

## Comets in 1984

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The number of cometary reports, 22, given provisional designations during 1984 was one less than in the record year of 1983, although as in 1983 one of the reports proved to be erroneous. Thirteen of the comets were new (as in the record year of 1975), and as many as eight of them were reported – four by the same observers – during an interval of little more than ten weeks during September–November. Six of the new comets proved to be of short period (also as in 1975), although the period of one was only slightly less than the rather arbitrary limit of 200 years. Observations were also made of 13 of the comets of 1983, two of the recoveries of 1982 and one discovery of 1980, as well as of the four ‘annual’ comets. The grand total was thus 41, as in the record year of 1978.

P/Schwassmann-Wachmann 1 seems to have been recorded only twice during 1984, on May 3 and June 19, in each case by M.P.Candy and his colleagues at Perth. Negative detections were reported in April and June by J.-C.Merlin (Le Creusot, France, 0.26-m reflector), the limiting magnitude being 13–14.

P/Encke was photographed by T.Seki (Geisei, Japan) on January 27 at mag 17. J.Bortle (Stormville, New York) picked up the comet visually some 36 hr later, estimating mag 11.8 (0.50-m reflector), and similar estimates were made on the 31st by the Dutch observers E.P.Bus and R.J.Bouma (0.25-m reflector). On February 20, C.S.Morris, observing from Whitaker Peak, California, put the comet at mag 9.5 (0.20-m reflector) and noted a tail 3 arcmin long in p.a. 315 deg. A series of astrometric observations were made between February 25 and March 14 at the observatory of the University of the Urals. Morris visually reported a 70-arcmin tail (in p.a. 53 deg) on March 20, the comet’s total magnitude being 7.3 (10 × 80 binoculars); the comet had brightened a little more three nights later, when he made the last known pre-perihelion detection. The first post-perihelion detection seems to have been that on April 11 (mag 7.4, 10 × 80 binoculars) by D.A.J.Seargeant (The Entrance, New South Wales), but the Perth observers succeeded in photographing the comet the following morning and on half a dozen other occasions during the following two months. On April 14 A.Pearce (Woodlands, Western Australia, 0.15-m reflector) remarked on a 4-arcmin tail (in p.a. 65 deg), and this observer followed the comet visually until May 4, the magnitude then being 9.4. A valuable series of astrometric observations was also made by A.C.Gilmore and P.M.Kilmartin with the 0.6-m reflector at the Mount John University Observatory between April 23 and July 25.

P/Gunn seems to have been observed during 1984 only by R.E.McCrosky

and his colleagues at the Oak Ridge Observatory; exposures were obtained with the 1.5-m reflector on six nights from August 24 to December 24.

P/Smirnova-Chernykh, at perihelion on February 20, was photographed at Oak Ridge at mag 17.0 on January 9, and the comet was also under observation at Perth from the beginning of February. A.Mrkos and Z.Vávrová (Kleť Observatory, 0.6-m Maksutov telescope) followed P/Smirnova-Chernykh during March 20–24, the estimated magnitude being 14.5 on the first night, while estimates by E.Bowell (Lowell Observatory, 0.3-m astrograph) gave mag 15.0 and 15.5 on April 3 and 8, respectively. The comet was still under observation at Oak Ridge in late May and was followed at Perth until June 19.

1982 I (= 1980b), Bowell, was again under observation at Oak Ridge on July 26 and by the discoverer using the 1.8-m reflector and CCD at the Lowell Observatory on September 21. The October 19 Oak Ridge observation was made a record (for a non-periodic comet) 56 months after discovery, and the comet's heliocentric distance was 8.8 AU.

*Observations 1980 February 11 to 1984 October 19*

1982i, P/Halley, was recorded several times during January 27–30 by H.Pedersen and R.M.West with the 1.5-m Danish reflector and CCD at the European Southern Observatory. Electronographic photometry a few nights later by J.Lecacheux and his colleagues with the Canada–France–Hawaii telescope showed apparent variability over a range of almost 2 mag in a period of 8.2 hr, although this was not necessarily to be interpreted as related to the comet's rotation period. The comet was also detected at  $V$  mag 23.6 by M.J.S.Belton and his associates with the cryogenic camera on the 4-m reflector at Kitt Peak on March 4. It was picked up after conjunction by Kiselev at Sanglok on September 20, and on the 22nd (with confirmation four nights later) Seki, using a 0.6-m reflector, became the first amateur astronomer to detect P/Halley at this return, his estimate of the magnitude being 20.5; by late November he was finding the comet to be perhaps 0.5 mag brighter. The first infrared detection, giving a  $J$  magnitude of 18.6, was made of P/Halley on December 20 by C.Birkett, S.Green, A.Longmore and J.Zarnecki with the 3.8-m U.K. Infrared Telescope at Mauna Kea.

*Observations 1982 October 16 to end of 1984, continuing*

1982k, P/Kopff, was observed spectroscopically by Belton on November 1.

*Observations 1982 December 20 to 1984 November 1*

1983h, P/Johnson, was under observation at Oak Ridge on four nights during the last quarter of the year.

*Observations 1983 June 7 to 1984 December 24*

1983j, P/IRAS, was observed for the last time at Oak Ridge in February.

*Observations 1983 June 28 to 1984 February 22*

1983k, IRAS, was accidentally discovered as a new comet by K.S.Russell on an exposure by M.Hawkins with the U.K. 1.2-m Schmidt on March 6.

The comet, which was under observation for only four weeks in 1983 July–August and had passed perihelion on 1983 May 2, was not expected to be as bright as mag 20, and no ephemeris had been published. Instead, it was a noticeable object of mag 16 and showed some evidence of a tail. Russell recorded the comet again on March 7, and beginning three or four weeks later observations were also made with the Perth, Mount John and Oak Ridge telescopes. It was followed at Oak Ridge into May.

*Observations 1983 July 11 to 1984 May 6*

1983l, Černis, south of declination  $-30$  deg, was under observation at Perth and particularly at Mount John during most of the year. A Mount John estimate on September 23 gave mag 16.6.

*Observations 1983 July 19 to 1984 November 25, continuing*

1983m, P/Wolf, faint and generally badly placed at this return, observed on only two nights in 1983, was again detected by recoverer J. Gibson with the 1.2-m Schmidt at Palomar on 1984 September 6 and November 3, and later also by E. Everhart with the 0.4-m reflector at the Chamberlin Observatory's field station near Denver.

*Observations 1983 August 1 to 1984 November 23*

1983n, P/Crommelin, beginning to brighten rapidly as it approached perihelion, was estimated at (nuclear) mag 18.5 on an Oak Ridge exposure on January 1 and at mag 17.5 by Seki on the 4th. Three visual observers, Bortle, Morris and A. Hale (observing with Morris), judged the comet as around total mag 11.5 on January 21, and perhaps 10.5 on the 25th, when Morris remarked on a tail in p.a. 280 deg. A radio detection of OH 1667-MHz emission was indicated by L. Snyder and associates at Effelsberg on January 27. By the beginning of February the comet had brightened to mag 9.5, and a spectrogram obtained on the 4th by H. Spinrad and P. A. Wehinger (Kitt Peak 4-m reflector and CCD) showed the usual emissions. There was further brightening to mag 8.5 by the middle of the month, and more definite radio OH detections were then made at Effelsberg and also by D. Bockelée-Morvan, J. Crovisier and E. Gérard at Nançay.

As P/Crommelin passed perihelion on February 21 some observers were noting a 20 arcmin tail, and magnitude estimates attained 7.5 from then on and – surprisingly – well into March. The almost immediate post-perihelion fading characteristic of the comet's previous apparitions did not occur, and magnitude estimates were still generally in the range 8.5–9.0 during the last week of March, when the International Halley Watch had requested that intensive observations be made of P/Crommelin as a trial run for the P/Halley campaign. Although the trial was in many ways considered a success, the comet's unexpected brightness seems to have been accompanied by extreme diffuseness, and this adversely affected the quality of both astrometry and photometry. Fading finally occurred immediately after the trial week, and there were no visual detections of the comet at all after April 4, when Morris put the comet at mag 9.8. Astrometric observations by Candy, Gibson and Gilmore continued during April and May, and the comet was last recorded by Gilmore on May 26 and 27.

*Observations 1983 August 9 to 1984 May 27*

1983o, IRAS, which had been so troublesome to observe from the ground in 1983, was picked up after conjunction and some five weeks after perihelion on January 2 by Gilmore at mag 16. The comet was under observation at Perth during February, and astrometry was being conducted at eight observatories in March and April. Visual detections on March 11 by Hale and Morris put the comet around mag 13. A spectrogram obtained by S.M.Larson with the 1.5-m reflector at the Lunar and Planetary Laboratory on May 2 showed only continuum. Three subsequent observations were made at Oak Ridge, and H.Kosai and K.Hurukawa estimated the comet at mag 17 on a plate taken with the 1.05-m Schmidt at the Tokyo Observatory's Kiso station on June 1.

*Observations 1983 July 27 to 1984 June 5*

1983p, Shoemaker, at declination  $-33$  deg when picked up after conjunction on May 30 at Mount John, continued to move southwards and to be observed only there and at Perth. Gilmore and Kilmartin estimated the comet at mag 17.0 on September 23.

*Observations 1983 September 7 to 1984 October 24, continuing*

1983r, P/Harrington-Abell, was under observation during the first quarter of the year by Everhart, McCrosky and Candy. On March 1 and 2 Larson recorded the continuous spectrum of a very small coma, but he also noted a narrow tail 30 arcsec long. The last observation was made at Oak Ridge on April 2.

*Observations 1983 September 17 to 1984 April 2*

1983s, P/Wild 2, was well placed for evening observation from the northern hemisphere during the first few months of the year. Bowell photographed the comet around mag 14.5 on January 4, while an observation by L.Kohoutek with the Hamburg 0.8-m Schmidt at Calar Alto on January 30 made the comet slightly fainter. Morris picked up the comet visually at mag 13.4 on April 4, and he made further magnitude estimates of 13.0 on April 21 and 13.1 on the 23rd. P/Wild 2 was observed spectroscopically in early May by Larson, when the only emission present was due to CN.

*Observations 1983 September 18 to 1984 May 2, continuing*

1983u, P/Taylor, was consistently estimated at mag 15.5–16.0 by Bowell and Seki in early January, and astrometric observations were also made during the early part of the year by Everhart, McCrosky and Gibson. The last detection was at Oak Ridge on May 3.

*Observations 1983 November 3 to 1984 May 3*

1983v, P/Hartley-IRAS, the unusual comet with a 21-year revolution period and orbit plane almost perpendicular to the ecliptic, remained generally around mag 10.0–11.0 during the first six weeks of 1984, according to the estimates of several visual observers, some of whom remarked on a tail 10–15 arcmin long. On February 23, however, Bortle was surprised to find that the comet had brightened to mag 7.9 (10×80 binoculars). His subsequent binocular estimates were mag 8.8 on February 27 and March 1,

9.3 on March 8, 9.5 on March 27 and 9.9 on April 2. On that last night an estimate with a 0.32-m reflector gave mag 10.3, and his subsequent reflector estimates were 10.4 on April 9 and 22, 10.5 on April 27, 10.7 on May 2 and 10.9 on May 3. P/Hartley-IRAS was no fainter in early May than it had been in early January, and even an inverse-square law would have suggested fading by two magnitudes. Fading did become more substantial during May: an estimate by Morris on May 27 gave mag 12.2 (0.26-m reflector), and the comet was last photographed by N.S. Chernykh and his colleagues at the Crimean Astrophysical Observatory on the 28th and at Oak Ridge a week later.

*Observations 1983 November 4 to 1984 June 4*

1983w, P/Clark, was under astrometric observation during the first two-thirds of the year at half a dozen observatories, notably Mount John and Perth, and visual observations by Morris, Hale and Pearce during May to July put the comet around mag 10.5–11.0. According to Maurice Clark (Tambellup, Western Australia, and no relation to the discoverer) P/Clark had faded to mag 12.0 (0.41-m reflector) on August 15, 12.3 on August 22 and 12.9 on September 19.

*Observations 1983 December 15 to 1984 September 19*

1984a was discovered by William A. Bradfield at Dernancourt, near Adelaide, on January 7.7. The twelfth discovery by this observer, and the first since the end of 1980, the new comet was diffuse and uncondensed, of mag 11, and moving southeastwards in Norma. With a revolution period of about 151 years, the comet was technically a short-period one. The most extensive series of astrometric observations, by Candy and his colleagues at Perth, began on January 9, when the comet's magnitude was given as 13. Gilmore and Kilmartin also observed the comet from January 14 onwards, when they recorded trailed images on a dark plate with the 0.13-m Mount John astrograph. With the 0.6-m reflector they were able to follow the comet until late May, when the nuclear magnitude was around 18.

*Observations 1984 January 7 to May 30*

1984b was the designation given to an uncondensed cometary image, of mag 12, reported by Michael Clark (discoverer of comet 1983w) on a Harvard patrol plate at Mount John on January 24.5 in the vicinity of  $\iota$  Eridani. The comet appeared to have been confirmed on a similar exposure made on January 8 (although this indicated that the motion was unusually small), and a further image was suspected on January 25. The discoverer failed to find the comet on the 27th, however, and searches at other observatories also seem to have been negative.

1984c, periodic comet Neujmin 1, was recovered by Gilmore and Kilmartin with the Mount John reflector on February 26. At recovery the object was of mag 18 and had its characteristic stellar appearance. The following night the comet was also observed at Perth, and regular observations were subsequently made at both observatories. A visual detection, at mag 13.6, was made by Morris on August 25, with brightening to perhaps mag 13.2



4 weeks later. As it approached perihelion passage in early October P/Neujmin 1 was definitely cometary, and spectroscopic observations on September 18 and 21 by E. Barker (McDonald Observatory) of a fan extending 0.2 arcmin southeast of the strong condensation showed CN and C<sub>2</sub> emissions. Australian amateur J. Wood estimated the comet at mag 12.5 on October 19 (0.25-m reflector), but Morris was unable to detect it down to mag 13.5 on November 20. Astrometric observations were also made during the last quarter of the year at Oak Ridge.

*Observations 1984 February 26 to end of year, continuing*

1984d was discovered by Kenneth S. Russell on an exposure by M. Hawkins with the U.K. Schmidt on March 7.7. Of mag 13, the comet was retrograding slowly in Virgo, and the discoverer also located images of it on prism plates taken on March 2 and 4. A new short-period comet, designated P/Russell 4, the object was widely photographed at several observatories in March and April, and Merlin made a visual detection at about mag 15.5 on April 21. A spectrogram obtained by Larson on May 2 showed only continuum, and the last observation was made only five night later at Oak Ridge.

*Observations 1984 March 2 to May 7*

1984e was periodic comet Giacobini-Zinner, recovered by S. Djorgovski, H. Spinrad, G. Will and Belton on April 3.4 using the Kitt Peak 4-m reflector and CCD. Four 2.5-min integrations over an interval of some 20 min yielded a stellar image of (red) mag 22.9 having the expected motion. Confirmation was provided by the presence of two unresolved images on longer integrations by Belton and Wehinger with one of the Kitt Peak 0.9-m reflectors five nights previously. Nicely round images, though fainter than mag 24.5 and near the telescope limit, were then located by Pedersen and West on CCD exposures obtained with the 1.5-m Danish telescope at the European Southern Observatory on January 28.3. P/Giacobini-Zinner was also observed in July by J.T. Clarke, J. Brodie and P. McCarthy with the Cerro Tololo 4-m reflector and CCD.

*Observations 1984 January 28 to July 22, continuing*

1984f was discovered by Carolyn and Eugene Shoemaker on May 27.4 in the course of their search programme with the 0.46-m Schmidt at Palomar for unusual minor planets. Their exposures on the same night also yielded 1984 KB and KD, the first Apollo objects to be discovered in the programme. Retrograding in Hercules, the new comet was of mag 14, moderately condensed but with fan-shaped coma structure to the north. Astrometric observations were obtained for several months at a number of observatories, a particularly noteworthy series being that by J.B. Tatum and D.D. Balam with the 0.25-m reflector at the University of Victoria. Mrkos noted brightening from mag 15.4 on June 1 to 15.0 on June 30, 14.5 on July 21-22 and 14.2 on August 17, and the last observation before conjunction was made at Oak Ridge towards the end of September.

*Observations 1984 May 27 to September 26, continuing*

1984g, periodic comet Wolf-Harrington, was recovered by Gibson with the 1.2-m Palomar Schmidt on June 4.4 at mag 17. Further exposures with a CCD on the 1.5-m reflector during June 8–11 showed a tail up to 50 arcsec long westwards. The comet was followed during July by Everhart, Tatum and McCrosky. Morris judged it visually at mag 12.8 on August 28, 13.3 on October 2 and 13.2 on December 2.

*Observations 1984 June 4 to end of year, continuing*

1984h, periodic comet Faye, at a difficult location in the dawn, although expected to be quite bright at its perihelion passage in early July, was recovered on CCD exposures by Gibson with the Palomar 1.5-m reflector on June 9.4, 10.4 and 11.4. Because of initial problems with the reduction of these exposures, the recovery had not been considered definite until the comet was independently found visually by Morris at Frazer Park, California, on June 23, 27 and 28. According to Gibson, the object was essentially stellar, of about mag 16.5, although the longer exposures showed a short tail westwards and some coma. The observations by Morris, both in June and in late August, showed the coma to be only slightly condensed and of mag around 12.5. The first available accurate position, secured by Gibson with the 1.2-m Schmidt on July 21, confirmed that P/Faye had in fact also been recorded by him with the same telescope at mag 20.5 on 1983 August 31. The comet faded gradually toward the end of 1984, Bouma giving the magnitude as 13.4 on November 2 (0.41-m reflector) and 14.0 on December 26.

*Observations 1983 August 31 to end of 1984, continuing*

1984i was the second cometary discovery by Rodney R.D. Austin, of New Plymouth, New Zealand. A condensed object of mag 8 at its discovery on July 8.7, this comet was moving eastwards in Columba at around 10 degrees per day, and prompt action by the individuals involved meant that accurate positions could be measured by Kilmartin at Mount John (on a Damon patrol film exposed by Michael Clark) and by P. Birch at Perth within hours of the discovery. The orbit determined with the help of further observations with the Mount John reflector on the following two nights indicated that the comet was some 0.25 AU away from the earth and that it would move to the north of the sun around its perihelion passage (heliocentric distance 0.29 AU) on August 12. A visual estimate by the discoverer (0.15-m refractor) the morning after discovery gave mag 6.5 and coma diameter 12 arcmin. The Mount John and Perth observers, and also D. Herald near Canberra, continued to make astrometric observations until August 1, and radio observations at Nançay by Gérard and J.P. Drouhin during July 27–29 showed the OH lines at 1665 and 1667 MHz in absorption. Observing with 9 × 63 binoculars at the Siding Spring Observatory, R.H. McNaught noted a tail 2.1 deg long on the 31st, and by August 3 the tail was 3.1 deg long and the total mag 5.1. The comet was comparably bright, but only 0.2 deg of tail could be detected, when this same observer last saw the comet at very low altitude, in twilight haze on August 7. Infrared observations on August 10 by E.P. Ney at the University of Minnesota showed comet 1984i to be about four times dimmer than comet 1973 XII at comparable distances and not to have any evident 10-micron silicate feature.

The comet seems to have been first detected after perihelion by W.C.Morrison (Peterborough, Ontario) and by Hale on August 25, the former observer putting the magnitude at about 6.2 (0.15-m reflector). As the comet moved into a darker sky during the following week several visual observers judged it to be slightly brighter than mag 6. On the 29th R.A.Keen (Boulder, Colorado, 0.32-m reflector) noted both a tail (1.0 deg long in p.a. 290 deg) and an antitail (0.4 deg long in p.a. 80 deg), and Morris reported the main tail as 2 deg on August 29 and September 2. The antitail was subsequently also reported by others, and on September 15 Keen remarked that it was perhaps twice as long as the 0.1-deg main tail. By then the comet had faded to mag 7.0–7.5, and by mid-October to perhaps mag 8.5. In spite of the wealth of visual data in September the photographic record was abysmal, the only astrometric results being obtained by Seki on September 4, McCrosky on the 17th, by Tatum beginning on the 27th and by Mrkos on the 30th. Bouma and Bus were still reporting a tail 0.2–0.3 deg long near p.a. 70 deg on October 30, by which time the comet had faded to about mag 9. Further fading took place during November, although Morris was still estimating mag 10.4 on the 26th. On November 21 the comet was accidentally picked up by the Shoemakers with the 0.46-m Palomar Schmidt at mag 16, but the observation on the 27th at Oak Ridge seems to have been the last made of the object.

*Observations 1984 July 8 to November 27*

1984j was discovered by Kesao Takamizawa with 20 × 120 binoculars at Saku-machi, Nagano Prefecture, on July 30.5. Near opposition in Capricornus and moving almost due southwards at 13 arcmin per day, the object was of tenth magnitude and unspecified appearance. A confirmatory observation was made the next night by K.Saito at the Tokyo Observatory's Dodaira Station, and during the following night-time hours in California Morris noted the comet as extremely condensed, of mag 9.5 and with a tail extending 4–5 arcmin to the west. After the discovery was known, an accidental image, also showing a short tail to the west, was easily located by E.Helin on one of her survey plates obtained with the Palomar 1.2-m Schmidt on August 1. It still seemed surprising that such a bright and evidently moderately distant comet should first have been noticed in such an accessible part of the sky and with the moon well past new, all the more so since the initial orbit determinations suggested that the comet was a short-period one that could not have been thrown into its present situation as the result of a recent approach to Jupiter. Prediscovery images, showing the comet to be as bright as mag 6.5, were soon found by Seki on exposures with his small-field 0.6-m reflector on July 26. P.Wild then reported even earlier prediscovery images from films taken with the 0.4-m Schmidt at the Zimmerwald station of the Berne Astronomical Institute. A July 8 image, consisting of an asymmetric, uncondensed, mag 13 coma and a fan-shaped tail extending about 1 arcmin to the west, had been noted by this observer at the time but dismissed as a defect because there was no similar image on a film obtained two nights before. After the first orbit of P/Takamizawa became available, Wild had been able to identify the comet on the July 6 film as a distinct nucleus of mag 17 in a very tenuous coma.



Moonlight began to interfere strongly with observations in early August, but several observers indicated that the comet remained around mag 9, and D.E.Machholz (San Jose, California, 0.25-m reflector) reported a tail 40 arcmin long (in p.a. 240 deg) on the 5th. The comet was rather well observed visually and photographically throughout August and September, Machholz estimating the magnitude as around 12.0 on September 23 (0.36-m reflector). Oak Ridge observations on October 16 and 18 put the comet at mag 18, and useful positions were determined on the 22nd by E.F.Tedesco with the encoders at the NASA Infrared Telescope Facility at Mauna Kea. The final detections of P/Takamizawa were made at Mount John on three nights during the following month.

*Observations 1984 July 6 to November 25*

1984k, periodic comet Arend-Rigaux, was recovered as its elongation from the sun increased sufficiently in early August. Gibson recorded stellar images of mag around 18.5 with the 1.2-m Palomar Schmidt on August 7.4 and 8.4, and a longer exposure on August 6.4 showed a hint of a very faint tail extending 1–2 arcmin in p.a. 255 deg. Seki independently noted an image of the comet at mag 18.0–18.5 on a single exposure on August 8.8, and another single image was identified by Everhart some 12 hr after that. Like P/Neujmin 1, P/Arend-Rigaux is a characteristically stellar comet that was making a particularly favourable return in 1984, and further evidence of cometary activity was also to be expected as it approached perihelion on December 1. An observation by Bortle on November 22 showed the coma to be as bright as mag 11.8, and rather similar estimates were made by several observers throughout December.

*Observations 1984 August 6 to end of year, continuing*

1984l, periodic comet Gehrels 3, was recovered by Gibson on Palomar Schmidt plates on August 7.5 and 8.5. The images, stellar within the limits of seeing and guiding, were of mag 20.0–20.5.

*Observations 1984 August 7 and 8, continuing*

1984m, periodic comet Schaumasse, was recovered by Gibson on September 5.5 and 6.5 as a stellar condensation of mag 19 with a very weak coma. This recovery confirmed the single observation made by E.Roemer with the Steward Observatory's 2.3-m reflector on Kitt Peak on 1976 December 27 (see the 1976 report). No other observations of this 8-yr-period comet had been possible since 1960. Although the faint 1984 recovery came only three months before perihelion, the return was to be very favourable. Dramatic brightening was anticipated, and by the end of October Bouma was finding P/Schaumasse to be as bright as mag 9.5. This brightness was maintained for the remainder of the year, and Morris reported a 3-arcmin tail on December 2.

*Observations 1984 September 5 to end of year, continuing*

1984n was a new comet discovered by Charles T.Kowal in September on plates taken with the 1.2-m Palomar Schmidt on April 23.3 and 30.3. The images were of mag 15 and almost stellar, but there was a faint but definite

coma. The comet was obviously identical with an object of mag 16.0 recorded by Mrkos at Kleř in Virgo on May 2; although the image had been noted as diffuse on the second exposure, Mrkos' object had been given the minor planet designation 1984 JD. After Kowal's discovery Mrkos succeeded in finding further mag 16 images on a pair of plates taken on May 19, and in a situation curiously reminiscent of that of P/Kowal-Vávrová a year earlier, comet 1984n turned out to be a short-period object. Exposures were made for P/Kowal-Mrkos by Gilmore and Kilmartin at Mt John on September 17 and 18, by Gibson and Helin with the 1.2-m Palomar Schmidt on September 18 and 20 by M.Hartley with the 1.2-m U.K. Schmidt on the 22nd, but no convincing images of the comet could be found.

*Observations 1984 April 23 to May 19*

1984o was discovered by Rolf Meier at the Indian River Observatory, 50 km west of Ottawa, on September 18.0. The new comet was on the border of Serpens Caput and Boötes, a diffuse but condensed object of magnitude 12. As with his three earlier discoveries, Meier detected comet 1984o using a 0.4-m reflector and unusually high power of  $56\times$  and only 82 search hours after his discovery of comet 1980q. Prompt communication enabled Gibson to obtain a sharp but rather weak image of comet 1984o with the Palomar 1.2-m Schmidt within 3 hr of discovery, but further photographic observations the following night at the Oak Ridge, Lowell and Palomar observatories indicated that the object had become significantly more diffuse, a circumstance that was also evident from exposures at these same observatories during September 20–23. The comet was observed at Perth on September 24 and 25. Visual estimates by Morris put the comet at mag 11.3–11.4 on the 23rd and 27th. The only subsequent observations were a pair obtained by Gibson with the 1.5-m Palomar reflector and CCD on October 6.

*Observations 1984 September 18 to October 6*

1984p, periodic comet Tsuchinshan 1, was recovered independently by Seki (using his 0.6-m reflector) on September 4.7 and by Gibson on September 5.5 and 6.5 with the 1.2-m Palomar Schmidt. Both observers gave the magnitude as 20.5, and Gibson remarked that in the mediocre seeing the comet's image was weak and near the plate limit. Seki recorded the comet again at mag 19.7 on September 22, but no further observations seem to have been made until November 20–December 5, when it was detected at Oak Ridge and Victoria. On December 23 the comet was being reported visually by Bouma and G.Comello (0.41-m reflector) at mag 12.3–12.4, and on the 31st, two days before perihelion passage, Morris estimated it at mag 10.8.

*Observations 1984 September 4 to end of year, continuing*

1984q was a mag 13 condensed object in Pegasus, discovered by Carolyn and Eugene Shoemaker on exposures with the 0.46-m Palomar Schmidt on September 27.2 and 28.3. Following Gibson's confirmation of the discovery on October 4 it seemed likely that this was another short-period comet, and despite the nearly full moon further observations were obtained on the 5th and 6th, also at Oak Ridge, Victoria and Perth. Prediscovery images were identified by McCrosky on patrol films obtained with the Damon camera at

Oak Ridge on September 1 and 22. Already receding from both the earth and the sun at its discovery, P/Shoemaker 1 maintained its brightness and was widely observed through November. According to Bouma it was still of mag 13.8 on December 25.

*Observations 1984 September 1 to end of year, continuing*

1984r was discovered, also by the Shoemakers with the 0.46-m Palomar Schmidt, on October 23.5, as a diffuse and relatively uncondensed object of mag 16, retrograding almost exactly along the ecliptic in Taurus. This extreme apparent great-circle motion made it difficult to decide whether the object was a rather nearby short-period comet or in a retrograde orbit and much more distant, but the latter solution, with the record high inclination of 179.2 deg, eventually prevailed. A magnitude estimate of 17 was made at Kleť on November 28, and the comet continued to be under observation at Oak Ridge in December.

*Observations 1984 October 23 to end of year, continuing*

1984s was yet another discovery by the Shoemakers, this one a mag 12 object with a strong condensation, moving to the south and slightly to the east in Aries when found on October 25.4. Morris noted brightening from mag 11.5 on November 3 to 10.7 on the 20th and 10.4 on December 12. Although still approaching perihelion, and near its closest distance of 0.37 AU from the earth, Morris made the comet slightly fainter on the 23rd, although there was by then a 6-arcmin tail in p.a. 80 deg. Comello reported the tail to be perhaps 15 arcmin long on December 27.

*Observations 1984 October 25 to end of year, continuing*

1984t was discovered by David H. Levy, a planetarium assistant in Tucson, Arizona, on November 14.1, as a diffuse object of mag 8.5 (0.40-m reflector) moving northwards and slightly westwards in Scutum. The object was confirmed the following evening by McCrosky, Meier, Gibson and Morris, and an independent discovery was made by Michael Rudenko, a computer technician in Amherst, Massachusetts. Rudenko (0.15-m refractor) and Morris both suggested that the comet was as faint as mag 10.5, while Levy's indication that there had been fading by perhaps 1 mag since the previous night was consistent with estimates of mag 9.2–9.7 by McNaught at Siding Spring (12 × 80 binoculars). Levy had spent more than 917 hr comet hunting since 1965, some 57 hr since his independent discovery of comet 1983v; Rudenko had been comet hunting since about 1981.

Estimates by Morris (15 × 80 binoculars) gave mag 8.7 on November 20 and 8.5 on the 26th, and during this time a tail developed and apparently increased from 0.2 deg to 0.5 deg in length. Morris again noted a 0.5-deg tail on December 12 and judged the comet at mag 8.2–8.3 then and on the 23rd and 31st. The northward and slow westward motion continued through perihelion passage on December 14, and the comet remained widely observed as it passed through conjunction more than 50 deg north of the sun during the last week of the year.

*Observations 1984 November 14 to end of year, continuing*

1984u, the Shoemakers' sixth cometary discovery in under 15 months, was retrograding in Aries, of mag 14.5 with a strong condensation and possibly a short tail to the northeast, when found on a pair of exposures with the 0.46-m Palomar Schmidt on November 21.3. Bowell quickly identified mag 15 predisccovery images on plates taken at the Lowell Observatory on November 18, and with the availability also of Lowell positions from November 27 it became clear that this was another short-period comet. P/Shoemaker 2 was observed by Seki (at mag 16) on November 28 and by Gibson on the 30th, but by the next dark of the moon it was evidently much fainter, and the only definite subsequent observations were obtained at Oak Ridge on December 18 and at the Chamberlin station two nights later, the magnitude then being given as 19.

*Observations 1984 November 18 to December 20*

1984v was discovered by Malcolm Hartley on exposures with the U.K. Schmidt on November 17.6 and 23.7. Some 3 deg southwest of Rigel on the former night, the mag 15 object was moving slowly away from the star, and its trails were surrounded by a faint halo. Gilmore and Kilmartin estimated the nuclear magnitude at 17 on December 1, and orbit computations showed the comet then to be 4.7 AU from the sun, with reduction to 4.0 AU occurring at perihelion ten months later. Comet 1984v was observed again on December 4 by its discoverer, and observations were also made by Everhart, Gibson, McCrosky and Candy.

*Observations 1984 November 17 to end of year, continuing*

P/Tuttle-Giacobini-Kresák, due at perihelion on July 28, was badly placed for recovery at this return; single candidate images were noted by Gibson on January 24 (mag 21) and by Seki on July 30 (mag 15.5), but confirmation was not forthcoming. Unsuccessful searches were also made by Gibson for P/Tritton (at perihelion in March) and P/Oterma (at perihelion in 1983 June), but the former was rather badly placed and the prediction uncertain, and the latter not expected to be brighter than mag 21. P/Haneda-Campos (perihelion 1984 December 26) and P/Schwassmann-Wachmann 3 (1985 January 11) were badly placed, and recoveries were essentially impossible.

The following continuation of the numerical designations of comets (in order of perihelion passage) is taken from *Minor Planet Circ. No. 9389-9390* (1985):

Comet		<i>T</i>	Name	Year/letter
1983	I	January	19.0 IRAS	1983f
	II	March	15.2 P/Bowell-Skiff	1983c
	III	April	2.2 P/Kowal-Vávrová	1983t
	IV	April	7.5 P/Pons-Winnecke	1983b
	V	May	1.3 Sugano-Saigusa-Fujikawa	1983e
	VI	May	2.7 IRAS	1983k
	VII	May	21.3 IRAS-Araki-Alcock	1983d
	VIII	May	22.4 P/Arend	1983q
	IX	June	1.3 P/du Toit-Neujmin-Delporte	1983g



X	June	1.5	P/Tempel 2	1982d
XI	July	9.8	P/Tempel 1	1982j
XII	July	21.2	Černis	1983l
XIII	August	10.3	P/Kopff	1982k
XIV	August	23.8	P/IRAS	1983j
XV	November	23.7	Shoemaker	1983p
XVI	November	28.0	IRAS	1983o
XVII	December	1.7	P/Harrington–Abell	1983r
XVIII	December	3.2	P/Johnson	1983h
XIX	December	27.8	P/Bradfield	1984a

The 1976 recovery of P/Schaumasse is designated 1976 XV.

On the following pages some recently computed orbital elements 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.

#### REFERENCES AND NOTES TO TABLE OF ELEMENTS

- (1) Co-author Chodas.
- (2) *Nakano Note No. 457* (1984).
- (3) *Ibid. No. 451* (1984).
- (4) *Ibid. No. 454* (1984).
- (5) *Ibid. No. 450* (1984).
- (6) *Ibid. No. 459* (1984).
- (7) *Ibid. No. 453* (1984).
- (8) *Ibid. No. 456* (1984).
- (9) *Ibid. No. 445* (1984).
- (10) *IAU Circ. No. 3987* (1984).
- (11) *Nakano Note No. 471* (1984).
- (12) *Ibid. No. 458* (1984).
- (13) *Ibid. No. 449* (1984).
- (14) *Ibid. No. 462* (1984).
- (15) *Minor Planet Circ. No. 9425* (1985).
- (16) *Ibid. No. 9304* (1984).
- (17) *Ibid. No. 8671* (1984).
- (18) *Nakano Note No. 460* (1984).
- (19) *Ibid. No. 461* (1984).
- (20) *Ibid. No. 467* (1984).
- (21) *Minor Planet Circ. No. 9025* (1984).
- (22) *Ibid. No. 8672* (1984).
- (23) *Ibid. No. 9213* (1984).
- (24) *Ibid. No. 8779* (1984).
- (25) *Ibid. No. 9211* (1984).
- (26) *Ibid. No. 8287* (1983).  $\Delta T < 0.01$  day.
- (27) *Nakano Note No. 426* (1983).  $\Delta T < 0.01$  day.
- (28) *Ibid. No. 469* (1984).
- (29) *Minor Planet Circ. No. 9685* (1985).
- (30) *Ibid. No. 8289* (1983).  $\Delta T = +0.03$  day.
- (31) *Acta Astr.* 31, 471 (1981).  $\Delta T = +0.02$  day.
- (32) *Minor Planet Circ. No. 9351* (1985).
- (33) *Handb. Br. Astr. Ass.*, 1984, p. 91 (1983).  $\Delta T = +0.01$  day.
- (34) *Minor Planet Circ. No. 7455* (1982).  $\Delta T < 0.01$  day.

- (35) *Ibid.* No. 9212 (1984).
- (36) *Minor Planet Circ. No.* 7659 (1983).  $\Delta T < 0.01$  day.
- (37) *IAU Circ. No.* 3977 (1984).
- (38) *Minor Planet Circ. No.* 9426 (1985).
- (39) *Ibid.* No. 9351 (1985).
- (40) *Ibid.* No. 9214 (1984).

Ref.	Comet	T	q	e	P	ω	Ω	i	Epoch	Obs.	Arc	Author
1618	III	18 Oct. 27.9	0.744	1.0	155.9	228.8	8.4	8.4	18 Nov. 11	6	11 - 18	Landgraf
1639		30 Nov. 29.4	0.816	0.967933	77.4	219.0	61.7	61.7	39 Oct. 25	4	25 - 39	Landgraf
1682	P/Halley	29 Sept. 15.7794	0.582621	0.967636	76.9	107.4	162.2617	162.2617	1682 Oct. 28	278*	1836	Yeomans
1739	P/Halley	30 Mar. 13.0623	0.584466	0.725946	6.87	110.6903	56.5292	162.3695	1739 Mar. 21	718*	1911	Yeomans
1772	P/Biela	72 Feb. 17.6903	0.590837	0.745947	6.74	213.3933	260.2210	172.0820	1772 Feb. 21	20*	1772	Landgraf
1806	I	66 Jan. 2.4028	0.907144	0.745947	6.74	218.1073	253.3334	18.3925	1772 Aug. 25	20*	1833	Landgraf
1812	P/Pons-Brooks	12 Sept. 15.8287	0.777102	0.953541	72.6	199.2938	34.9387	73.9576	1812 Aug. 30	264*	1956	Yeomans
1815	I	15 Apr. 26.4951	1.212909	0.931712	74.9	65.5813	44.5981	44.5981	1815 Apr. 17	84*	1954	Yeomans
1826	P/Biela	26 Mar. 18.9484	0.902423	0.746566	6.72	221.2882	253.2565	13.2187	1772 Mar. 30	20*	1833	Landgraf
1832	III	32 Mar. 26.6155	0.879062	0.751290	6.64	221.6867	249.9423	13.2187	1772 Dec. 3	20*	1833	Landgraf
1835	III	35 Nov. 16.4396	0.586563	0.967394	76.3	110.6854	56.8019	162.2558	1835 Nov. 18	633*	1984	Yeomans
1846	P/Biela (Noel. A)	46 Feb. 11.4933	0.856451	0.756559	6.60	223.0865	247.4129	12.5771	1846 Jan. 24	13*	1846	Landgraf
1846	II	46 Feb. 11.5742	0.856482	0.756733	6.61	223.0871	247.4067	12.5780	1846 Jan. 24	13*	1846	Landgraf
1852	III	30 Sept. 23.5600	0.860617	0.755987	6.62	223.2542	247.2788	12.5514	1852 Sept. 29	13*	1852	Landgraf
1852	III	32 Sept. 24.2277	0.860815	0.755943	6.62	223.2300	247.2789	12.5503	1852 Sept. 29	13*	1852	Landgraf
1852	IV	32 Sept. 23.2187	1.249862	0.519321	61.2	57.0325	347.5382	40.9308	1852 Sept. 29	266	1852	Yeomans
1867	I	67 Jan. 20.6477	1.575367	0.858435	37.1	357.5162	79.6571	18.2931	1867 Feb. 3	264*	1867	Yeomans
1873	VII	73 Dec. 2.4190	0.747466	0.919076	28.1	196.0877	250.8780	28.7956	1873 Nov. 18	279*	1984	Yeomans
1884	I	84 Jan. 26.2161	0.775729	0.955052	71.7	199.1824	255.0745	74.0418	1884 Jan. 25	264*	1954	Yeomans
1887	V	87 Oct. 8.9741	1.199085	0.590968	72.4	65.3467	85.3653	44.5718	1887 Oct. 16	84*	1956	Yeomans
1889	V	89 Sept. 30.8461	1.949832	0.470804	71.07	343.6349	18.7906	6.0752	1889 Oct. 5	166*	1904	Yeomans
1896	VI	96 Nov. 4.6314	1.959218	0.469433	71.10	343.8171	18.7441	6.0653	1896 Nov. 17	166*	1904	Yeomans
1903	V	03 Dec. 6.7480	1.958906	0.469749	71.10	343.6460	18.7334	6.0679	1903 Nov. 22	83*	1886	Yeomans
1910	II	10 Apr. 20.1785	0.587208	0.967302	76.1	111.7181	57.8462	162.2157	1910 May 9	633*	1910	Yeomans
1911	I	11 Jan. 8.6506	1.962996	0.468850	71.10	343.5177	18.7618	6.0634	1911 Jan. 4	48*	1903	Yeomans
1913	VI	13 Nov. 26.8252	1.254027	0.919830	61.9	57.1099	347.3002	40.8828	1913 Nov. 9	265	1852	Yeomans
1925	IX	23 Nov. 1.8196	1.861656	0.487296	8.52	195.7072	177.7696	5.5497	1925 Oct. 17	53*	1913	Yeomans
1927	III	27 Mar. 22.1980	1.772495	0.574949	8.52	38.4825	65.9293	13.7636	1927 Mar. 21	71*	1926	Forti
1928	III	28 Nov. 4.9696	0.745022	0.919051	27.9	195.8927	250.3648	28.8953	1928 Nov. 10	279*	1984	Yeomans
1929	I	29 Mar. 23.1924	2.094842	0.394642	6.42	357.7405	126.3248	3.7280	1929 Mar. 10	121*	1956	Forti
1932	VIII	32 Oct. 9.5294	1.870007	0.486081	6.94	195.8329	177.6982	5.5448	1932 Oct. 20	69*	1940	Yeomans
1935	III	35 Aug. 28.6248	2.094651	0.394889	6.42	357.9951	126.2888	3.7281	1935 Aug. 26	121*	1929	Yeomans
1935	III	35 Oct. 6.5759	1.777142	0.574447	8.53	38.7876	65.7057	13.7225	1935 Oct. 5	71*	1926	Forti
1939	VII	39 Sept. 15.4272	1.871487	0.486053	6.95	195.6907	177.7034	5.5458	1939 Sept. 14	68*	1946	Yeomans
1942	I	42 Feb. 13.8366	2.143689	0.385405	6.51	358.0325	126.0388	3.7249	1942 Feb. 14	121*	1929	Forti
1942	IX	42 Dec. 19.0897	1.592294	0.860984	38.9	358.2700	78.6084	17.9010	1942 Dec. 27	264*	1867	Yeomans
1944	I	44 Apr. 11.4962	1.765569	0.475761	8.50	38.8385	65.7217	13.7319	1944 Apr. 20	69*	1913	Forti
1946	VI	46 Aug. 25.8018	1.878839	0.484389	6.96	195.6102	177.6974	5.5394	1946 Aug. 8	60*	1954	Yeomans
1948	VII	48 Aug. 23.6430	2.152261	0.385756	6.53	358.1304	126.0149	3.7234	1948 Aug. 6	129*	1982	Forti
1948	IX	48 Oct. 4.7838	2.310993	0.395604	7.48	348.5045	12.5136	48 Oct. 16	1948	1948	1979	Forti
1952	VII	52 Sept. 10.7805	1.766919	0.576976	8.54	39.9458	62.9107	13.4675	1952 Sept. 25	79*	1962	Forti
1953	V	53 Aug. 7.3585	1.866090	0.486662	6.93	195.6905	177.6808	5.5508	1953 Aug. 11	56*	1946	Yeomans
1954	IV	54 Feb. 20.7653	2.414438	0.550143	12.4	134.3515	148.9754	6.5901	1954 Feb. 27	99*	1979	Marsden
1954	VII	55 May 27.8813	1.736556	0.954847	70.9	199.0346	255.1909	74.1781	1954 May 18	264*	1954	Yeomans
1955	I	55 Feb. 27.1991	2.150964	0.384270	6.53	359.8725	126.0091	3.7249	1955 Feb. 22	119*	1969	Forti
1956	IV	56 Apr. 6.1798	1.324506	0.933310	7.51	349.0892	2.2857	12.4930	1956 Apr. 28	84*	1948	Forti
1956	IV	56 June 19.1391	1.178461	0.933277	69.6	64.6352	85.4121	44.6108	1956 June 16	84*	1956	Yeomans
1956	VI	56 Oct. 25.2068	1.743369	0.919172	27.9	195.9800	250.4284	28.8815	1956 Oct. 14	279*	1984	Yeomans
1960	VI	60 June 13.2375	1.443165	0.603376	7.02	350.9762	76.1934	31.0665	1960 May 26	40*	1981	Yeomans
1960	VI	60 June 17.1162	1.763172	0.504853	6.72	197.0844	176.8903	5.5713	1960 July 5	43*	1973	Yeomans

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Ref.	Comet	T	q	e	P	ω	Ω	i	Epoch	Obs.	Arc	Author
(1)	1961 III P/Comas Solá	61 Apr. 4.0444	1.777192	0.576102	8.58	40.0189	62.8448	13.4417	61 Apr. 11	89*	1951	Forri
	1961 V Wilson-Hubbard	61 July 17.4953	0.040199	0.999962		270.7141	296.2439	24.2080	61 Aug. 9	84	61 Nov. 9	Brannham
(2)	1963 VII P/Solmass.-Wach. 2	61 Sept. 5.0419	2.157283	0.382857	6.54	357.9949	123.9986	3.7233	61 Sept. 18	119*	1947	Forri
	1963 II P/Whipple	63 Apr. 28.7321	2.471074	0.327740	7.46	189.9949	188.3920	10.2437	63 May 11	55*	1962	Nakano
	1963 VI P/Aabrook-Jaakson	63 Oct. 2.14074	0.395751	0.799751	7.49	348.9530	2.2825	12.5070	63 Oct. 17	*	1948	Forri
(3)	1963 VIII P/Keenan-Kwee	63 Dec. 7.0087	2.313217	0.486525	8.95	131.1939	315.4386	8.9920	63 Nov. 27	*	1963	Forri
	1964 X P/Daniel	64 Apr. 21.2400	1.661373	0.500012	7.09	10.7875	68.5179	20.1405	64 May 5	6	1964	Nakano
(4)	1964 X P/Holmes	64 Nov. 15.9308	2.346939	0.378899	7.35	21.8021	329.5545	19.5178	64 Nov. 21	31	1964	Nakano
	1965 VI P/Ki omola	65 Aug. 18.3636	1.763398	0.642319	10.9	148.0416	181.9933	10.6067	65 Aug. 28	63	1965	Milbourn
	1966 III P/Van Biesbroeck	66 July 17.8173	2.408675	0.550423	12.4	134.2473	148.8313	6.5976	66 July 14	99	1964	Marsden
	1967 VIII P/Borrelly	67 June 17.7153	1.446643	0.604445	6.99	351.0303	76.1410	31.1155	67 May 30	40*	1960	Yeomans
	1968 II P/Solmass.-Wach. 2	68 Mar. 14.2694	2.147433	0.384406	6.32	357.6622	123.9927	3.7264	68 Mar. 5	117*	1984	Forri
	1969 VIII P/Comas Solá	69 Oct. 29.0635	1.768763	0.576924	8.35	40.0649	62.7516	13.4448	70 Oct. 26	50*	1960	Forri
	1970 XI P/Kopff	70 Oct. 2.3227	1.566997	0.546109	6.41	162.7619	120.3838	4.7243	70 Oct. 21	58*	1963	Yeomans
	1970 XIV P/Whipple	70 Oct. 9.4113	2.479507	0.351135	7.47	189.8153	188.3936	10.2355	70 Oct. 21	55*	1978	Nakano
	1971 III P/Aabrook-Jaakson	71 Mar. 13.4448	2.284576	0.399765	7.43	348.8286	2.1511	12.5267	71 Mar. 30	31	1948	Forri
(5)	1971 IX P/Shajn-Schaldach	71 Oct. 1.9362	2.227380	0.406303	7.27	213.1226	167.2662	6.1508	71 Oct. 16	37	1971	Milbourn
(6)	1971 IX P/Shajn-Schaldach	71 Oct. 1.9576	2.227380	0.406303	7.27	213.1226	167.2662	6.1508	71 Oct. 16	37	1971	Nakano
	1972 I P/Holmes	72 Jan. 30.8254	2.155173	0.413637	7.05	23.4369	327.4616	19.2180	72 Feb. 13	31	1964	Nakano
(7)	1972 VI P/Giacobini-Zimmer	72 Aug. 4.8844	0.994007	0.715091	6.52	171.9035	195.1308	20.5453	72 July 22	139*	1972	Nakano
	1972 XI P/Keenan-Kwee	72 Nov. 28.4418	2.228026	0.485226	9.01	131.2511	315.4062	8.9790	72 Nov. 19	*	1963	Forri
	1973 XI P/Gehrels 2	73 Dec. 1.6080	2.348446	0.409848	7.94	183.3337	215.6133	6.6705	73 Nov. 14	41	1982	Nakano
	1974 I P/Brocoks 2	74 Jan. 3.9930	1.840048	0.481199	6.88	198.1507	176.2387	5.5700	73 Dec. 24	34*	1960	Nakano
	1974 VIII P/Solmass.-Wach. 2	74 May 12.6329	1.316511	0.631529	6.76	352.6731	75.1165	30.2137	74 Apr. 23	40*	1960	Yeomans
(8)	1975 I P/Boethin	75 Jan. 5.6220	2.095603	0.385328	6.51	357.3138	125.9672	3.7269	74 Dec. 19	75	1966	Forri
(9)	1975 VII P/Sailorova-Cher.	75 Aug. 6.2340	3.567168	0.145378	8.53	90.1781	77.1079	6.6415	75 Aug. 16	97	1963	Nakano
	1976 X P/Ki omola	76 Aug. 10.1939	1.765578	0.641717	10.9	148.8816	181.5716	10.6401	76 Aug. 10	63	1963	Milbourn
(10)	1976 XV P/Solmass	76 Sept. 5.0658	1.205430	0.704247	6.23	57.2320	80.5688	11.8613	76 Sept. 19	44*	1959	Marsden
(11)	1977 I P/Taylor	77 Jan. 11.3953	1.950787	0.465529	6.97	355.5573	108.2108	20.5453	77 Jan. 17	45	1976	Nakano
	1977 V P/Konff	77 Mar. 7.9628	1.577030	0.545343	6.43	162.9146	120.3247	4.7247	77 Feb. 26	123*	1970	Yeomans
(12)	1977 VII P/Gehrels 3	77 Apr. 23.1959	3.423448	0.151899	8.11	231.4772	242.5497	1.1013	77 Apr. 7	34	1975	Nakano
	1977 VIII P/Gehrels 3	77 Apr. 23.2011	3.423446	0.151899	8.11	231.4773	242.5504	1.1012	77 Apr. 7	34	1975	Marsden
(2)	1978 IX P/Whipple	78 Mar. 27.3386	2.468636	0.382445	7.44	189.9747	188.3393	10.2461	78 Apr. 2	53*	1962	Nakano
	1978 IX P/Twehinhan 1	78 May 17.4565	1.493474	0.576112	6.65	22.7797	96.2033	10.5044	78 Apr. 12	22*	1963	Nakano
(3)	1978 XII P/Wild 2	78 June 15.8781	1.491078	0.576112	6.17	59.8776	136.1144	3.2752	78 June 21	139	1978	Yeomans
	1978 XIII P/Daniel	78 July 8.5320	1.661498	0.499979	7.09	10.8447	68.4983	20.1363	78 June 21	6	1964	Nakano
	1978 XIV P/Aabrook-Jaakson	78 Aug. 19.8795	2.284200	0.399858	7.43	349.0138	2.0396	12.5256	78 July 31	90*	1968	Forri
	1978 XV P/Comas Solá	78 Sept. 24.2232	1.895853	0.656818	8.94	42.8381	62.4257	6.6185	78 Sept. 19	99*	1960	Forri
	1978 XXIV P/Van Biesbroeck	78 Dec. 3.0236	2.369546	0.552516	12.4	134.2526	148.8781	6.6185	78 Nov. 28	99*	1979	Marsden
(5)	1979 I P/Shajn-Schaldach	79 Jan. 8.9405	2.223145	0.406751	7.25	213.2951	167.1949	6.1540	79 Jan. 7	37	1971	Milbourn
(13)	1979 II P/Shajn-Schaldach	79 Jan. 8.9655	2.223151	0.406750	7.25	213.3039	167.1936	6.1538	79 Jan. 7	37	1971	Nakano
(6)	1979 III P/Kowal 2	79 Jan. 13.7913	1.520840	0.563609	6.51	189.4149	247.1649	15.8047	79 Jan. 7	14	79 Jan. 27	Nakano
(4)	1979 IV P/Giacobini-Zimmer	79 Feb. 17.7738	0.996045	0.714658	7.02	171.9735	195.0901	31.6999	79 Feb. 16	139*	1972	Nakano
	1979 V P/Holmes	79 Feb. 22.6678	2.160005	0.413115	6.56	23.6012	327.3895	19.2046	79 Feb. 16	31	1964	Nakano
	1980 IX P/Brocoks 2	80 Nov. 23.8664	1.849689	0.489794	6.90	198.2237	176.2325	5.5462	80 Nov. 17	34*	1960	Yeomans
	1980 X P/Stephan-Oterma	80 Dec. 5.1658	1.574354	0.859981	37.7	358.1611	78.5120	17.9811	80 Nov. 17	264*	1967	Yeomans
	1981 IV P/Solmass.-Wach. 2	81 Feb. 20.0091	1.319275	0.631485	6.77	352.7702	75.0387	30.2008	81 Feb. 5	40*	1960	Yeomans
	1981 VI P/Solmass.-Wach. 2	81 Mar. 16.9571	2.135024	0.386703	6.50	357.4636	125.8336	3.7293	81 Mar. 17	117*	1954	Forri
(7)	1981 XVII P/Gehrels 2	81 Nov. 18.8208	2.361635	0.408805	7.98	183.4656	215.5342	6.6626	81 Nov. 12	41	1973	Nakano



Ref.	Comet	T	q	e	P	$\omega$	$\Omega$	i	Epoch	Obs.	Arc	Author
(14)	1981 XX P/Kearns-Kwee	81 Nov. 30.4241	2.223383	0.485504	8.98	131.3822	315.2616	8.9860	81 Nov. 12	*	1963	Forti
(15)	1982 I P/Russell 1	82 Mar. 12.2934	3.363943	1.057313		134.8888	114.0539	1.6649	82 Mar. 12	161	84 July 26	Nakano
(16)	1982 IX P/Russell 3	82 Mar. 12.2934	3.363943	1.057309		134.8901	114.0527	1.6648	82 Mar. 12	97	84 Oct. 19	Marsden
(17)	1983 III P/Kowal-Yavrova	82 Nov. 23.2419	2.510292	0.344571	7.50	353.4538	248.0011	14.0978	82 Nov. 7	30	83 Oct. 31	Nakano
(18)	1983 VI IRAS	83 Apr. 2.4203	2.608863	0.588167	15.9	19.4967	201.8472	4.3176	83 Apr. 16	12	83 May 8	Nakano
(19)	1983 XI P/Tempel 1	83 May 2.7005	2.417904	0.990401	5.49	265.5768	171.0511	138.8440	83 Apr. 16	10	83 July 14	Marsden
(20)	1983 XII Cernis	83 July 9.7975	1.491118	0.520898	5.49	179.0413	10.53289	10.53289	83 July 5	242*	84 Mar. 7	Landgraf
(21)	1983 XIII P/Kopf	83 July 21.2161	3.317868	1.001868	6.44	162.2182	208.8836	134.7038	83 July 5	127	84 Aug. 27	Nakano
(22)	1983 XIV Shoemaker	83 Aug. 10.2998	1.576316	0.544524	6.44	186.8198	120.2997	4.7246	83 Aug. 14	153	84 Aug. 27	Yocumans
(23)	1983 XV IRAS	83 Nov. 23.8034	3.344848	1.000038		176.0391	163.9842	137.6036	83 Dec. 12	76	84 Sept. 7	Nakano
(24)	1983 XVI IRAS	83 Nov. 27.9936	2.254782	1.000196		333.9794	200.5608	120.7432	83 Dec. 12	14	84 Aug. 4	Marsden
(25)	1983 XVII IRAS	83 Nov. 28.0006	2.254776	1.000196		333.9819	200.5608	120.7432	83 Dec. 12	14	84 Aug. 4	Marsden
(26)	1983 XIX P/Broadfield	83 Dec. 27.7921	1.357447	0.932190	151	219.1602	356.1597	51.7944	83 Dec. 12	32	84 Jan. 9	Nakano
(27)	1983 XIX P/Broadfield	83 Dec. 27.7921	1.357455	0.932214	151	219.1607	356.1597	51.7944	83 Dec. 12	32	84 Jan. 9	Nakano
(28)	1984 I P/Russell 4	84 Jan. 5.9679	2.152009	0.383241	6.40	91.2519	71.8880	6.2476	84 Jan. 21	49	84 May 30	Marsden
(29)	1984 I P/Russell 4	84 Jan. 5.9679	2.152009	0.383241	6.40	91.2519	71.8880	6.2476	84 Jan. 21	49	84 May 30	Marsden
(30)	1984 I P/Russell 4	84 Jan. 5.9679	2.152009	0.383241	6.40	91.2519	71.8880	6.2476	84 Jan. 21	49	84 May 30	Marsden
(31)	1984 I P/Russell 4	84 Jan. 5.9679	2.152009	0.383241	6.40	91.2519	71.8880	6.2476	84 Jan. 21	49	84 May 30	Marsden
(32)	1984 I P/Russell 4	84 Jan. 5.9679	2.152009	0.383241	6.40	91.2519	71.8880	6.2476	84 Jan. 21	49	84 May 30	Marsden
(33)	1984 I P/Russell 4	84 Jan. 5.9679	2.152009	0.383241	6.40	91.2519	71.8880	6.2476	84 Jan. 21	49	84 May 30	Marsden
(34)	1984 I P/Russell 4	84 Jan. 5.9679	2.152009	0.383241	6.40	91.2519	71.8880	6.2476	84 Jan. 21	49	84 May 30	Marsden
(35)	1984 I P/Russell 4	84 Jan. 5.9679	2.152009	0.383241	6.40	91.2519	71.8880	6.2476	84 Jan. 21	49	84 May 30	Marsden
(36)	1984 I P/Russell 4	84 Jan. 5.9679	2.152009	0.383241	6.40	91.2519	71.8880	6.2476	84 Jan. 21	49	84 May 30	Marsden
(37)	1984 I P/Russell 4	84 Jan. 5.9679	2.152009	0.383241	6.40	91.2519	71.8880	6.2476	84 Jan. 21	49	84 May 30	Marsden
(38)	1984 I P/Russell 4	84 Jan. 5.9679	2.152009	0.383241	6.40	91.2519	71.8880	6.2476	84 Jan. 21	49	84 May 30	Marsden
(39)	1984 I P/Russell 4	84 Jan. 5.9679	2.152009	0.383241	6.40	91.2519	71.8880	6.2476	84 Jan. 21	49	84 May 30	Marsden
(40)	1984 I P/Russell 4	84 Jan. 5.9679	2.152009	0.383241	6.40	91.2519	71.8880	6.2476	84 Jan. 21	49	84 May 30	Marsden