computed from longer arcs gave much more satisfactory results.

Van Biesbroeck computed the following elements from observations made at Yerkes Observatory, Williams Bay[10]:—

$$\left.\begin{aligned} \omega &= 48^\circ\ 38' \\ \Omega &= 77^\circ\ 12' \\ i &= 84^\circ\ 48' \end{aligned}\right\} 1927.0$$

T = 1927, December 18.360 G.M.T.

q = 0.1793.

For an Ephemeris using the method of Dr. Adams and Dr. Crommelin[11] these elements gave:—

$$x = +\ 0.01436\ (1 - \tan^2 \tfrac{v}{2}) - 0.08057 \tan \tfrac{v}{2}$$
$$y = +\ 0.05521\ (1 - \tan^2 \tfrac{v}{2}) - 0.33032 \tan \tfrac{v}{2}$$
$$z = +\ 0.16998\ (1 - \tan^2 \tfrac{v}{2}) + 0.11407 \tan \tfrac{v}{2}$$

whence the following Ephemeris:—

Date.	R.A.	Dec.
December, 1927.		
4.0	16h. 13m.	— 54° 9′
12.0	17h. 15m.	— 35° 4′
20.0	17h. 46m.	— 12° 14′
28.0	18h. 00m.	— 13° 15′

which was in a fairly good agreement with the observed positions.

A second orbit was computed by Dr. Crommelin[12] using observations from December 3rd to December 20th, and was as follows:—

$$\left.\begin{aligned} \omega &= 46^\circ\ 9.7' \\ \Omega &= 76^\circ\ 25.2' \\ i &= 85^\circ\ 27.2' \end{aligned}\right\} 1927.0$$

T = 1927, Dec. 18.008 G.M.T.

q = 0.1724

(10) Van Biesbroeck, Prof. G., "Comet Notes," *Popular Astronomy*, 1928, February.

(11) Adams, Dr. C. E., "Calculation of a Comet's Co-ordinates," *Journal B.A.A.*, vol. 32, Nr. 6, p. 231, and Crommelin, Dr., "Simplification of the Computation of an Ephemeris of a Comet moving in a Parabola," *ibid*, Nr. 8, p. 305.

(12) Crommelin, Dr. A. C. D., *Journal B.A.A.*, vol. 38, Nr. 4 (1928), p. 125, also *Nature*, 1928, January 21, p. 113.

For an Ephemeris these gave:—

$$x = +\ 0.01846\ (1 - \tan^2 \tfrac{v}{2}) - 0.07680 \tan \tfrac{v}{2}$$
$$y = +\ 0.05932\ (1 - \tan^2 \tfrac{v}{2}) - 0.31241 \tan \tfrac{v}{2}$$
$$z = +\ 0.16081\ (1 - \tan^2 \tfrac{v}{2}) + 0.12406 \tan \tfrac{v}{2}$$

from which the following Ephemeris:—

Date.	R.A.	Dec.
December, 1927. 4.0	16h. 14m.	— 53° 34′
12.0	17h. 16m.	— 35° 12′
20.0	17h. 46m.	— 12° 15′
28.0	17h. 59m.	— 13° 17′

This was in good agreement with the observed places; in better agreement in fact than are the calculated places from van Biesbroeck's orbit. For convenience, this orbit will be referred to as "Crommelin II," to distinguish it from Crommelin's preliminary orbit.

A third orbit was computed by the writer from observations over the period December 8th to December 24th. This will be referred to as "Glover II," as distinct from the preliminary orbit by the same computer. The elements of this were:—

$$T = 1927,\ \text{Dec.}\ 18.390\ \text{G.M.T.}$$
$$\left.\begin{aligned} \omega &= 47^\circ\ 48' \\ \Omega &= 77^\circ\ 49' \\ i &= 84^\circ\ 06' \end{aligned}\right\}\ 1927.0$$
$$q = 0.1750$$

from which, for an Ephemeris:—

$$x = +\ 0.01178\ (1 - \tan^2 \tfrac{v}{2}) - 0.07834 \tan \tfrac{v}{2}$$
$$y = +\ 0.05672\ (1 - \tan^2 \tfrac{v}{2}) - 0.32086 \tan \tfrac{v}{2}$$
$$z = +0.16513\ (1 - \tan^2 \tfrac{v}{2}) + 0.11581 \tan \tfrac{v}{2}$$

which gave the following:—

Date.	R A.	Dec.
December, 1927. 4.0	16h. 15m.	— 54° 18′
12.0	17h. 15m.	— 36° 43′
20.0	17h. 46m.	— 12° 29′
28.0	18h. 00m.	— 13° 26′

These values did not fit the observations so well as did those from the orbits by van Biesbroeck and Crommelin.

A comparison of the orbits was made by considering the O-C residuals of the places computed from each. These residuals were as follows, the sign of the declination being taken into account:—

Orbit	Dec. 4.0		Dec. 12 0		Dec. 20.0		Dec. 28 0	
	O-C in		O-C in		O-C in		O-C in	
	R.A. m.	Dec. ′	R.A. m.	Dec. ′	R.A. m.	Dec. ′	R.A. m.	Dec. ′
Crommelin II ..	—1	— 6	+1	—18	+1	0	—1	—3
van Biesbroeck	+1	+25	0	—26	+1	— 1	0	—5
Glover II ...	—1	+38	0	+73	+1	+14	0	+6

The outstanding feature of these residuals was that for the declinations they were unduly large. From the nature of the observations one would not expect a remarkably good result, for in declination the circle readings could be as much as 5 minutes in error. It was evident, though, that the elements were still in need of adjustment in order to make the agreement in declination more satisfactory. The residuals for each individual orbit were then considered.

1. Glover II.—The residuals in right ascension were quite satisfactory compared with those for the two other orbits, but in declination the residuals were much greater than is the case for Crommelin's orbit or van Biesbroeck's orbit. We thus disposed of this orbit as being the least satisfactory of the three.

2. van Biesbroeck.—With regard to the right ascension residuals, the same remarks as for the preceding applied. With regard to the residuals in declination, these were a considerable improvement on those from the preceding, but were not so good as those from Crommelin's orbit.

3. Crommelin II.—The residuals in right ascension were as satisfactory as those from the two preceding cases, when we considered that the value scaled from the graph for December 12.0 was interpolated in an interval of 6 days, throughout which recorded observations were entirely lacking, and that for December 28.0 was extrapolated. Further, the residuals in declination, although by no means good, were decidedly better than in either of the two preceding cases.

It was justifiable then to rule out the orbits by van Biesbroeck and by Glover, as being the least satisfactory, and in retaining Crommelin's second orbit as being, though not good, at least the best orbit published up till that time.

I should like here to appeal to amateur astronomers in New Zealand to take up computational work, as it is an invaluable asset to be able to get out an approximate orbit, or ephemeris, instead of having to wait for one to come from England or Copenhagen. The

standard English[13] and foreign[14] treatises may be difficult, but I recommend to the amateur, with the confidence of experience, the remarkably easy method of Merton[15]. Apart from Merton's paper, one requires only a set of 7 figure logarithmic and trigonometric tables and a *Nautical Almanac*. Dr. Merton's method is equally well adapted to both machine and logarithmic calculation. The work is not difficult, in spite of the popular superstition to the contrary.

In New Zealand the computing of Ephemerides and Orbits is left in the hands of about two people; a highly unsatisfactory state of affairs.

Returning to our consideration of the orbit of the Comet 1927k. I have shown that the best set of elements computed during the early stages of the investigation was that by Dr. Crommelin, and I give below the extended Ephemeris based on those elements.

THE EXTENDED EPHEMERIS.

The following Ephemeris is based on Crommelin's second set of elements, and proved to be a fair representation of the course of the comet.

Date.	R A.	Dec
1928.		
Jan. 24.0	18h. 37m.	— 22° 35′
Feb. 9.0	18h. 54m.	— 26° 20′
Feb. 25.0	19h. 6m.	— 29° 46′
Mch. 12.0	19h. 13m.	— 33° 10′
Mch. 28.0	19h. 12m.	— 37° 0′
May 31.0	17h. 18m.	— 50° 23′

After the bulk of this paper had been prepared, a considerable amount of information in the nature of additional observations and orbital elements came to hand.

(13) Plummer, H. C., 1918, *Dynamical Astronomy*, Cambridge University Press.
Watson, J. C., 1900, *Theoretical Astronomy*, Philadelphia, Lippincott Co.
Moulton, F. R., 1914, *Celestial Mechanics*, New York, Macmillan Co.

(14) Bauschinger, Julius, *Bahnbestimmung der Himmelskörper*, Leipzig, W. Engelmann, Zweite Auflage, 1928.
Valentiner, W., *Handwörterbuch der Astronomie*, Leipzig: J. A. Barth, 1902 (Band 4) and Breslau, E. Trewendt, 1901 (Bände 1, 2, 3).
von Oppolzer, Th., *Lehrbuch zur Bahnbestimmung der Kometen und Planeten*. Leipzig, W. Engelmann, 1882. There is a French edition *Traité de la Détermination des Orbites des Comètes et des Planètes*, Paris, Gauthier-Villars, 1886.
Klinkerfues, W., *Theoretischen Astronomie* Braunschweig, F. Vieweg, 1912.

(15) Merton, G., *A Modification of Gauss's Method for the Determination of Orbits*, M.N.R.A.S., vol. 85, Nr. 8.

The additional observations were:—

Date.	Right Ascension.			South Declination.			Observatory.
December, 1927.	h.	m.	s.	°	′	″	
6.106	16	20	30	50	22		Johannesburg
8.3279	16	48	28	45	37	12	La Plata
9.121	16	55	48	43	44		Johannesburg
21.5986	17	48	48	11	24		Turku
21.6118	17	48	52	11	25	54	Turku*
22.2910	17	50	6	11	21		Turku
25.2681	17	55	18	12	2		Turku
February, 1928.							
10.12425	18	57	36.90	26	47	36.2	Cape†
11.08398	18	58	31.01	27	00	13.3	Johannesburg†
11.11875	18	58	32.77	27	00	43.7	Cape†
13.12091	19	00	21.70	27	26	47.9	Cape†
23.32042	19	06	40.8	29	40	23	La Plata§
24.09735	19	08	59.28	29	47	38.1	Johannesburg†
29.11940	19	12	06.07	30	52	12.0	Cape†
March, 1928.							
3.30480	19	11	59.0	31	36	39	La Plata§
21.30243	19	16	25.6	35	44	57	La Plata§

Three additional orbits have come from America (see *L.O. Bull.* 395, and *Publ. A.S.P.*, XL, 233) and are given below.

1.

T ..... 1927 Dec. 19.363 G.M.T.
ω ..... 57° 26′
Ω ..... 73° 33′ } 1927.0
i ..... 83° 5′
q 0.1924

Computer: Dr. Smiley.

Reference: *Publ. A.S.P.* XL, 233.

This orbit was not a very satisfactory one, and gave poor residuals.

2.

T ..... 1927 Dec. 17.7.
ω ..... 31° 24′
Ω ..... 81° 24′ } 1927.0
i ..... 85° 48′
q 0.173

Computer: Makemson.

Reference: *Publ. A.S.P.*, XL 233.

This was not a satisfactory orbit. The value of ω was too small, and of Ω too large. The residuals were unsatisfactory.

*Sextant observation.
†Referred to mean equinox 1928.0.
§Referred to mean equinox 1900.0.

3.

T	1927 Dec. 18.1162 G.M.T.			
ω	46° 40′ 46″	1928.0	46° 40′ 46″	1927.0
Ω	77° 13′ 32″		77° 12′ 42″	
i	85° 12′ 41″		85° 12′ 41″	
q	0.17524			

Computers: Mayall and Whipple.

Reference: *L.O.B.* 395 and *Publ. A.S.P.* XL, 233.

This was a fairly good orbit giving reasonable residuals, but it was not as good as a more recent orbit computed by Dr. Crommelin given below:—

T	1927 Dec. 18.1671 G.M.T.	
ω	47° 8.82′	1927.0
Ω	77° 14.90′	
i	85° 12.81′	
q	0.176112	

This orbit was computed from normal places for Dec. 5th and 21st, and with an observation from South Africa on Feb. 11th. It is decidedly the best and most reliable orbit so far obtained. The Gaussian equations for the coordinates are:—

$$x = 0.23524\ r \sin (v + 157°\ 22.20′)$$
$$y = 0.97201\ r \sin (v + 160°\ 8.32′)$$
$$z = 0.99993\ r \sin (v + 69°\ 59.14′)$$

for the mean equinox and equator 1927.0.

Dr. Adams very kindly sent me an Ephemeris by Dr. Crommelin based on the above, from April 25th to May 19th.

G.M.T. 1928.	R.A.	Dec.
Apr. 25.0	18h. 52m. 33s.	— 44° 56′
May 3.0	18h. 38m. 3s.	— 47° 1′
May 11.0	18h. 20m. 12s.	— 48° 51′
May 19.0	17h. 59m. 29s.	— 50° 18′
to which I have added:—		
May 31.0	17h. 24m. 26s.	— 52° 21′

For this latter position, the logarithm of the radius-vector was 0.4997 and the logarithm of the geocentric distance was 0.3315.

From the approximate formula[16] connecting the brightness of a comet at two times when radii vectores and geocentric distances are known, I found that in May the comet should have been of about the 8th or 9th magnitude, at which time it was in the constellation Corona Australis.

A comparison with the observed places given above shows that the latest elements computed by Dr. Crommelin (see the last of the

(16) Traylor, M. C., *Popular Astronomy*, 86, 342, 1901.

third lot of additional orbits preceding) are a very good representation of the movements of the comet, and indeed the most accurate yet calculated.

This description of the attempts to define the motions of the Comet 1927k would be incomplete without reference to an orbit which did not reach me until after this paper had been read. It is by Dr. Crommelin[17] and represents the observational data from 1927, Dec. 6 to 1928 March 31 within 2 seconds of arc, and is thus the most accurate description of the comet's motion yet obtained. The elements of this orbit are as follow:—

$$\left.\begin{aligned} \omega &= 47^\circ\ 11'\ 13.24'' \\ \Omega &= 77^\circ\ 13'\ 29.62'' \\ i &= 85^\circ\ 6'\ 22.01'' \end{aligned}\right\} \quad 1927.0$$

T = 1927 Dec. 18.18340 G.M.T.

q = 0.1763108.

The smallness of the residuals from this orbit show that there is practically no sensible deviation from the parabola.

In conclusion, I wish to record my thanks to Dr. C. E. Adams, Dominion Astronomer, who has kept me well supplied with all the latest information from abroad regarding the comet, and who was kind enough to supply me with a copy of a table he is preparing for the solution of Euler's Equation for the parabola, which table is a considerable improvement on the tables by Bauschinger and by Watson, especially when the computing is done on a machine. My thanks are also due to Dr. V. M. Slipher, of the Lowell Observatory, for a photograph and spectrogram of the Comet, to Professor Dr. Schorr, Director of the Hamburger Sternwarte, for a catalogue of the observations made there, to my friend, Prof. C. Coleridge Farr, D.Sc., F.R.S., for reading this paper for me during my unavoidable absence from Christchurch, and to Dr. Hartmann for the La Plata observations.

Christchurch,
May 10th, 1928.

(17) M.N., R.A.S., vol. 88, Nr. 7, May 1928, and Journal B.A.A., vol. 38, Nr. 7, June 1928.