

Compared to the previous year, there is a decrease of activity, the decrease being 12.2 per cent in the case of areas and 9 per cent in the case of numbers. The predominant activity is in the latitude belt 20° – 25° in the northern hemisphere and in the latitude belt 30° – 35° in the southern hemisphere.

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COMETS

The year 1969 was a rather typical one, with five new comets discovered and four periodic comets recovered on the basis of predictions. All but one of these comets were announced during the second half of the year. In addition, observations were reported of the 'annual' comet Schwassmann-Wachmann 1, six of the comets of 1968 (although one identification is unconfirmed) and two of those of 1967. What made the year unusual, however, was that around the month of October no fewer than seven comets were bright enough to be observed by amateur astronomers, and four of these were, in fact, short-period comets.

P/Schwassmann-Wachmann 1 was photographed by K. Tomita with the Tokyo Astronomical Observatory's 188-cm reflector at Okayama in mid-January and with the 91-cm reflector at Dodaira on March 24. On each occasion the appearance was normal, the cometary images being of magnitude 17 and centrally condensed. The comet's appearance was also rather normal on plates exposed by Elizabeth Roemer with the 154-cm $f/13.5$ Cassegrain reflector at the Catalina station of the Lunar and Planetary Laboratory (near Tucson, Arizona) on March 16 and May 17. On the former date there was an essentially stellar nucleus of magnitude 18.6, with a semicircular coma of radius 0.3 to the east and a weak, narrow jet to the north-east. The comet was not found on a 30-min exposure with the 183-cm Perkins reflector of the Lowell Observatory on June 9. Albert Jones, using a 32-cm reflector at Nelson, New Zealand, has patrolled the comet visually for outbursts: his failure to identify the comet in July and August suggests that it was then fainter than magnitude 11 if cometlike or fainter than magnitude 13 if stellar.

1967 i, P/Schwassmann-Wachmann 2, was observed by Roemer in March, April and May. On March 15 the comet appeared as a well-condensed nucleus of magnitude 19.3, with a trace of a narrow tail 0.3 long slightly to the north of west. On April 20 the comet was a nearly stellar object of magnitude 19.1, with a weak trace of coma, and when last observed four weeks later it was again well condensed and of magnitude 19.0.

Observations 1967 August 8 to 1969 May 18

1967 n, Ikeya-Seki, was easily detected on plates taken by Tomita with the Okayama reflector on October 9 and 10. The cometary images were of magnitude about 19, fan-shaped and centrally condensed. The comet was also photographed in November by Roemer, who was using on this occasion the Steward Observatory's 229-cm $f/9$ reflector on Kitt Peak. An excellent plate showed the comet as a nearly stellar nuclear condensation of magnitude 21.5 at the apex of a weak, fan-shaped tail extending 10" northwards; the comet was then at a heliocentric distance of 6.7 a.u.

Observations 1967 December 28 to 1969 November 4

1968 d, Bally-Clayton, seems to have been photographed on April 7 at Kochi, Japan, by T. Seki, who gave the magnitude as 16. No other observations were reported in 1969.

Observations 1968 August 24 to 1969 April 7 (?)

1968 e, Honda, moved northwards after its conjunction with the Sun and was photographed by Roemer with the 154-cm reflector on March 15 as a well condensed, but weak object of magnitude 19.6. The comet was also observed the following month, but the plates were of poor quality because of a guiding problem.

Observations 1968 August 30 to 1969 April 19

1968 g, P/Comas Solá, was observed in January by Tomita, magnitude 18. Following conjunction, from September onwards, the comet was quite widely observed, attaining a total magnitude of 13 (Seki). On September 14 C.Scovil and J.E.Bortle photographed it with a 56-cm $f/3.7$ Maksutov telescope at Stamford, Connecticut, as a centrally condensed diffuse coma 0.3 in diameter. There was a faint fan-shaped tail extending 2.5 towards p.a. 277° and containing a central spine. A week later the second observer estimated the total magnitude visually as 13.6. On October 9 B.Milet, using the 42-cm double astrograph at the Nice Observatory, noted a 2' tail and a 10" central condensation of magnitude 15.5. Two days later Roemer found the tail to be 2' long visually, while on 10-min exposures only a trace 0.1 long was recorded; there was a sharply condensed nucleus of magnitude 16.8. Longer exposures at about the same time by Tomita with the Okayama reflector showed a 5' tail. On December 7 Scovil and Bortle photographed a straight, diffuse tail up to 20' long in p.a. 275° , but it was not more than 2' wide. The coma was 0.4 in diameter, with a very strong central condensation.

Observations 1968 October 27 to end of 1969, continuing

1968 h, P/Perrine-Mrkos, was photographed on January 13 and 14

by Seki and on January 14 and 17 by Tomita (Okayama). The former observer gave the magnitude as 16, while the latter reported the comet as a diffuse round image of magnitude 17 and some 1' in diameter. As is often the case with this comet, rapid fading must then have set in, for a good quality 60-min exposure by Roemer on February 16 failed to reveal any convincing image of the comet as bright as magnitude 20.

Observations 1968 October 24 to 1969 January 17

1968 i, P/Harrington-Abell, was observed during the first part of 1969 in both Tokyo and Tucson. On February 16 it was photographed with the Catalina reflector as a rather well-condensed object of magnitude 19.8 to 20.0 with the weakest trace of coma. Single 50-min exposures on April 19 and 20 also showed weak, rather diffuse images of magnitude about 19 near the expected position, which was by then low in the north-west at the end of evening twilight.

Observations 1968 October 27 to 1969 April 20

1968 j, Thomas, was photographed on several occasions during the first five months of 1969 by R.L. Waterfield with his 15-cm $f/4.5$ Cooke triplet at Woolston, Somerset, the total magnitude fading during that time from 12.5 to 14.5. This observer remarked on the fine spikes or jets of various lengths that frequently extended radially from the central condensation in many different directions. On January 8, for example, there was a spike 2' long in p.a. 110° and another 1.5' long in p.a. 150° , while on May 18 there was one extending 3.0' in p.a. 0° . The comet was observed visually at Jacksonville, Florida, on January 11 by K. Simmons (20-cm reflector), the coma being 1' in diameter and of magnitude 11.2. Ten-minute exposures by Roemer on April 20 showed a nearly stellar condensation of magnitude 17.4, with a slight trace of coma, and on similar exposures four weeks later the comet was fainter by one magnitude. On June 23, however, and in rather bright moonlight, the images of the comet on 30-min exposures were well condensed and again of magnitude 17.4. A 20-min exposure on June 6 by H.L. Giclas with the 33-cm photographic telescope at the Lowell Observatory produced a magnitude 16.5 image of the comet, without condensation, and the comet was not markedly condensed on a 30-min exposure taken July 5, the total magnitude then about 17. With its large perihelion distance, this comet was again observed in 1970.

Observations 1968 December 19 to end of 1969, continuing

1969 a was periodic comet Faye, recovered by Roemer on a 30-min exposure with the Catalina reflector on May 17.5. The cometary image was well condensed, of magnitude 17.3, and there was a weak, fairly

narrow tail 0'·2 long slightly south of west. After unsuccessful searches in March and April, condensed magnitude 18·5 images of the comet were also recorded by Tomita with the Dodaira reflector on May 20. At the Catalina station on May 25 the magnitude of the comet was estimated as 18·4, but the comet was about a magnitude brighter again on June 13 and 23. Precise positions of the comet were obtained during July and August by Seki and also by A.Mrkos and R.Petrovičová at the Kleť Observatory, near České Budějovice, Czechoslovakia.

Subsequently P/Faye was under rather general observation, for this was a particularly favourable return. On September 14 Scovil and Bortle noted that the tail, in p.a. 260° , was diffuse and straight, 8' to 9' long and 1'·5 to 2' wide; there was also a jet in p.a. 263° . A week later Bortle traced the tail visually up to 15' (in p.a. 280°), and using a 25-cm reflector he made the coma diameter 3' and the magnitude 11·6. On October 5 the magnitude was 10·8, and the comet was visible in 15×80 binoculars. Two nights later Roemer, using the 229-cm reflector, photographed a sharp, magnitude 16·8 nuclear condensation embedded in an asymmetrical trace of coma; a 15-min exposure showed a coma extending north-eastwards to 0'·5 and a trace of tail westwards to at least 2'·5. On November 5 she judged the magnitude of the nucleus to be 15·6, and on a 30-min exposure the coma extended to 0'·8, the somewhat diffuse tail to 5'. At Lucas González, Argentina, F.W.Gerber estimated the magnitude as 10·2 to 10·5 on December 1, although he found the comet rather fainter on the two succeeding nights, and Bortle estimated the magnitude on December 6 as 11·6.

Observations 1969 May 17 to end of year, continuing

1969 b was a new comet, discovered by the Czechoslovak astronomer Luboš Kohoutek on spectral plates exposed with the 80-cm $f/3$ Schmidt (and a 4° prism) at the Hamburg Observatory, Bergedorf, on July 26·0. The plates were centred on the two novae that had appeared in Vulpecula in 1968, and the images of the comet were continuous spectra. A 14th magnitude image of the comet, centrally condensed and having a tail 1' long, was then found on a direct plate taken two nights previously. At discovery comet Kohoutek was 3·4 a.u. from the Sun, and since it was not due at perihelion for eight months, observations should still be possible in 1971. Early in August N.S.Černyh, at the Crimean Astrophysical Observatory, noted a 2' tail in p.a. 170° . Waterfield described marked variations in the outer coma: on August 5, for example, it was extremely compact and almost disc-like, about 25" in diameter, while on the following two nights it was diffuse and 40" to 60" in diameter.

At the beginning of September Milet reported that the tail had lengthened to 3', and Waterfield noted two fine streamers 90" and 60"

long in p.a. 150° and 130° . On September 19 Scovil and Bortle photographed a 4' tail in p.a. 128° , with a strong jet 1'·5 long and about as wide as the coma (0'·4) in p.a. 120° . Two nights later Bortle visually (25-cm reflector) made the total magnitude 12·8. Three-minute exposures at Catalina on October 11 showed nearly stellar images of magnitude 16·2, and a longer exposure revealed a gently curved, structureless tail extending 1'·5 to the south-east. On the 14th Waterfield observed three highly curved streamers, although most of his plates in October and November recorded only a single tail. On December 4 the tail was more diffuse and fan-shaped in the quadrant 30° to 120° , the total magnitude 12·1.

Observations 1969 July 23 to end of year, continuing

1969 c, periodic comet Whipple, was recovered on July 20·2 by Z.M. Pereyra with the 154-cm $f/5$ reflector at the Bosque Alegre station of the Córdoba Observatory. Further observations were made on August 9. Estimated at magnitude 19, the comet was making its sixth appearance. P/Whipple was also observed with the Catalina reflector on September 6. Sixty-minute exposures with this longer-focus instrument produced very small, essentially stellar images of magnitude a little fainter than 20·5.

Observations 1969 July 20 to end of year, continuing

1969 d was discovered on August 12·7 by Shigehisa Fujikawa, who works for the Education Committee in Onohara, Kagawa, and who was an independent discoverer of comets 1968 a and 1968 c. Since the discovery of 1968 c this observer has hunted comets for 267 hours on 163 nights (the new discovery being made with a 16-cm reflector, $23\times$), whereas during the previous two years he had searched for 206 hours on 173 nights. At discovery comet 1969 d was a diffuse 11th magnitude object with neither condensation nor tail, and it was located in the morning sky in Taurus 1·7 a.u. from the Earth and 1·4 a.u. from the Sun. The following night accurate positions were measured by Tomita (who, contrary to first reports, did not observe a tail) and by Seki, and shortly afterwards by Milet.

On August 14 V.L.Matchett (Indooroopilly, Queensland) estimated the magnitude as 11·5 (30-cm reflector, $40\times$), while ten days later Bortle noted that in 16×50 binoculars it had brightened to 9·0. On September 10 the latter observer gave the magnitude as 8·5 and suspected a double tail, one branch extending westwards and the other somewhat north of west up to 15'. Four nights later Scovil and Bortle photographed a diffuse, straight, very narrow 18' tail in p.a. 290° and recorded a well-defined central condensation. Around September 21 the tail was more than 20' long (Bortle, Milet). Early in October the comet attained its

brightest (magnitude about 7); and on the 12th, the date of perihelion passage, a 1-min exposure with the Catalina reflector showed a centrally condensed, but distinctly non-stellar image of magnitude rather fainter than 13.5. The last known observation is by Seki on October 27, the comet being then only 24° from the Sun and of total magnitude about 9.

Observations 1969 August 12 to October 27

1969 e was periodic comet Honda-Mrkos-Pajdušáková, recovered by one of the original 1948 discoverers, A.Mrkos, on August 12.0 on plates exposed simultaneously with the 100-cm $f/4$ reflector and the 40-cm $f/2.6$ Maksutov camera at the Kleť Observatory. The comet was of magnitude 14, diffuse without condensation, and the appearance was similar when observed again four nights later. Faint images were also located on photographs exposed by Seki on August 11 and 12 (possibly even on August 9) and by N.Kojima (Ishiki, Aichi) on August 12 and 13. The comet, which has a perihelion distance of 0.56 a.u., normally brightens extremely rapidly as it approaches perihelion: large diffuse 15th magnitude images could be seen on plates taken with the 91-cm Dodaira reflector on August 13, but a week earlier there had been no trace of the comet.

By September 2 the total magnitude had brightened to 9 (Seki), and a week later Bortle estimated the magnitude as 8.3. The maximum reported brightness was 8.1 on September 21, a day and a half before perihelion passage. On September 12 Scovil and Bortle photographed a central condensation, and extending from it in p.a. 120° (sunwards) was a diffuse jet perhaps 0.25 wide and 0.5 long (reaching the edge of the coma). The tail was an extremely faint spike up to 21' long in p.a. 300° , and there was a suggestion of a second tail in p.a. 280° . Two nights later they photographed a 25' tail (in p.a. 297°).

Early in October the comet passed about 1° north-west of comet Fujikawa, the latter comet being as much as two magnitudes brighter, and observers with astrographs were able to record both comets simultaneously. Although the seeing was very poor and the altitude low Roemer photographed P/Honda-Mrkos-Pajdušáková on October 11 as a relatively sharp central condensation of magnitude 15.8 embedded in a trace of symmetrical coma; a trace of tail could be detected visually. By that time the comet was fading rapidly, Seki reporting a drop from magnitude 9 on October 1 to magnitude 11 on October 12, and the last observation seems to have been made by Mrkos on October 15. Precise positions were also reported during the apparition by M.Antal (Skalná Pleso Observatory), Milet, G.Van Biesbroeck (Lunar and Planetary Laboratory), Waterfield and P.Wild (Astronomical Institute, Berne).

Observations 1969 August 9 (?) to October 15

1969 f was periodic comet Slaughter-Burnham, which has a period of 12 years and was making its first predicted return. The recovery was announced early in September by Pereyra, but the object he observed turned out to be an asteroid. After unsuccessful searches by Giclas and by Tomita, the comet was finally recovered by Roemer on plates exposed with the 229-cm Steward reflector. On November 4.1 the condensed image of the comet was of magnitude 20.1, and there was a trace of tail north of east. The following night the magnitude was 19.9 and the tail, 0.1 long, was definitely fan-shaped. The prediction by G.Sitarski required a correction of $\Delta T = -1.1$ day, and since the comet had previously been under observation for only four months, this is surprisingly small.

Observations 1969 November 4 to end of year, continuing

1969 g, another new comet, was originally discovered on October 10.4 by Akihiko Tago, of Tsuyama, Okayama, using a 15-cm reflector, magnification $30\times$. He confirmed the comet two evenings later and then telephoned news of the discovery to the Tokyo Observatory. Within 40 minutes of his confirmatory observation on October 12.4 the comet had been discovered independently by 19-year-old Yasuo Sato, of Nishinasuno, Tochigi (15-cm reflector, $20\times$), and by 17-year-old Kozo Kosaka, of Akasaka, Okayama (15-cm reflector, $23\times$), all three reports arriving at the Tokyo Observatory practically simultaneously. Tago and Sato were both discoverers of comet 1968 a, and since finding that comet they had hunted for 344 and 182 hours, respectively.

On October 10 Tago described the comet as of magnitude 10.3 to 10.5, without condensation, and on October 12 it was perhaps half a magnitude brighter. In Serpens Caput, the comet was 1.6 a.u. from the Sun and 2.0 a.u. from the Earth. From the first accurate positions, obtained by N.Kobayashi and H.Kosai at Tokyo, by several observers at the Perth Observatory, and by Seki and Antal, it was clear that the comet would be a bright naked-eye object at the end of December and into January. The comet's rapid southward motion after discovery made observation from the Northern Hemisphere more and more difficult, and the accuracy of the ephemeris predicted for January was in no small measure due to the series of positions, extending to November 10, obtained by Pereyra and his colleagues at Córdoba. A final Northern Hemisphere observation was made on November 8 from 30 km south of Jacksonville by Simmons, who estimated the comet's total magnitude as 8.0. Though less than 18° from the Sun, and mainly south of it, the comet was observed on isolated occasions in late November and early December. At the European Southern Observatory, near La Serena, Chile, F.Dossin estimated the magnitude as 7 on

November 27. Gerber reported the magnitude as 6 on December 7 and Albert Jones 5.5 on December 9. A number of approximate positions were measured by P. Davison at Adelaide University.

Comet Tago-Sato-Kosaka was under rather general visual observation in the Southern Hemisphere from December 20 onwards, Jones that day noting a straight 1° tail in p.a. 159° and a coma magnitude of 5.0. J.D. Whelan (New Plymouth, New Zealand) estimated the total magnitude as 3.5. The comet was observed with the Córdoba astrograph from December 24, the total magnitude then being 3.0. Tails of both type I and type II, and up to 3° long, were present. Objective-prism spectra gave a weak continuum, as well as emission bands of C_2 and CN, the former being the stronger. Coudé spectra by Dossin revealed that C_2 and CN were fairly strong, C_3 and CH weak; the tail spectrum showed CH^+ and CO^+ , both with well-resolved rotational structure. As the comet became more easily visible in a dark sky it became more conspicuous. At the Perth Observatory on December 30 the tail could be traced with the naked eye to at least 7° , and a comparable length was reported the following day by M.V. Jones (Maryborough, Queensland).

Observations 1969 October 10 to end of year, continuing

1969 h was discovered by Klim Ivanovič Čurjumov near the edge of a plate taken on September 11.9 by Svetlana Ivanovna Gerasimenko with the 50-cm meniscus Maksutov telescope at the Alma-Ata Observatory. The comet was first noticed on September 19 and initially supposed to be P/Comas Solá, for which the plate had been exposed. Not until October 22, when these astronomers had returned to their headquarters in Kiev, did they realize that the comet was more than 2° from P/Comas Solá, which also appeared on the plate but was some two magnitudes fainter. The new comet was of magnitude 13, had a centrally condensed faint coma $0.6'$ across, and a tail about $1'$ long in p.a. 280° . The discoverers were able to find images of it on further plates exposed for P/Comas Solá on September 9 and 21, and accurate positions were reduced from their measurements by M.Ja. Šmakova at the Institute for Theoretical Astronomy in Leningrad.

Preliminary orbits and ephemerides were calculated by Šmakova, and also by M.P. Candy and D. Gans (Perth Observatory) and by the writer. As a result, faint but condensed magnitude 14 images of the comet were secured by Scovil with the Maksutov camera at Stamford on October 31. Bortle also identified the comet on the plate for P/Comas Solá taken with this instrument on September 14, the new comet being slightly brighter than the other and having a narrow, straight tail some $3.5'$ long in p.a. 290° . An image of the new comet was also found on a plate exposed for P/Comas Solá on September 13 at Nice.

From November 1 onwards accurate positions were obtained by

Candy, Milet, Mrkos, Seki and Van Biesbroeck, and in the Soviet Union at the Alma-Ata Observatory (Gerasimenko), the Bjurakan Observatory (V.L.Afanas'ev and S.K.Vsehsvjatskij) and the Crimean Astrophysical Observatory (B.A.Burnaševa and N.S.Černyh). It became clear that the comet was a new short-period one, having a period of 6.5 years and a perihelion distance of 1.28 a.u. Prior to a close approach to Jupiter in 1959 the period had been longer and the perihelion distance larger. Using the 229-cm reflector Roemer recorded P/Čurjumov-Gerasimenko on November 5 as a nearly stellar nucleus of magnitude 16.9 embedded in a faint symmetrical coma. A 10-min exposure showed a weak trace of tail extending 2'.5 in p.a. 290°. Scovil and Bortle reported a 5' tail on December 7, while at Tokyo a 10' tail was photographed on November 6 and December 16.

Observations 1969 September 9 to end of year, continuing

1969 i was discovered with a 12-cm Moonwatch apogee telescope (magnification 21×) on December 28.8 by John Caister Bennett, an officer in the Transvaal Provincial Administration and well-known amateur astronomer of Riviera, a suburb of Pretoria. The discoverer had spent 333 hours hunting for comets during the preceding three years, and on this occasion he was searching specifically for possible members of the Kreutz sungrazing group. The new comet was a small, diffuse magnitude 8.5 object in Tucana, about 24° from the South Pole, and after it had been located again by the discoverer the following evening (not, as was previously reported, by the Smithsonian Astrophysical Observatory's station in Olifantsfontein), some 0°.5 west of its previous position, it was evident that it could not belong to the sungrazing group. Nevertheless, an orbit from the early observations at the Perth Observatory (from December 30 onwards) showed that the comet should, in fact, become a bright naked-eye object in 1970 March. On December 31 Matchett estimated the magnitude as 9.

Observations 1969 December 28 to end of year, continuing

Published ephemerides were also available for the following comets:

1968 f, Wild. The ephemeris extended into February, but it is not known whether any observations were attempted.

P/Schaumasse. A continuation of the ephemeris was provided, but the comet would have been extremely faint.

1968 c, Honda. This comet could perhaps have been observed during the second quarter of 1969, in declination about -40° , but no searches are known to have been made.

P/Tempel-Swift. A new prediction was supplied by the writer, in which use was made of observations at all four apparitions, and an

attempt was made to allow for nongravitational effects, as well as for the planetary perturbations. Searches were conducted early in October with the Okayama reflector and subsequently by C.Kowal and G.A. Tammann with the 122-cm Palomar Schmidt. It is concluded that the comet was either outside the anticipated uncertainty range of $\Delta T = \pm 5$ days or fainter than magnitude 19. Since the latter is a very distinct possibility, it is hoped that searches can be renewed at the slightly more favourable return in 1982.

P/Johnson. Predictions were prepared by E.A.Vorob'ev and also by F.D.Byers and W.H.Julian. No convincing images of the comet were found on pairs of 60-min exposures with the Catalina reflector on May 17, 25 and June 8. Search plates were also taken by Tomita on March 14 and April 13 (91-cm reflector) and July 13 (188-cm reflector). This return is not a particularly favourable one, but the comet is expected to be a little brighter after perihelion in 1970.

P/Pons-Winnecke and P/Kopff. Ephemerides, starting in December, were published for these comets, both of which were recovered in 1970 February.

P/Ashbrook-Jackson. An ephemeris was supplied by M.A. Mersljakova, but the comet was not expected to be brighter than magnitude 20, and no observations appear to have been attempted. The comet should be recovered rather early in 1970.

The following continuation of the numerical designations of comets (in order of perihelion passage) is taken from *I.A.U. Circ.*, No. 2196 (1969). The perihelion times (*T*) are from orbits noted in these annual reports.

Comet	<i>T</i>		Name	Year and letter
1968 I	February	25.7	Ikeya-Seki	1967 n
II	March	14.3	P/Schwassmann-Wachmann 2	1967 i
III	March	31.3	Wild	1968 f
IV	May	16.2	Tago-Honda-Yamamoto	1968 a
V	June	4.5	Whitaker-Thomas	1968 b
VI	August	7.9	Honda	1968 c
VII	August	20.9	Bally-Clayton	1968 d
VIII	November	1.5	P/Perrine-Mrkos	1968 h
IX	November	3.8	Honda	1968 e

On the following pages the elements of recently computed orbits are tabulated. The times are in Ephemeris Time, and the angles are referred to the ecliptic and mean equinox 1950.0. The column headed 'Obs.' gives the number of observations on which the calculation is based, the symbol *p* indicating predicted elements only; an asterisk means that nongravitational acceleration terms were included. The column headed 'Arc' gives the interval of time covered by the observations used in the

calculation; a date in parentheses indicates that the mean motion was assumed in order to link roughly with the observations at that time, rather than that the observations were used in the orbit determination. If no reference is given, the elements are from as yet unpublished calculations by the writer, perturbations by all nine planets having been taken into account.

Ref.	Comet		<i>T</i>	<i>q</i>	<i>Elements of</i>	
					<i>e</i>	<i>P</i> <i>y</i>
(I) 1923 II	P/d'Arrest		23 Sept. 15·5478	1·357281	0·615716	6·64
— 1928 II	P/Encke		28 Feb. 19·8359	0·332636	0·849500	3·29
— 1931 II	P/Encke		31 June 3·1130	0·331875	0·849783	3·28
— 1934 III	P/Encke		34 Sept. 15·2831	0·331873	0·849807	3·28
(I) 1937 I	P/Daniel		37 Jan. 27·8501	1·535672	0·573197	6·83
— 1937 VI	P/Encke		37 Dec. 27·7539	0·332409	0·849603	3·29
(2) 1941 IV	de Kock-P.		41 Jan. 27·6589	0·790013	0·999957	2530000
— 1941 V	P/Encke		41 Apr. 17·1481	0·341380	0·846164	3·31
(I) 1942 VII	P/Oterma		42 Aug. 21·0859	3·388893	0·144722	7·89
(I) 1943 III	P/d'Arrest		43 Sept. 22·4804	1·385531	0·610768	6·72
(I) 1943 IV	P/Daniel		43 Nov. 22·5228	1·526828	0·574614	6·80
— 1947 XI	P/Encke		47 Nov. 26·3274	0·341028	0·846290	3·30
(I) 1947 XIII	P/Wirtanen		47 Dec. 2·9311	1·634956	0·540490	6·71
(I) 1950 II	P/d'Arrest		50 June 6·3713	1·377555	0·612359	6·70
(I) 1950 III	P/Oterma		50 July 16·4698	3·404882	0·142763	7·92
(I) 1950 V	P/Daniel		50 Aug. 23·9104	1·464567	0·586266	6·66
— 1951 III	P/Encke		51 Mar. 16·2079	0·338006	0·847463	3·30
(I) 1951 X	P/Arend		51 Nov. 23·4083	1·820974	0·535570	7·76
(3) 1952 II	P/Wolf-Harrington		52 Feb. 6·6843	1·599140	0·540638	6·50
— 1954 IV	P/Van Biesbroeck		54 Feb. 20·7584	2·414455	0·550140	12·4
— 1954 IX	P/Encke		54 July 2·5188	0·338406	0·847301	3·30
(I) 1954 XI	P/Wirtanen		54 Aug. 13·5083	1·625235	0·542063	6·69
— 1957 VIII	P/Encke		57 Oct. 19·8488	0·338116	0·847401	3·30
(I) 1958 IV	P/Oterma		58 June 10·5008	3·387823	0·144488	7·88
(3) 1958 V	P/Wolf-Harrington		58 Aug. 11·4192	1·604509	0·539856	6·51
(4) 1958 VI	P/Slaughter-B.		58 Sept. 5·1109	2·543327	0·503994	11·6
(I) 1959 V	P/Arend		59 Sept. 1·2032	1·831538	0·533960	7·79
— 1961 I	P/Encke		61 Feb. 5·5945	0·339003	0·847066	3·30
(I) 1961 IV	P/Wirtanen		61 Apr. 15·2378	1·618049	0·543305	6·67
(I) 1962 I	P/Perrine-Mrkos		62 Feb. 12·7674	1·268886	0·643141	6·70
(5) 1962 III	Seki-Lines		62 Apr. 1·6629	0·031397	1·000003	—
(I) 1963 VII	P/d'Arrest		63 Oct. 23·0194	1·368944	0·613789	6·67
(I) 1964 II	P/Daniel		64 Apr. 21·2489	1·661655	0·549915	7·09
— 1964 IV	P/Encke		64 June 3·4901	0·339250	0·846998	3·30
— 1964 VI	Tomita-Gerber-H.		64 June 30·6216	0·500363	0·995933	1360
(3) 1965 III	P/Wolf-Harrington		65 Feb. 15·5625	1·614422	0·538156	6·54
— 1966 III	P/Van Biesbroeck		66 July 17·8162	2·409692	0·550420	12·4
(I) 1967 VI	P/Arend		67 June 13·6615	1·822121	0·535166	7·76
— 1967 XIII	P/Encke		67 Sept. 22·0593	0·338199	0·847406	3·30
(I) 1967 XIV	P/Wirtanen		67 Dec. 15·6597	1·612334	0·544248	6·65
(I) 1968 VIII	P/Perrine-Mrkos		68 Nov. 1·5374	1·272212	0·642630	6·72
(6) 1968 j	Thomas		69 Jan. 12·160	3·31603	0·99524	18400
(7) 1969 h	P/Čurjumov-G.		69 Sept. 11·029	1·28483	0·63301	6·55
(8) 1969 e	P/Honda-Mrkos-P.		69 Sept. 23·0050	0·558693	0·814291	5·22

cometary orbits

ω °	Ω °	i °	Epoch	Obs.	Arc	Ref.
174·1140	143·7701	18·0546	23 Sept. 18·0	60*	1923-...-1964	(1)
184·9235	334·8949	12·5509	28 Feb. 4·0	130*	1927-...-1967	—
184·9067	334·9024	12·5640	31 May 19·0	130*	1927-...-1967	—
184·9404	334·8858	12·5606	34 Aug. 31·0	130*	1927-...-1967	—
6·0455	70·4784	19·8244	37 Jan. 27·0	26*	1937, 43-44, 50-51, 64	(1)
184·9400	334·8777	12·5485	37 Dec. 13·0	130*	1927-...-1967	—
268·6695	42·3827	168·1977	41 Feb. 5·0	158	1941 Jan. 18-Sept. 17	(2)
185·1637	334·7589	12·3497	41 May 6·0	130*	1927-...-1967	—
354·6747	155·1714	3·9897	42 Aug. 29·0	222	42 Feb. 17-62 Aug. 7	(1)
174·3853	143·6210	18·0109	43 Oct. 3·0	60*	1923-...-1964	(1)
6·1091	70·4405	19·8520	43 Nov. 12·0	26*	1937, 43-44, 50-51, 64	(1)
185·1927	334·7399	12·3504	47 Dec. 1·0	130*	1927-...-1967	—
343·5195	86·5093	13·3558	47 Dec. 1·0	29*	1948, 54, 60-61, 67	(1)
174·4233	143·6064	18·0538	50 June 8·0	60*	1923-...-1964	(1)
354·7892	155·1300	3·9887	50 July 18·0	222	42 Feb. 17-62 Aug. 7	(1)
7·2424	69·7468	19·7023	50 Aug. 27·0	26*	1937, 43-44, 50-51, 64	(1)
185·2118	334·7389	12·3800	51 Mar. 15·0	130*	1927-...-1967	—
44·4867	357·6951	21·6997	51 Nov. 10·0	48*	1951-52, 1959-60, 1967	(1)
186·9041	254·2767	18·4945	52 Mar. 9·0	81*	1951-52, 57-59, 64-65	(3)
134·3508	148·9754	6·5901	54 Feb. 27·0	135	1954-55, 1965-66	—
185·1982	334·7466	12·3737	54 June 27·0	130*	1927-...-1967	—
343·5242	86·4847	13·3765	54 Aug. 6·0	29*	1948, 54, 60-61, 67	(1)
185·2257	334·7320	12·3747	57 Oct. 9·0	130*	1927-...-1967	—
354·8724	155·1093	3·9922	58 June 6·0	222	42 Feb. 17-62 Aug. 7	(1)
187·0264	254·2255	18·4791	58 Aug. 25·0	81*	1951-52, 57-59, 64-65	(3)
44·3232	346·2591	8·1650	59 Feb. 1·0	17	1958-59, 1969	(4)
44·5930	357·6090	21·6488	59 Aug. 20·0	48*	1951-52, 1959-60, 1967	(1)
185·2287	334·7207	12·3595	61 Jan. 21·0	130*	1927-...-1967	—
343·5062	86·4663	13·3888	61 Apr. 11·0	29*	1948, 54, 60-61, 67	(1)
165·9606	240·2268	17·7666	62 Feb. 25·0	16	1961-62, 1968	(1)
11·4787	303·9767	65·0101	62 Apr. 6·0	92	62 Feb. 7-63 Jan. 25	(5)
174·5008	143·5969	18·0789	63 Oct. 18·0	60*	1923-...-1964	(1)
10·7833	68·5123	20·1408	64 May 5·0	26*	1937, 43-44, 50-51, 64	(1)
185·9081	334·2407	11·9757	64 June 14·0	130*	1927-...-1967	—
58·4394	309·1857	161·8277	64 June 14·0	16	64 June 11-65 Jan. 26	—
187·0249	254·2154	18·4589	64 Dec. 31·0	81*	1951-52, 57-59, 64-65	(3)
134·2466	148·8314	6·5977	66 July 14·0	135	1954-55, 1965-66	—
44·6852	357·5273	21·6625	67 May 30·0	48*	1951-52, 1959-60, 1967	(1)
185·9128	334·2389	11·9892	67 Sept. 27·0	130*	1927-...-1967	—
343·6098	86·4018	13·4021	67 Dec. 16·0	29*	1948, 54, 60-61, 67	(1)
166·0641	240·1590	17·7619	68 Oct. 31·0	16	1961-62, 1968	(1)
82·555	15·416	45·223	—	41	68 Dec. 19-69 Apr. 20	(6)
11·192	50·353	7·145	—	13	1969 Sept. 9-Nov. 20	(7)
184·1695	233·1053	13·1684	69 Sept. 16·0	p *	1948-49, 1954, 1964	(8)

Ref.	Comet	<i>T</i>	<i>q</i>	<i>e</i>	<i>Elements of</i>	
					<i>P</i>	<i>y</i>
(9) }	1969 a	P/Faye	{ 69 Oct. 7·6389	1·616285	0·574674	7·41
(10) }			{ 69 Oct. 7·6697			
(11)	1969 d	Fujikawa	69 Oct. 12·4480	0·773917	1·0	—
(12)	1969 g	Tago-Sato-Kosaka	69 Dec. 21·2677	0·472638	0·999916	419000
(13)	1969 i	Bennett	70 Mar. 20·0394	0·537496	0·996000	1560
(14)	1969 b	Kohoutek	70 Mar. 21·6329	1·718997	0·999097	83100
(4)	1969 f	P/Slaughter-B.	70 Apr. 13·1672	2·543359	0·504196	11·6
(15)	1969 c	P/Whipple	70 Oct. 9·4114	2·479505	0·351135	7·47

REFERENCES AND NOTES TO TABLE OF ELEMENTS

(1) Marsden, B.G., 1970. *Astr. J., N.Y.*, **75**, 75. Perturbations by Mercury to Pluto.

(2) Van Biesbroeck, G., 1969. Private communication. Perturbations by Venus to Neptune; 7 normals. *T* is in Universal Time. The osculating value of $1/a = +0·0000539 \pm 0·0000124$. The original and future values have been determined by the writer as $+0·0009467$ and $+0·0000474$, respectively.

(3) Sitarski, G., 1970. Private communication. Perturbations by Mercury to Neptune. Mean residual $1''·98$. Secular acceleration $\dot{n} = (+400''·9 \pm 12''·6) \times 10^{-8}$ day⁻². Prediction given for 1971.

(4) Sitarski, G., 1970. Private communication. Perturbations by Mercury to Neptune. Mean residual $0''·87$.

(5) Marsden, B.G., 1969. *I.A.U. Circ.*, No. 2160. Perturbations by Mercury to Pluto. Mean residual $1''·79$. The osculating value of $1/a = -0·0001054 \pm 0·0000120$. The original and future values are $+0·0000243$ and $+0·0003506$, respectively.

(6) Marsden, B.G., 1969. *I.A.U. Circ.*, No. 2146.

(7) Marsden, B.G., 1969. *I.A.U. Circ.*, No. 2187.

(8) Marsden, B.G., 1969. *I.A.U. Circ.*, No. 2145. Perturbations by Mercury to Pluto. Observations in 1969 indicate correction $\Delta T = -0^d·02$.

(9) Hanina, F.B. & Beljaev, N.A., 1968. *I.A.U. Circ.*, No. 2062. Perturbations by Venus to Uranus. Observations in 1969 indicate correction $\Delta T = -0^d·05$.

(10) Lea, G., Milbourn, S.W., Jones, D.R.L. & Walker, E.R.M., 1968. *Handb. Br. astr. Ass.* for 1969. Perturbations by Venus to Neptune. Observations in 1969 indicate correction $\Delta T = -0^d·08$.

cometary orbits

ω	Ω	i	Epoch	Obs.	Arc	Ref.
203·6780	199·0468	9·0815	69 Oct. 26·0	p	1932-...-1955	(9)
203·6669	199·0514	9·0822	69 Oct. 26·0	p	(1954-56), 1961-63	(10)
299·0297	191·6874	8·9319	—	47	1969 Aug. 14-Oct. 27	(11)
267·8274	100·9628	75·8198	69 Dec. 5·0	167	69 Oct. 13-70 Feb. 18	(12)
354·1647	223·9486	90·0323	—	68	69 Dec. 30-70 Feb. 12	(13)
123·4748	301·0599	86·3080	69 Sept. 16·0	102	1969 July 23-Nov. 17	(14)
44·2570	346·1011	8·1591	70 Apr. 4·0	17	1958-59, 1969	(4)
189·8172	188·3930	10·2355	70 Oct. 21·0	p^*	1933-...-1964	(15)

- (11) Marsden, B.G., 1969. *I.A.U. Circ.*, No. 2190.
(12) Marsden, B.G., 1970. *I.A.U. Circ.*, No. 2218. Perturbations by Mercury to Pluto. Mean residual $1''\cdot21$.
(13) Marsden, B.G., 1970. *I.A.U. Circ.*, No. 2219. The departure from parabolic motion seems to be significant.
(14) Marsden, B.G., 1970. *I.A.U. Circ.*, No. 2199. Perturbations by Mercury to Pluto. Mean residual $1''\cdot24$.
(15) Marsden, B.G., 1969. *I.A.U. Circ.*, No. 2157. Perturbations by Mercury to Pluto. Recovery observations in 1969 indicate correction ΔT is small.

CORRIGENDA

1967 report, *Q. Jl R. astr. Soc.*, 9, No. 3 (1968):
Page 306. Lines 14-16 should be amended to read: 'the last known observation there was by L. Boethin at Abra, the Philippines, on April 30. The comet was subsequently photographed by J.A.Bruwer with the Franklin-Adams camera at the Republic Observatory Annexe, Hartbeespoort, the magnitude fading from 10·5 on May 4 to 13·0 on June 7. *Observations 1966 December 2 to 1967 June 7.*'
Catalogue of Cometary Orbits 1960, Mem. Br. astr. Ass., 39, No. 3 (1961):
Page 36, No. 444. For 1·000937 read 1·000927; for -0·0008816 read -0·0008722.
Page 39, No. 490. For +0·0006588 read +0·0143281.
Page 45, No. 565. For Nov. 17·84807 read Nov. 18·34807.

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