

Comets in 1974

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Cometary research in 1974 was dominated by the widely-heralded comet 1973 f (Kohoutek), but significant observations were also made of the much less publicized comet 1974 b (Bradfield), which became comparably bright some two to three months later. The discoveries of five new comets (including comet Bradfield) were announced during the year, one of these comets having by far the largest perihelion distance on record and another providing a rather well documented case of a comet that completely faded out; a single image of a sixth comet was subsequently located, and this same comet was accidentally rediscovered in 1975. The recoveries of four short-period comets were reported, and again, images of a fifth were identified early in 1975, long after the plates had been taken. Observations were also made of 11 of the comets of 1972 and 1973 (including comet Kohoutek) and the three 'annual' comets. Altogether, therefore, the number of comets under observation was 23 – or 25 if the late discovery and recovery are included.

P/Schwassmann–Wachmann 1 seems to have been particularly active during 1974, and at least three outbursts were recorded, the comet attaining total mag 13 or brighter during two of them. Although its orbital eccentricity is very small, this comet did in fact pass through perihelion in February, and the current perihelion distance of 5.45 AU represents the closest approach of P/Schwassmann–Wachmann 1 to the Sun within at least several centuries of the present time. It remained at almost exactly 1.00 AU from Jupiter during the entire year, and the resulting perturbations are causing the comet's orbit to become even more nearly circular: at the next aphelion passage in 1982 the heliocentric distance will be 6.3 AU, while the distance at perihelion in 1989 will be 5.8 AU. P/Schwassmann–Wachmann 1 was already active when recorded by E. Roemer with the Steward Observatory's 229-cm *f*/9 reflector on June 16, the essentially stellar nucleus of magnitude about 18.4 being at the apex of an asymmetric coma 0.2 arcmin across and brightest in the southern sector. A month later C.Y. Shao and G. Schwartz, observing with the 155-cm *f*/5 reflector at the Agassiz Station of the Harvard

It is hoped that it will be possible during 1978 to publish all outstanding reports on comets – Ed.

College Observatory, estimated the total magnitude as 15 and noted a condensed nucleus, of mag 16.0 on July 20 and 16.8 on the following night, in a uniformly bright circular coma 25 arcsec or more across. Observations by R.E. McCrosky, J.H. Bulger and Shao at the Agassiz Station during August 11–22 and by A. Mrkos and Růžena Petrovičová at the Kleť Observatory during August 12–16 were consistent in putting the comet at mag 17.5–18.0, closer to its normal brightness. On September 11, however, Petrovičová found the comet to have brightened to mag 12, there being a bright condensation in a coma about 2 arcmin in diameter. On the 16th Roemer, using the 154-cm $f/13.5$ reflector at the Lunar and Planetary Laboratory's Catalina Station, noted a very sharply condensed nucleus of mag 17.0 with the barest trace of coma in pa 150° . The Kleť observers were then describing the comet as a magnitude or so fainter than on the 11th, although on September 21 and 23 K. Tsuchiya (Asahigawa, Japan), using both an 11-cm camera and a 20-cm reflector, reported that the comet was as bright as mag 10.5–11.0; this same observer, and also T. Seki (Geisei, Japan), who used a 22-cm $f/5$ camera, agreed that the magnitude was some 12.5–13.0 during October 5–7, and Seki noted fading by perhaps as much as two magnitudes by the 13th. According to Mrkos and Petrovičová the comet again brightened from mag 17.2 on November 9 to 12.8 on the 13th (and 12.5 on the 14th); it had faded slightly by the 17th, and when next observed, on December 14, it was down to mag 17.0.

P/Encke was detected visually on April 11 by J.E. Bortle (Stormville, New York) with his 32-cm reflector (88 $\times$); it was an extremely difficult object, low in the evening twilight, very small and only slightly condensed, of total mag 9.0. The comet steadily brightened to mag 8.2 on the 20th, at which time it appeared to be quite condensed, and there were suggestions of extensions both towards and away from the Sun (near pa 40 and 220°). This elongation of the coma was also noticeable on April 26 (in pa 65 and 245°); the condensation was located in the sunward half, and the total magnitude was then about 8.0. Bortle's final observation, which put the comet at total mag 7.7, was made on April 27.0, slightly less than 2.0 day before the comet's perihelion passage. This was the closest that P/Encke had been observed to the Sun since 1848, when G.P. Bond made an accurate micrometric measurement with the Harvard Observatory's 38-cm refractor only 0.13 day before perihelion; the only other known observations within 2 day of perihelion were in 1842 and 1805. Pre-perihelion visual observations in 1974 were also reported by T. Igawa (Tottori, Japan, 8-cm reflector) on April 19 (mag 8.0) and 21 (mag 7.5). Infrared observations by E.P. Ney and J. Stoddart of the University of Minnesota gave the magnitude at λ 35 000 (using a diaphragm of 20 arcsec) as 5.9 on April 16 and 5.3 on April 25, while at λ 85 000 the magnitude on the latter date was 1.2. After perihelion, P/Encke was picked up on May 20 by D. Seargent (The Entrance, New South Wales), who estimated the magnitude in 20 $\times$ 65 binoculars to be 8.5. On May 25 A.F. Jones (Nelson, New Zealand) judged the magnitude to be 8.3 (8-cm refractor), and on May 28 J.C. Bennett (Pretoria, South Africa) obtained mag 8.7 (12-cm refractor, 21 $\times$). A photograph by R.R.D. Austin with the 25-cm $f/7$ astrograph at Mount John University Observatory on May 30

showed a well-condensed coma of mag 8.8, and Jones noted fading visually from mag 8.8 on June 1 and 2 to 12.3 on June 17 and 12.5 on the 19th (the last two observations being made with a 32-cm reflector). The comet was also recorded on a 60-min exposure by A.C.Gilmore with the 41-cm Cassegrain reflector at the Carter Observatory, Wellington, through passing cloud on July 20, and the only reported later observations were by Roemer on a pair of 60-min exposures with the 229-cm reflector on September 12, at which time the nuclear magnitude was about 21.0.

P/Gunn was photographed by the Agassiz observers on four nights from January to March, the magnitude on February 14 being about 18.7. Observations were also made with the Steward reflector on three occasions between February 25 and May 25, during which time the well-condensed comet brightened from about mag 19.4 to 18.8. The comet was noticeably brighter when it was picked up in December after conjunction, Seki then estimating the magnitude as 17 on plates exposed with a 40-cm $f/5$ reflector. In spite of poor seeing, the comet appeared to be fairly well condensed, of magnitude near 18.0, on an exposure with the Catalina reflector on December 16, and the comet was also recorded with the Agassiz telescope on the 23rd.

1972 IX (= 1972 h), Sandage, was recorded by Roemer with the Kitt Peak instrument on June 17 as a sharply condensed nucleus of magnitude about 21.0 at the centre of a large semicircular coma extending 15 to 18 arcsec to the south and east. On September 12 the nucleus was again of mag 21.0 and the semicircular coma, by then some 25 arcsec in radius, was brightest in a 90° sector centred near $pa\ 90^\circ$. This large coma was also noted at Agassiz on October 19 and again at Kitt Peak on November 10; on the latter occasion, when the comet had receded to a heliocentric distance of 7.1 AU, the nuclear magnitude was about 20.5 and the radius of the coma some 20 arcsec.

OBSERVATIONS 1972 JUNE 9 TO 1974 NOVEMBER 10

1972 j, Kojima, was recorded with the 229-cm reflector on May 25, the nearly stellar images of the comet being of mag 19.3, rather brighter than expected. A single exposure on June 15 through clouds showed the comet to have faded by perhaps 0.3 mag. The comet had also been recorded at the Agassiz Station the previous day, and an exposure there by Shao on August 21 showed a faint, but measurable image of mag 20.0–20.5. Comet Kojima was then 6.0 AU from the Sun.

OBSERVATIONS 1972 OCTOBER 31 TO 1974 AUGUST 21

1972 XII (= 1972 l), Araya, was under observation in January by C.Torres with the Maksutov astrograph at the Cerro El Roble Station of the University of Chile, and the same observer picked up the comet again in April after conjunction. Astrometric positions were reported by B.Blanco and A.Gomez with the 61-cm Curtis Schmidt telescope at Cerro Tololo Interamerican Observatory on June 20 and 21 and by Gilmore and Pamela M.Kilmartin with the Carter Observatory's 41-cm reflector on September 12

and October 13. The comet was accidentally recorded in August on exposures obtained in the course of the Southern Sky Survey with the SRC 122-cm Schmidt telescope at Siding Spring. A 32-min exposure in September with the 10-cm astrograph at the Carter Observatory showed the comet at total mag 15. On October 13, when the heliocentric distance was almost 7.0 AU, the nuclear magnitude was 18.5–19.0.

OBSERVATIONS 1972 NOVEMBER 15 TO 1974 OCTOBER 13

1972 VIII (= 1973 a), Heck–Sause, was photographed on January 13 by T. Furuta (Tokai, Japan, 31-cm reflector), the magnitude being about 18. The comet was recorded by Roemer with the Steward reflector on the 19th, and by the discoverers and others with the CNRS-Liège Schmidt telescope at Haute Provence on the 21st, at which time the magnitude was given as 19. Comet Heck–Sause was still unexpectedly bright in February, a 60-min exposure by McCrosky and Schwartz showing a short tail. A similar exposure by Roemer at Kitt Peak on February 26 revealed a fairly well condensed image of magnitude about 19.6; the comet was then 5.6 AU from the Sun.

OBSERVATIONS 1973 JANUARY 4 TO 1974 FEBRUARY 26

1973 f, Kohoutek, the ‘comet of the century’, was very widely observed indeed as soon as it was conveniently placed in the western sky on the first evenings of the new year. Some 15 to 20 observers in Japan agreed that the comet’s total magnitude was between 0 and 1 on January 2. Forty-eight hours later a large number of observers using small instruments made the magnitude close to 3.0. By January 9, when the Moon was out of the way, there had been a further drop of about half a magnitude. One week later the magnitude was close to 5.0, a week after that almost 6.0, and at the end of January about 7.0. Many astronomers (and others) have complained that some of the predictions for the brightness of this comet were far too optimistic. It is, of course, unfortunate that one of the predictions had been grossly exaggerated by the press, but the comet did in fact turn out in January to be significantly fainter than *any* of the predictions. The point is simply that there was a difference of some 1.5 mag between the comet’s pre-perihelion and post-perihelion performance at identical heliocentric distances, and there was no way of predicting that; further details on this subject have been given in *Hermes*, **21**, 123 (1974).

Comet 1973 f attracted the interest of hundreds of professional scientists, and important observations of many kinds were being made throughout the month of January, from the ground and from space, and at all wavelengths. It would be pointless to try to mention all these contributions here, and the reader is referred instead to the special issue of *Icarus*, **23**, No. 4 (1974). Among the highlights, we mention that in mid-January the observers at the Joint Observatory for Cometary Research (Socorro, New Mexico) traced the tail out to almost 25° on plates taken with the 37-cm *f*/2 Schmidt telescope, and that the antitail mentioned in the 1973 report persisted throughout the month. Harvard–Smithsonian astronomers added CH to the list of cometary molecules observed at radio wavelengths. A rocket experiment conducted by C. Opal and G. Carruthers (Naval Research Laboratory)

on January 8 showed that the La hydrogen cloud was detectable over a region 10 by 8° , and emissions of O at $\lambda 1304$ and C at $\lambda 1557$ (the latter being some four times stronger than the former) were also recognized.

The antitail persisted during February, and as was pointed out by R.L. Waterfield (Woolston, Somerset), the brightness in relation to the main tail became much greater than previously. On February 13 a photograph with his 15-cm $f/4.5$ Cooke triplet showed the antitail extending 15 arcmin in pa 270° , whereas the main tail, almost twice as intense as the antitail, could be traced out to 4° in pa 65° . Four nights earlier the antitail, and indeed a nebulous cloud covering the whole northern sector, were noted visually by G.E.D. Alcock (Peterborough, Northamptonshire, 25×105 binoculars). On February 19, 24 and 25 the antitail was also noted visually by Bortle, who described it (on the 24th and using 20×120 binoculars) as a bright, narrow ray 45 arcmin long in pa 283° ; a faint fan of light, at least 20 arcmin in radius, extended thence through north to pa 50° , with a brightening near pa 40° indicating the presence of the normal tail. Some hours later Waterfield also remarked that the antitail was considerably brighter than the main tail. According to Bortle, the comet's total magnitude faded from 7.4 on February 12 to 7.9 on the 19th and 8.4 on the 24th and 25th (10×50 binoculars).

Further estimates by Bortle (20×120 binoculars) showed fading from mag 9.0 on March 11 to about 10.0 on the 22nd. There was still a suggestion of the antitail on the first date, but this feature was not recorded photographically by Waterfield one week later, and there was then only a suggestion of the main tail. On March 21 the latter observer commented on the striking contrast between the comet's appearance then and one year earlier, the compact, almost stellar object of the days immediately following discovery having become a large, very faint and excessively diffuse circular cloud. The only successful observations in April were made on the 26th, when a 10 and a 20-min exposure with the Steward reflector showed the comet at nuclear magnitude near 18.0, fainter than it had been at considerably greater distances before perihelion passage. Attempts were made by McCrosky *et al.* and by Roemer to photograph the comet in October and November after conjunction; a possible image, of magnitude near 22.0, on a 90-min exposure with the Steward reflector on November 10 will have to be confirmed by accurate measurement.

OBSERVATIONS 1973 JANUARY 28 TO 1974 NOVEMBER 10 (?)

1973 g, P/Reinmuth 2, emerging into morning twilight around the time of its perihelion passage in May, was picked up by Bulger and Shao on August 20–21. A pair of 30-min exposures with the Steward reflector on September 11 showed a sharp condensation of magnitude about 19.2 embedded in an asymmetric coma extending some 0.1 arcmin north of west. Tsuchiya gave the total magnitude as 16 on September 23, and Seki suggested that the comet was even slightly brighter on October 13. On October 21 Roemer noted a near-stellar condensation of magnitude about 18.0 embedded in a trace of coma, while exposures with the Catalina instrument on November 16 yielded sharply condensed images of magnitude about 18.4.

In mid-November Seki estimated the comet's total magnitude as 15. The comet was also under observation with the Agassiz and Catalina reflectors in mid-December, the Catalina exposures on the 17th showing a sharp condensation of mag 19.0–19.2 in a trace of coma.

OBSERVATIONS 1973 APRIL 26 TO END OF 1974, CONTINUING

1973 k, Sandage, was reported by Seki at total mag 17 on several occasions during January, and observations were also made that month by Roemer (154-cm reflector) and by Shao and McCrosky. Very weak, but sharply condensed images of magnitude about 19.5 appeared on a pair of 10-min exposures with the Steward reflector on March 22, and a longer exposure was stopped by clouds after 54 min on April 26. Observations by K. Tomita (Tokyo Astronomical Observatory) put the comet still at mag 17 on April 27 (Dodaira Station, 91-cm reflector) and at mag 18 on May 24, 25 and 27 (Okayama Station, 188-cm reflector). Pairs of 60-min exposures obtained by Roemer with the 229-cm reflector on May 25 and June 16 showed the typical head and tail structure of comets of large perihelion distance; on the latter occasion there was a nucleus of magnitude about 20.0 and a tail some 1.5–2.0 arcmin long in pa 105 to 110°. After conjunction, a single 60-min exposure on December 20 showed the comet at the same brightness, and a trace of coma was still present.

OBSERVATIONS 1973 JULY 4 TO END OF 1974, CONTINUING

1973 l, P/Schwassmann–Wachmann 2, at perihelion in September, was picked up in the morning sky by Roemer on November 16. Of magnitude about 16.5, the comet was fairly well condensed in mediocre seeing, and there was a trace of coma north of west. Better seeing on December 17 yielded well-condensed images of magnitude about 16.8, again with a trace of coma. The comet was accidentally recorded by A.R. Sandage on plates taken with the 122-cm Schmidt telescope at Palomar on December 18 and 19; it was of magnitude about 16 and had a short tail.

OBSERVATIONS 1973 AUGUST 5 TO END OF 1974, CONTINUING

1973 m, P/Borrelly, at perihelion in May and too close to the Sun for observation during much of the year, was photographed by McCrosky on November 10. The 30-min Kodak IIIa-J exposure revealed a tail about 2 arcmin long. On December 17 a 90-min 103a-O exposure by Roemer showed a quite sharp condensation of magnitude about 18.8 and a trace of a narrow, slightly curved tail extending 0.3 arcmin in pa 325°. The comet was also recorded by Schwartz on the 23rd and followed into 1975.

OBSERVATIONS 1973 AUGUST 23 TO END OF 1974, CONTINUING

1973 n, P/Gehrels 2, was under observation with the Harvard and Steward reflectors in January and February, a 60-min exposure with the latter telescope on February 25 showing the comet at about mag 19.0 with a trace of a fan-shaped tail to the northeast. After conjunction the comet failed to record on a 57-min exposure by Shao on November 16, but very weak

images (of magnitude very approximately 21.5) were found on two 90-min exposures by Roemer on December 20.

OBSERVATIONS 1973 SEPTEMBER 28 TO END OF 1974, CONTINUING

1973 o, Gibson, which remained south of declination -50° , was observed by the discoverer with the 51-cm double astrograph at the Yale-Columbia Southern Station on January 3 and 13, although on the former occasion the seeing was bad and the comet's image weak in the moonlight. Z.M.Pereyra, observing with the 154-cm reflector at Bosque Alegre, gave the magnitude as 16.0 during January 15-17. The comet was also recorded by Gilmore with the Wellington reflector on January 22 and 25, a very faint, narrow tail, about 1 arcmin long in pa 50° , being suspected on the latter date. Gibson obtained a final pair of simultaneous blue and yellow exposures on January 29, the blue image being stellar and the visual one quite diffuse. A possible image, a very faint, diffuse spot more than 20 arcmin across, appeared on a 60-min exposure by Gilmore through variable cirrus on July 26. The result of an attempt by Torres to photograph the comet at Cerro El Roble in October, when the comet would have been little more than 1° from the south celestial pole, is still unclear.

OBSERVATIONS 1973 NOVEMBER 24 TO 1974 OCTOBER 11 (?)

1974 a was periodic comet Forbes, recovered by Roemer and L.M.Vaughn with the 229-cm reflector on January 19.5. The comet was rather well condensed, of magnitude about 19.5. Further observations were made with the same telescope on February 25 and March 22, and by April 20 the comet had brightened to magnitude about 16.0 (Catalina). The comet was also photographed in late April and early May by Torres and S.Barros at Cerro El Roble and by Seki at Geisei, the former observers noting a 2 arcmin tail and the latter that the total brightness had increased to mag 13. On June 14 J.A.Bruwer estimated the magnitude as 13.3 on plates taken with the Franklin-Adams camera at the South African Astronomical Observatory's outstation in Hartbeespoort. On July 17, 19 and 22 Bortle detected the comet visually with his 32-cm reflector, noting an uncondensed circular coma, of total mag 12.6 and diameter 1.0-1.5 arcmin. The comet had faded by some 0.3 mag in mid-August, and a plate taken by G.H.Rutter at Woolston on the 17th showed a nearly stellar condensation of mag 15.5 and a very faint, diffuse, highly elongated coma or fan-tail extending for 6 arcmin in pa 260° . A sharp condensation of magnitude about 16.2 and a trace of coma were recorded on plates taken by Roemer with the Steward reflector on September 11, and on the 15th Seki was still describing the total magnitude as 15. Seki gave the magnitude as 16 on October 8, 16.5 on October 13, and other observations were made in September and October at the Agassiz Station and by L.I. and N.S.Chernykh with the 40-cm astrograph at the Crimean Astrophysical Observatory. Very weak images of magnitude about 20.2 were recorded by Roemer on 60-min exposures with the Catalina telescope on November 17.

OBSERVATIONS 1974 JANUARY 19 TO NOVEMBER 17

1974 b, a new comet discovered on February 12.5 by William A. Bradfield at Dernancourt, near Adelaide, became about as spectacular and conveniently observable an object as 1973 f turned out to be. The fact that comet 1974 b was discovered a mere month, rather than nine months, before perihelion caused this comet to be virtually ignored by the press, but it also resulted in far less attention from professional scientists; in particular, no observations could be made from space.

Bradfield's discovery, when the comet was a ninth-magnitude, uncondensed object moving east-northeastwards in Sculptor, was made with a 15.2-cm refractor ($26\times$) 306 search-hours after his discovery of comet 1972 III. This was in fact the first visual discovery of a comet anywhere since 1972 III had been found just 23 months previously. The first orbit of comet 1974 b was calculated at the Perth Observatory by M.P. Candy from observations made there by D. Gans during February 14–16. A long exposure by Candy on the 14th showed a faint tail 5 arcmin long, and the comet's total magnitude was then estimated visually by T.B. Tregaskis (Mount Eliza, near Melbourne, 15-cm reflector, $64\times$) to be 8.5. A blue exposure by N. Irvine on February 25 with the Curtis Schmidt telescope showed a type I tail that was already 2° long, although an exposure the night before on red emulsion indicated that any type II tail was poorly defined and no more than 15 arcmin long. Other early astrometric observations were made by D. Herald in Canberra, using a 31-cm reflector, and by Torres at the Cerro Calán Observatory.

The first observation of the comet from the northern hemisphere seems to have been made – at very low altitude – by K. Simmons and M. Rogers at Switzerland, Florida, on March 9, at which time the magnitude was judged to be 7.2. Six nights later, Bortle estimated that the comet had brightened to about mag 5.0 (15×80 binoculars), and a large number of observers agreed that the comet's total brightness became somewhat greater than mag 4.5 during the last ten days or so of the month. On March 22 a gas tail more than 9° long (in pa 90°) and a dust tail more than 3° long (in pa 120°) were photographed at the Joint Observatory for Cometary Research. Bortle noted a $4^\circ.3$ tail visually on March 26 (in pa 82°), and on the 30th Alcock remarked on a nebulous cloud extending around to the south and a double antitail directed to the west of south. Infrared observations at the University of Minnesota in late March showed that the comet was very similar to comet 1973 f at comparable heliocentric distances.

At the Joint Observatory an 8° gas tail could still be recorded on April 9, at which time the comet's total magnitude was still about 5, although on the 14th, when the comet was perhaps a magnitude fainter, only a $1^\circ.5$ gas tail was photographed. A few hours earlier a long exposure by P.B. Monk at Woolston showed a broad, fan-shaped tail contained between a straight, bright streamer $1^\circ.7$ long in pa 22° and a more diffuse curved streamer about 1° long in pa 85° . By the end of April the comet had faded to total magnitude about 8.

Spectroscopic observations (in the range $\lambda\lambda$ 5000–8800) by P.A. Wehinger and S. Wyckoff at the Wise Observatory in late March showed several of the H_2O^+ bands previously identified in the spectrum of the tail of comet 1973 f.

The relative intensities in the two comets were somewhat similar. The spectrum of the coma of comet 1974 b showed C_2 , CN and NH_2 , superimposed on a strong continuum. W.M.Jackson, T.Clark and B.Donn, using the NEROC 36.6-m radio telescope in early May, succeeded in detecting the 22.93-GHz line of neutral H_2O .

On May 15, when comet Bradfield was little more than $\frac{1}{2}^\circ$ from the north celestial pole, Bortle judged the magnitude to be 8.2 (10×50 binoculars), and on the 24th he made it 9.0. The following night Roemer, observing with the 229-cm reflector, estimated the nuclear magnitude as not fainter than mag 16.5. The comet was tadpole-shaped, the head sharply condensed, and there was a narrow tail with a tendency towards a central spine extending 2.5 arcmin in pa 170° . Roemer noted a sharply condensed nucleus of mag 16.1 on June 17, around which time Bortle was estimating the total magnitude as 10.7–10.8 (32-cm reflector). A month later the comet was down to mag 12.4 (Bortle), and a plate taken at Woolston by R.H.S.South showed a moderately condensed inner coma 20 arcsec in diameter and a very diffuse, faint outer coma of 2.0 arcmin. The comet was last suspected by Bortle on August 16, the total magnitude then 12.8, and the comet was also seen and photographed the same night by Roemer (Catalina) as a sharp condensation of magnitude about 19.2. A plate taken some hours later by Rutter showed the very faint image of mag 15.0 to be only moderately condensed. On September 11 (Steward telescope) Roemer gave the nuclear magnitude as 18.8, with a trace of a fan-shaped tail 0.2 arcmin long to the northeast, and on the 15th McCrosky judged the total magnitude to be 17.5. Two further observations were made by the Agassiz observers, on October 12 and November 18.

OBSERVATIONS 1974 FEBRUARY 12 TO NOVEMBER 18

1974 c was discovered on March 22.0 by Miklós Lovas in the course of the supernova-patrol programme conducted with the 60-cm $f/3$ Schmidt telescope at the Budapest Observatory. A condensed object of mag 13, the new comet was located about 2° northeast of γ Virginis and moving very slightly south of westwards at about 10 arcmin per day. Orbital computations from the early observations by Shao and McCrosky, Seki, Gilmore, Monk, the discoverer and H.L.Giclas (Lowell Observatory) indicated that the comet was then 5.6 AU from the Sun and that it would move in to a distance of 3.0 AU at perihelion in 1975 August. Shao estimated the total magnitude as 14 on exposures with the 41-cm Metcalf astrograph at Agassiz on March 26 and remarked on the strong condensation, of mag 14.5–15.0, on exposures with the 155-cm reflector two nights later; on the other hand, 10-min exposures by Roemer with the long-focus Catalina reflector on April 20 suggested that the nuclear magnitude was something like 17.0. The Agassiz observers agreed that the nuclear magnitude was near 17 on May 15, and a faint, broad tail 10–15 arcsec long could be detected near pa 40° . Although the comet should have been brightening slightly, there were strong indications that the total brightness was also diminishing during the weeks after discovery. On April 14 the Woolston observers noted a 15 arcsec inner coma and a 30 arcsec outer coma, the total magnitude being about 16.1; the appearance was somewhat similar on May 17, the comet then being perhaps

0.3 mag fainter. Thirty-minute exposures of the comet were made with the Catalina reflector on May 21 and June 20, the comet being of magnitude about 17.6 on the latter date. The comet was also observed in late May and early June by Tomita (Okayama reflector), Giclas and Bulger.

OBSERVATIONS 1974 MARCH 21 TO JUNE 20, CONTINUING

1974 d, periodic comet Finlay, was recovered by Seki on June 24.8, although the recovery was not announced until a confirmatory observation could be obtained some $3\frac{1}{2}$ weeks later; the comet was diffuse, but condensed, of mag 15–16 on June 24, 13–14 on July 18 and 14 on July 19. The total magnitude was also estimated as 14 on a 5-min exposure by McCrosky on July 20. Fading was evidently then quite rapid, for a 40-min exposure on August 16 by Roemer with the 154-cm reflector failed to reveal the comet. However, a comparable exposure with the 229-cm reflector on September 12 yielded a well-condensed nucleus of magnitude about 19.8 embedded in an ill-defined coma some 0.2 arcmin in diameter, and the comet was under observation by both Roemer and McCrosky in November. On December 19, in spite of poor seeing, Roemer found the comet to be nearly stellar in appearance, of magnitude about 20.3, with a possible trace of coma to the west.

OBSERVATIONS 1974 JUNE 24 TO END OF YEAR, CONTINUING

1974 e was discovered by Carlos U.Cesco and his son Mario R.Cesco on July 26.2 with the 51-cm double astrograph at the Felix Aguilar Observatory's station in El Leoncito, Argentina (formerly the Yale–Columbia Southern Station). Not long past opposition and retrograding in Sagittarius, the comet was found on an exposure for the minor planet 1973 EE; it was of mag 14, with condensation but no tail. The discoverers were able to obtain accurate positions on July 27 and 28, but because the comet was then near its maximum southern declination extrapolation of the motion was unreliable, and the comet failed to appear on the small-field plate exposed at the Carter Observatory on August 2. Further accurate positions were obtained by the discoverers on August 7 and 8, however, and it was then possible to establish that the comet had passed perihelion at a distance of 1.4 AU in May, and that since its orbital inclination was almost 180° , its elongation from the Sun would decrease very rapidly. The discoverers followed the comet until mid-September, and the only other observations made of this comet seem to have been those by Torres and Barros at Cerro El Roble, where the comet was last observed on October 8.

OBSERVATIONS 1974 JULY 26 TO OCTOBER 8

1974 f was periodic comet Honda–Mrkos–Pajdušáková, recovered by Roemer and Vaughn with the Steward reflector on November 10.1. In the poor seeing the comet appeared as a small spot, of magnitude near 19.0. An attempt to record the comet on a 30-min exposure at the Agassiz Station a few hours earlier seems to have been unsuccessful, but a satisfactory image was subsequently identified on a 15-min exposure obtained the next night,

after word of the recovery had been received. At recovery P/Honda-Mrkos-Pajdušáková was 1.05 AU from the Sun (a record for pre-perihelion observations of this comet), and as is characteristic at favourable returns of this comet, the brightness increased dramatically as the heliocentric distance diminished to its minimum of less than 0.6 AU on December 28. The comet was fairly well condensed and had brightened to magnitude about 18.2 on a single exposure with the Catalina reflector on November 17, and on December 3 Seki estimated the magnitude visually to be 10.5 (40-cm reflector, $57\times$). Some 18 hr later Bortle judged the magnitude to be 10.4 (32-cm reflector), while on December 9 the magnitude was 9.9 and there was some suggestion of a small condensation. Observations by D.Green (Boone, North Carolina, 20-cm reflector) and C.Sherrod (North Little Rock, Arkansas, 15-cm refractor) were consistent in giving the magnitude as 9.2–9.3 during December 14–16, while on the 18th Bortle and Simmons each made the magnitude about 8.8–8.9. Moonlight interfered with observations on the following few nights, but during December 26–30 Bortle, Green and also B.Comsa (West Covina, California, 25-cm reflector) were generally agreed that the magnitude was around 8.3–8.6. On December 31.0 Bortle noted that the comet was as bright as mag 8.0, and even 7.8 in 15×80 binoculars; the coma diameter was estimated as 3.1 arcmin, and there was a suggestion of a very faint, short, narrow tail directed more or less due east. Astrometric observations were made in December by Seki, McCrosky, Mrkos and Petrovičová, Torres and T.Urata (Nohondaira Observatory).

OBSERVATIONS 1974 NOVEMBER 10 TO END OF YEAR, CONTINUING

1974 g was discovered by the Canadian astronomer Sidney van den Bergh on November 12.2 near M 33 in Triangulum. Of 17th mag, the comet was diffuse and uncondensed, about 8 arcsec across, and the 45-min exposure with the 122-cm Schmidt telescope at Palomar showed a tail perhaps 2.5 arcmin long in pa 308° . Shao and Schwartz estimated the nuclear magnitude on November 14 to be as bright as 18.5, and on the 16th Roemer judged the magnitude to be about 19.2. One problem with the observations around November 15–16 was that the comet was in front of the outer portions of M 33. The comet was also under observation by Seki and by Furuta in Japan, the former observer noting a decrease in total brightness from mag 17 during November 14–19 to 18 on December 3 and 16. The comet appeared to be as faint as mag 19.4 on exposures with the Catalina telescope on December 16, but observations with the Steward telescope on the 19th revealed a well-condensed nucleus of magnitude about 18.0 in a trace of coma. Comet van den Bergh was found to have passed perihelion in 1974 August at a distance of 6.0 AU (more than 1.0 AU larger than for any other long-period comet), and it was under observation again in late 1975.

OBSERVATIONS 1974 NOVEMBER 12 TO END OF YEAR, CONTINUING

1974 h, the second comet discovered by John C.Bennett, of Riviera, near Pretoria, was a diffuse, uncondensed object in Hydra, of magnitude about 9.0. Bennett, who found this comet on November 13.1 with a 12-cm short-focus refractor ($21\times$), had spent 482 hr searching for comets following his

discovery of the celebrated comet 1970 II. Since the new discovery came only a short while before dawn there was no possibility of detecting any motion during the half-hour available for observation, but observations the next morning by Bennett, J. Hers and R. Smith showed that the comet had moved some 40 arcmin almost due southwards. Bennett noted that the comet had brightened to mag 8.5 on the 14th and to 8.3 on the 15th, but on the 18th he was surprised to note that the comet was fainter than mag 10; he felt that the comet had experienced a sudden surge in brightness shortly before it was discovered. Although the comet was very low in the Japanese sky, Seki noted that the comet was already significantly fainter some 18 hr after Bennett's observation on November 15, and 48 hr or so after that Jones in New Zealand gave the magnitude as 10.6. On November 19 Seki judged the magnitude as 11.5 visually, and the photographic image was much less condensed and more difficult to measure than previously. Other astrometric observations were made in the northern hemisphere during November 14–19 by Giclas, K. Suzuki (Asuke, Japan) and K. Hestir (Joint Observatory for Cometary Research). In the southern hemisphere astrometric observations were made on November 14 and 15 by Hers (using a 20-cm Celestron reflector), by Gilmore, Kilmartin, B. M. Lewis and R. G. Gibb with the Carter Observatory's astrograph during November 17–25 and by Herald at Canberra on November 22 and 24. The Wellington plates, obtained on six different nights, are interesting in that while they did not indicate much change in the comet's total brightness, they show the comet becoming progressively larger and more diffuse.

Although comet Bennett was rapidly approaching the Earth and had initially been expected to brighten to about sixth magnitude, it instead became more and more difficult to observe. No trace of the comet appeared on an exposure by Austin at Mount John Observatory on November 26, and a visual search by Herald during the total lunar eclipse on November 29 indicated that the comet must certainly have been fainter than mag 12. A cursory examination of a 30-min exposure with the Curtis Schmidt telescope at Cerro Tololo on December 5 did not reveal the comet, which should then have been near declination -80° ; after that the comet would have moved rapidly northwards, and the failure of the comet to show on exposures with the Wellington reflector on December 12 and 15 and on a 20-min exposure with the Catalina reflector on December 16 suggests that there was no condensed feature at the expected position brighter than mag 18. Torres subsequently reported that faint nebulous images, some 5 by 15 arcmin in extent, with the longest axis directed northwest and southeast, appeared near the expected position of the comet on plates taken on December 8, 9 and 10 by J. Parra and himself with the Maksutov telescope at Cerro El Roble. The approximate positions derived leave no doubt that these images were in fact produced by the comet, which was then near its minimum distance of 0.31 AU from the Earth – less than one-third the distance at discovery. Shao was then able to find a faint, diffuse, cloudlike structure, basically circular and about 10 arcmin in diameter, on the Curtis Schmidt plate of December 5; this structure appeared to be somewhat brighter in the northwestern quadrant, but the surface structure was nowhere

brighter than mag 20 per arcmin². Further exposures were made with the Curtis Schmidt telescope on December 17, but there was then no trace of the comet.

OBSERVATIONS 1974 NOVEMBER 13 TO DECEMBER 10

1974 i, periodic comet Wirtanen, was recovered by Roemer and Vaughn on a single 90-min exposure with the Steward telescope on December 20.5. The comet's image was fairly well condensed and of magnitude about 21.5. Having been at perihelion in July, the comet was very badly placed for observation at this return (and the same will be true at the next return in 1980), but further observations were made early in 1975.

OBSERVATIONS 1974 DECEMBER 20, CONTINUING

Periodic comet du Toit 1, discovered in 1944 but missed at its first return to perihelion in 1959, was due to return again in 1974. Circumstances were relatively unfavourable, at least for observers in the northern hemisphere, and a search by C.T.Kowal with the 122-cm Palomar Schmidt on January 26 and 27 did not show any trace of the comet down to mag 19 and for ΔT within some 7–10 day of the predicted perihelion dates in early April. A search was also made at Cerro El Roble in March and April, when the comet should have been at its brightest, but this also did not produce any immediate results. Search plates over a more limited range of ΔT were also taken with the Steward telescope during June 15–17. Careful examination by Torres of the Cerro El Roble plates in 1975 January finally revealed a promising nineteenth-magnitude candidate for the comet near the edge of an exposure on 1974 March 22. Unfortunately, the comet would have been in a region of the plate taken on March 24 that was lacking in emulsion, and it would have been off the edge of the March 25 plate. However, a good plate had also been taken on April 22, and a condensed cometary image of mag 18–19 and 1 arcmin in diameter appears on it. Accurate measurement of the two plates leaves no doubt that the images belong to P/du Toit 1. The comet was evidently too faint to register on the plates taken in January at Palomar, and the Steward plate in June would not have covered its position.

OBSERVATIONS 1974 MARCH 22 AND APRIL 22

In 1975 January Richard M. West, working at the European Southern Observatory's headquarters in Geneva, found the trail of a comet on a plate exposed on 1974 October 15 as part of the southern-hemisphere 'Quick Blue Survey' being made with the 100-cm Schmidt telescope at the station near La Silla, Chile. On the 60-min exposure by G. Pizarro and D. Ballereau the comet was of mag 12, condensed, and had a short tail; it was near opposition in Phoenix and travelled westwards (or eastwards) by about 0.5 arcmin. No other exposures seem to have been taken of the appropriate area of the sky at the time, and the comet was not given a preliminary designation. Most unexpectedly, however, the same comet was accidentally picked up again in 1975 February. Further details are therefore deferred to the 1975 report.

Ephemerides were also available for the following comets:

1972 X, P/Tempel 2; and 1973 i, P/Clark. The ephemerides extended into February, but no further observations seem to have been attempted.

1972 XI, P/Kearns-Kwee. A 60-min exposure was obtained by McCrosky with the 155-cm reflector on April 17, but the comet was not found.

1972 k, P/Gehrels 1. Further unsuccessful attempts to record this comet were made on exposures of up to 60 min at the Agassiz Station on January 20 and 23.

1973 j, P/Brooks 2. A final attempt to observe this comet was made by Roemer at Kitt Peak in moonlight on January 1 but was not successful.

1930 VI, P/Schwassmann-Wachmann 3. See the 1973 report.

1895 II, P/Swift; and 1918 III, P/Schorr. Predictions for these one-apparition comets were provided by O.I.Stal'bovskij and N.A.Belyaev for P/Swift and by V.V.Emel'yanenko, N.Yu.Goryajnova and Belyaev for P/Schorr, but in each case the uncertainty was quite large and the observational circumstances not very favourable (particularly for P/Schorr). No observations seem to have been attempted.

P/Arend. Due at perihelion in 1975 May, this comet would not be particularly well placed at this return, but there seemed a chance that it might be as bright as nineteenth magnitude and observable – particularly in the southern hemisphere – in the latter part of 1974. Unsuccessful attempts to recover the comet were made by Torres on October 7 and 8 and by McCrosky and Schwartz on November 10. A.J.Longmore (UK Schmidt Telescope Unit) also reports that the comet does not appear on a 60-min exposure made on August 13 with the 122-cm Schmidt telescope at Siding Spring. On the other hand, recent examination by C.D.Vesely (Lunar and Planetary Laboratory) of plates taken in 1967 by the late G.Van Biesbroeck has revealed faint, but definite images of P/Arend on exposures with the 154-cm Catalina reflector on 1967 September 7 and 8 (although it should be noted that the September 8 object is not the one previously mentioned by Van Biesbroeck: see the 1967 report).

The following photometric parameters (reduced to an effective aperture of 6.8 cm) have been provided by J.E.Bortle, Stormville, New York:

Comet	No. of observations	Arc	H_0	n	H_{10}
1971 II	7	1974 April 11–27	8.34 ± 0.19	0.83 ± 0.21	11.22 ± 0.40
1973 f	24	1974 January 4–March 22	6.17 ± 0.05	2.34 ± 0.10	(5.99)
1974 a	5	1974 July 17–August 16	9.47 ± 0.06	5.40 ± 0.11	10.27 ± 0.04
1974 b	45	1974 March 15–August 16	7.32 ± 0.03	3.08 ± 0.05	(7.21)
1974 f	8	1974 December 4–30	11.19 ± 0.10	4.12 ± 0.19	11.13 ± 0.10

E.Everhart, University of Denver, has provided values of u_b = osculating $1/a$ minus original (barycentric) $1/a$ and u_a = future (barycentric) $1/a$ minus osculating $1/a$ for the new long-period comets of 1974. The first set of figures below (in units of $10^{-6}/\text{AU}$) has been calculated on the assumption that the osculation epoch is at perihelion, and the second set corresponds to the nearest standard 40-day date.

Ref.		Comet	<i>T</i>		<i>q</i>	<i>e</i>	<i>P</i> <i>y</i>	<i>Elements of</i>
(I)	1844 I	P/de Vico–Swift	44 Sept.	2·9748	1·186379	0·617410	5·46	
–	1844 III	(Wilmot)	44 Dec.	14·1914	0·250537	0·999302	–	
(2)	1884 III	P/Wolf	84 Nov.	18·2894	1·571967	0·560906	6·77	
(3)	1887 I	Southern Comet	87 Jan.	11·934	0·004834	1·0	–	
(2)	1891 II	P/Wolf	91 Sept.	3·9318	1·592792	0·557150	6·82	
(2)	1892 V	P/Barnard 3	92 Dec.	11·1746	1·432189	0·589631	6·52	
(I)	1894 IV	P/de Vico–Swift	94 Oct.	12·6272	1·391695	0·572056	5·86	
–	1895 IV	Perrine	95 Dec.	18·8292	0·191978	1·000051	–	
(2)	1898 IV	P/Wolf	98 July	5·0670	1·603058	0·555336	6·85	
(4)	1911 VI	Quénisset	11 Nov.	12·8493	0·787623	0·998167	–	
(2)	1912 I	P/Wolf	12 Feb.	24·2578	1·587177	0·557971	6·80	
–	1915 II	Mellish	15 July	17·6523	1·005286	1·000151	–	
(5)	1916 I	P/Taylor	{ 16 Jan.	31·4156	1·557968	0·546381	6·37	
(2)	1918 V	P/Wolf	{ 16 Jan.	31·4211	1·557891	0·546087	6·36	
			18 Dec.	13·9890	1·582148	0·558688	6·79	
(6) }	1925 X	P/Wolf	{ 25 Nov.	8·0144	2·434687	0·405177	8·28	
(2) }			{ 25 Nov.	8·0202	2·434687	0·405171	8·28	
(6) }	1934 I	P/Wolf	{ 34 Feb.	27·7593	2·450275	0·403654	8·33	
(2) }			{ 34 Feb.	27·7636	2·450274	0·403654	8·33	
(7)	1936 IV	P/Jackson–Neujmin	36 Oct.	3·408	1·46261	0·65066	8·57	
–	1937 IV	Whipple	37 June	20·0624	1·733791	1·000137	–	
(2) }	1942 VI	P/Wolf	{ 42 June	23·5659	2·437382	0·404776	8·29	
(6) }			{ 42 June	23·5699	2·437382	0·404774	8·29	
(8)	1944 III	P/du Toit 1	44 June	17·4945	1·276960	0·788045	14·8	
–	1948 I	Bester	48 Feb.	16·4233	0·748125	1·000363	–	
(9)	1948 IV	Honda–Bernasconi	48 May	15·9052	0·207625	0·999873	–	
–	1949 VI	P/Shajn–Schaldach	49 Nov.	26·9193	2·233905	0·404978	7·27	
(6) }	1950 VI	P/Wolf	{ 50 Oct.	23·6538	2·497593	0·396328	8·42	
(2) }			{ 50 Oct.	23·6605	2·497591	0·396371	8·42	
(2)	1951 IV	P/Tuttle–G.–K.	51 May	9·3687	1·116472	0·640580	5·47	
(10)	1955 III	Mrkos	55 June	4·1670	0·534426	0·989360	356·0	
–	1955 V	Honda	{ 55 Aug.	4·0603	0·884616	1·000947	–	
(11) }			{ 55 Aug.	4·0641	0·884614	1·001316	–	
(6) }	1959 II	P/Wolf	{ 59 Mar.	21·8386	2·506906	0·394758	8·43	
(2) }			{ 59 Mar.	21·8391	2·506905	0·394752	8·43	
(2)	1962 V	P/Tuttle–G.–K.	62 Apr.	23·8778	1·122559	0·639209	5·49	
–	1963 VIII	P/Kearns–Kwee	{ 63 Dec.	7·0039	2·213170	0·486531	8·95	
(12) }			{ 63 Dec.	7·0049	2·213406	0·487116	8·97	
(I)	1965 VII	P/de Vico–Swift	65 Aug.	23·2404	1·624277	0·524476	6·31	
(2)	1966 I	P/Giacobini–Zinner	66 Mar.	28·2851	0·933503	0·729394	6·41	
–	1966 II	Barbon	66 Apr.	17·7914	2·018766	0·998183	–	
–	1967 II	Rudnicki	67 Jan.	20·8843	0·419225	1·000391	–	
(2) }	1967 XII	P/Wolf	{ 67 Aug.	30·1194	2·506052	0·394913	8·43	
(6) }			{ 67 Aug.	30·1206	2·506056	0·394906	8·43	
–	1969 II	P/Gunn	69 Apr.	18·7770	2·441869	0·319453	6·80	

cometary orbits

ω °	Ω °	i °	Epoch	Obs.	Arc	Ref.
278·9319	65·0478	2·9180	44 June 28·0	78	1844 Sept. 3–Dec. 31	(I)
177·4980	119·8977	45·5689	44 Dec. 20·0	41	44 Dec. 27–45 Mar. 9	–
172·6987	207·2964	25·2537	84 Oct. 31·0	164*	1884–. . .–1919	(2)
83·511	3·885	144·377	–	15	1887 Jan. 21–29	(3)
172·7985	207·2029	25·2369	91 Aug. 16·0	164*	1884–. . .–1919	(2)
170·0013	207·3318	31·2663	92 Dec. 8·0	40	1892 Oct. 14–Dec. 8	(2)
296·6690	49·3797	2·9710	94 Oct. 19·0	32	94 Nov. 22–95 Jan. 30	(I)
272·6723	321·2614	141·6209	96 Jan. 2·0	78	95 Nov. 18–96 Aug. 9	–
172·8697	207·1899	25·1989	98 July 10·0	164*	1884–. . .–1919	(2)
122·0314	35·7313	108·0951	11 Nov. 20·0	205	11 Sept. 24–12 Jan. 24	(4)
172·8317	207·1956	25·2620	12 Feb. 8·0	164*	1884–. . .–1919	(2)
247·7767	72·7588	54·7908	15 July 2·0	217*	15 Feb. 16–16 Sept. 26	–
354·8128	114·3645	15·5247	16 Jan. 28·0	134	15 Dec. 2–16 May 28	(5)
354·8124	114·3695	15·5202	16 Jan. 28·0	23	1916 Jan. 22–Mar. 29	
172·9340	207·1351	25·2887	19 Jan. 2·0	164*	1884–. . .–1919	(2)
160·7529	204·4442	27·2991	25 Nov. 6·0	83	1925–. . .–1967	(6)
160·7553	204·4439	27·2992	25 Nov. 26·0	56	1925–. . .–1967	(2)
160·8167	204·4103	27·2633	34 Feb. 27·0	83	1925–. . .–1967	(6)
160·8180	204·4102	27·2632	34 Feb. 12·0	56	1925–. . .–1967	(2)
197·313	164·433	13·287	36 Sept. 29·0	36*	1936, 1970	(7)
107·7273	127·9151	41·5560	37 July 6·0	136	1937 Feb. 4–Oct. 25	–
160·9698	204·3420	27·3032	42 June 10·0	56	1925–. . .–1967	(2)
160·9711	204·3422	27·3032	42 June 25·0	83	1925–. . .–1967	(6)
257·0170	22·4572	18·7452	44 May 30·0	39	1944 May 29–Oct. 22	(8)
350·2248	270·7491	140·5674	48 Feb. 19·0	123	47 Sept. 28–49 Feb. 6	–
317·0637	203·1141	23·1545	48 June 18·0	~150	1948 June 5–Sept. 3	(9)
215·3052	167·3929	6·1520	49 Nov. 20·0	68	1949, 1971	–
161·1463	203·8786	27·3172	50 Oct. 21·0	83	1925–. . .–1967	(6)
161·1474	203·8791	27·3164	50 Oct. 6·0	56	1925–. . .–1967	(2)
37·9366	165·6439	13·7909	51 Apr. 24·0	99*	1951, 1962, 1973	(2)
32·5098	48·2437	86·4977	55 Aug. 1·0	120	1955 June 14–Sept. 8	(10)
348·1948	338·7233	107·5159	55 Aug. 1·0	102	1955 July 30–Nov. 12	–
348·2000	338·7952	107·5200	55 Sept. 20·0	~180	1955 July 30–Nov. 12	(11)
161·0796	203·9046	27·2976	59 Mar. 23·0	83	1925–. . .–1967	(6)
161·0800	203·9044	27·2977	59 Mar. 13·0	56	1925–. . .–1967	(2)
38·0063	165·5715	13·7642	62 Apr. 6·0	99*	1951, 1962, 1973	(2)
131·1905	315·4399	8·9913	63 Nov. 27·0	99	1963–65, 1971–73	–
131·1174	315·4664	8·9922	63 Apr. 21·0	102	1963–65, 1971–73	(12)
325·3502	24·4202	3·6064	65 May 30·0	15	1965 July 5–Oct. 15	(1)
172·9198	195·9650	30·9442	66 Mar. 16·0	82*	1959–60, 1972	(2)
136·1683	166·9923	28·7123	66 Apr. 25·0	87	1966 Aug. 19–Nov. 7	–
79·7433	75·0494	9·0787	67 Jan. 30·0	46	66 Oct. 17–67 Feb. 8	–
161·2541	203·7988	27·3070	67 Aug. 18·0	56	1925–. . .–1967	(2)
161·2542	203·7989	27·3071	67 Aug. 28·0	83	1925–. . .–1967	(6)
197·1213	68·0350	10·3937	69 Apr. 9·0	14	70 Oct. 27–74 Mar. 28	–

		<i>Elements of</i>				
Ref.	Comet		<i>T</i>	<i>q</i>	<i>e</i>	<i>P</i> <i>y</i>
—	1969 IV	P/Churyumov–G.	69 Sept. 11·0366	1·284924	0·632980	6·55
—	1970 II	Bennett	70 Mar. 20·0446	0·537606	0·996193	—
(7)	1970 IX	P/Jackson–Neujmin	70 Aug. 6·423	1·42775	0·65416	8·39
—	1971 IX	P/Shajn–Schaldach	71 Oct. 1·9366	2·227492	0·406285	7·27
(2)	1972 VI	P/Giacobini–Zinner	72 Aug. 4·8862	0·994015	0·715076	6·52
—	1972 VIII	Heck–Sause	72 Oct. 5·4639	2·511124	1·000501	—
—	1972 IX	Sandage	72 Nov. 14·8093	4·275707	1·006288	—
(12)	1972 XI	P/Kearns–Kwee	72 Nov. 28·4379	2·228568	0·485249	9·01
—			72 Nov. 28·4400	2·228580	0·485243	9·01
(13)			72 Nov. 29·0618	2·229279	0·485146	9·01
(14)	1972 XII	Araya	72 Dec. 18·9448	4·860748	0·999910	—
—	1973 II	Kojima	73 Feb. 12·2775	2·147032	1·001018	—
—	1973 V	P/Clark	73 May 24·8785	1·560361	0·500354	5·52
(2)	1973 VI	P/Tuttle–G.–K.	73 May 30·0869	1·151920	0·632997	5·56
—	1973 VII	Kohoutek	73 June 7·1814	1·382019	0·998723	—
—	1973 X	Sandage	73 Nov. 8·1651	4·812054	1·000036	—
—	1973 XI	P/Gehrels 2	73 Dec. 1·6457	2·348455	0·409859	7·94
(15)	1973 XII	Kohoutek	73 Dec. 28·4307	0·142425	1·000008	—
(16)	1974 b	Bradfield	74 Mar. 18·3563	0·503191	0·999697	—
			74 Mar. 18·3564	0·503191	0·999737	—
(8)		P/du Toit 1	74 Apr. 4·0585	1·294039	0·786950	15·0
(17)			74 Apr. 4·8806	1·293971	0·787026	15·0
—	1974 e	Cesco	74 May 13·0963	1·373498	0·981819	657·0
(18)	1974 a	P/Forbes	74 May 20·1267	1·533073	0·555105	6·40
(19)			74 May 20·28	1·53307	0·555083	6·40
(20)	1974 d	P/Finlay	74 July 3·8715	1·095856	0·699186	6·95
(21)			74 July 3·9489	1·095877	0·699181	6·95
(22)	1974 i	P/Wirtanen	74 July 5·6655	1·256059	0·614209	5·87
—	1974 g	van den Bergh	74 Aug. 16·104	6·02136	1·0	—
—	1974 h	Bennett	74 Dec. 1·5229	0·864646	1·0	—
(23)	1974 f	P/Honda–M.–P.	74 Dec. 28·1355	0·578869	0·809079	5·28
(24)			74 Dec. 28·357	0·578909	0·809086	5·28
—	1974 c	Lovas	75 Aug. 22·1237	3·012560	1·0	—
—			P/Gunn	76 Feb. 10·9595	2·444931	0·319011

cometary orbits

ω °	Ω °	i °	Epoch	Obs.	Arc	Ref.
11·1976	50·3581	7·1455	69 Sept. 16·0	47	69 Sept. 9–70 May 8	–
354·1510	223·9589	90·0437	70 Apr. 4·0	391*	69 Dec. 30–70 Oct. 27	–
196·238	163·225	14·069	70 Aug. 2·0	36*	1936, 1970	(7)
215·1225	167·2667	6·1510	71 Oct. 16·0	68	1949, 1971	–
171·9054	195·1312	31·7093	72 July 22·0	82*	1959–60, 1972	(2)
346·2352	175·1787	138·6348	72 Oct. 10·0	188	73 Jan. 4–74 Feb. 19	–
56·6628	224·7868	79·3723	72 Nov. 19·0	129	72 June 9–74 Oct. 19	–
131·2467	315·4069	8·9784	72 Dec. 29·0	102	1963–65, 1971–73	(12)
131·2484	315·4076	8·9783	72 Nov. 19·0	99	1963–65, 1971–73	–
131·4719	315·4113	8·9776	72 Nov. 19·0	33	(1963–65), 1971–73	(13)
267·2089	314·1872	113·0852	72 Dec. 29·0	49	72 Nov. 15–74 Oct. 13	(14)
334·2980	42·4838	141·8510	73 Feb. 7·0	255	72 Oct. 31–74 Aug. 21	–
209·1276	59·1303	9·5008	73 June 7·0	40	1973 June 1–Nov. 21	–
38·7796	165·1518	13·5966	73 June 7·0	99*	1951, 1962, 1973	(2)
74·8584	164·1185	121·6046	73 June 7·0	38	1973 Feb. 28–Sept. 22	–
72·5541	278·5454	137·4017	73 Nov. 14·0	25	73 July 4–75 Feb. 15	–
183·3460	215·6130	6·6706	73 Nov. 14·0	32	73 Sept. 29–74 Feb. 25	–
37·8238	257·7656	14·3051	73 Dec. 24·0	597	73 Jan. 28–74 Mar. 16	(15)
333·1302	143·0379	61·2898	74 Mar. 14·0	159*	1974 Feb. 14–Nov. 18	(16)
333·1298	143·0363	61·2902	74 Mar. 14·0	159	1974 Feb. 14–Nov. 18	
257·2051	22·1418	18·7032	74 Feb. 2·0	<i>p</i>	1944 May 29–Oct. 22	(8)
257·2090	22·1404	18·7034	74 Apr. 23·0	<i>p</i>	1944 May 29–Oct. 22	(17)
176·8420	165·0470	173·1652	–	15	1974 July 27–Sept. 18	–
259·9228	25·1976	4·6250	74 June 2·0	<i>p</i> *	1942, 1948, 1961	(18)
259·933	25·200	4·625	74 June 2·0	<i>p</i>	(1948), 1961	(19)
322·1293	41·7816	3·6453	74 July 12·0	<i>p</i>	1960–61, 1967	(20)
322·1278	41·7813	3·6454	74 July 12·0	<i>p</i> *	1953–54, 1960–61, 1967	(21)
351·8301	83·5425	12·2677	74 July 12·0	<i>p</i> *	1948, 54, 60–61, 67	(22)
152·541	225·441	60·763	–	23	1974 Nov. 12–Dec. 16	–
324·9597	50·6446	134·8232	–	15	1974 Nov. 14–24	–
184·5674	232·9814	13·1327	74 Dec. 19·0	<i>p</i> *	1948, 1954, 1964, 1969	(23)
184·5743	232·9813	13·1322	74 Dec. 19·0	<i>p</i>	(1964), 1969	(24)
261·3343	11·6700	50·6368	–	57	74 Mar. 21–75 Jan. 12	–
197·4835	67·9745	10·3876	76 Jan. 23·0	14	70 Oct. 27–74 Mar. 28	–

Comet	Perihelion		40-day date				Total $u_b + u_a$
	u_b	u_a	u_b	u_a			
1974 b	-170	+184	-168	+182	(1974 March	14.0)	+ 14
1974 e	-236	+255	-223	+242	(1974 June	2.0)	+ 19
1974 g	-668	+1225	-667	+1225	(1974 August	21.0)	+557
1974 h	-845	+181	-850	+185	(1974 December	19.0)	-664
1974 c	+100	+381	+ 96	+385	(1975 August	16.0)	+481

A new edition of the *Catalogue of Cometary Orbits* has been prepared. It contains orbital information for 964 cometary apparitions between the year -86 and 1975 March. Osculation epochs and non-gravitational parameters are included. Copies may be purchased, for \$3.00 (plus \$2.00 airmail postage, if so desired, outside North America), from the Central Bureau for Astronomical Telegrams, Smithsonian Astrophysical Observatory, 60 Garden Street, Cambridge, Massachusetts 02138, USA; or for £1.50 from the Assistant Secretary, British Astronomical Association, Burlington House, Piccadilly, London W1V 0NL.

The following continuation of the numerical designations of comets (in order of perihelion passage) is taken from *IAU Circ. 2732* (1974). The perihelion times (T) are from orbits noted in these annual reports.

Comet	T		Name	Year and letter
1973 I	January	25.2	P/Gehrels 1	1972 k
II	February	12.3	Kojima	1972 j
III	March	11.6	Huchra	1973 h
IV	March	21.3	P/Reinmuth 1	1972 i
V	May	24.9	P/Clark	1973 i
VI	May	30.1	P/Tuttle-Giacobini-Kresák	1973 b
VII	June	7.2	Kohoutek	1973 e
VIII	July	2.8	P/Wild	1973 c
IX	August	10.1	Gibson	1973 o
X	November	8.2	Sandage	1973 k
XI	December	1.5	P/Gehrels 2	1973 n
XII	December	28.4	Kohoutek	1973 f

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 non-gravitational 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 actual observations were used in the orbit determination. If no reference is given, the elements are from unpublished calculations by B.G.Marsden and/or Z.Sekanina at the Center for Astrophysics; and in such cases, if an Epoch is specified, perturbations by all nine planets have been taken into account. Non-gravitational parameters, calculated according to the Style II specified in *Catalogue of Cometary Orbits* 1975 or by Marsden, Sekanina & Yeomans (1973, *Astr. J.*, **78**, 211), are:

		A_1	A_2
P/Wolf	1884-1919	+0.14	+0.0081
P/Jackson-Neujmin	1936-1970	+0.8	-0.45
P/Tuttle-Giacobini-Kresák	1951-1973	+0.61	+0.0215
P/Giacobini-Zinner	1959-1972	+0.32	+0.0230
1915 II Mellish		+2.8	+0.2
1970 II Bennett		+1.9	+0.1
1974 b Bradfield		+0.9	-0.4

REFERENCES AND NOTES TO TABLE OF ELEMENTS

- (1) Shaporev, S.D., 1974-1975. *Kiev Komet. Tsirk.*, Nos 164, 185 and private communication. Perturbations in 1844 and 1894 by Venus to Pluto, in 1965 by Mercury to Pluto. Mean residuals 2.92 arcsec in 1844, 3.24 in 1894 and 0.74 in 1965.
- (2) Yeomans, D.K., 1975. *Publ. astr. Soc. Pacific*, 87, 635 and private communication. Perturbations by Mercury to Pluto.
- (3) Sekanina, Z., 1973. Private communication. Hypothetical orbit, assuming that the direction of perihelion is identical with that of members of the Kreutz sungrazing group and that the unobserved head of this comet was on a great circle through the Sun and inner part of the tail.
- (4) Van Biesbroeck, G., Vesely, C.D. & Marsden, B.G., 1974. *Astr. J.*, 79, 1455. Perturbations by Mercury to Pluto. Mean residual 1.58 arcsec.
- (5) Emel'yanenko, V.V., 1974. *Kiev Komet. Tsirk.*, No. 167. Perturbations by Venus to Uranus. The first orbit refers to component B (mean residual 2.23 arcsec), the second to component A (mean residual 1.87 arcsec). The ascription of observations to the particular nuclei differs from that in the orbits in the 1973 report but agrees with that by H.M. Jeffers in *Lick Obs. Bull.*, 10, 120 (1922).
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- (11) Buchinger, F., 1975. Private communication. Perturbations by Venus to Pluto; 28 normals.
- (12) Shaporev, S.D., 1975. *Kiev Komet. Tsirk.*, No. 177 and private communication. Perturbations by Mercury to Pluto. Mean residual 1.48 arcsec.
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- (17) Belyaev, N.A., Emel'yanenko, V.V. & Goryajnova, N.Yu., 1973. *IAU Circ.* 2601. Perturbations by Venus to Neptune. $\Delta T = -3.4$ day.
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 $\Delta T = -0.02$ day.
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 $\Delta T = -0.07$ day.
- (23) Marsden, B.G., 1974. *IAU Circ.* 2697. Perturbations by Mercury to Pluto.
 $\Delta T = +0.01$ day.
- (24) Luss, R., 1973. *Hand. Br. astr. Ass.* for 1974, 79. Perturbations by Venus to Saturn.
 $\Delta T = -0.1$ day.

CORRIGENDUM

1973 report, *Q. Jl R. astr. Soc.*, **15**, 4 (1974), p. 458, line 1 of text. For following read preceding.