The comets of 2000

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A report of the Comet Section (Director: J. D. Shanklin)

This report is the eleventh in the annual series which gives for each comet: the discovery details, orbital data and general information, magnitude parameters and BAA Comet Section observations. Further details of the analysis techniques used in this report are given in an earlier paper.[1] Ephemerides for the comets predicted to return during the year can be found in the BAA or ICQ *Handbooks*.[2,3]

The comets with discovery letter designations

2000 A1 (Montani)

J. Montani, Lunar and Planetary Laboratory, reported his discovery of a faint 19th magnitude comet on CCD images taken with the 0.90m Spacewatch telescope at Kitt Peak on 2000 January 12.33. The comet showed a coma with diameter 53"–63", slightly elongated in p.a. 245–250°. An R CCD image taken by S. Kern with the 2.3m Steward telescope on Jan 13 showed the comet to be clearly extended toward the southwest, and she derived magnitude 18.1. W. Shook found the object to be nonstellar with a 23.6 tail toward the southwest on an image taken with the 3.5m WIYN telescope on Jan 13 [reported on IAU *Circular* 7346, 2000 Jan 14]. The comet was very distant (9.8 AU) and close to perihelion. The perihelion distance was at the time the largest on record for a confirmed comet, though some trans-Neptunian objects, for example 1999 DP_8, have larger perihelia. Its absolute magnitude is rather average, suggesting that there may be many such distant objects awaiting discovery by the next generation of survey telescopes.

2000 B2 (LINEAR)

A 19th magnitude object with unusual motion and reported as asteroidal by LINEAR on January 29.24 was found to be cometary in appearance following posting on the Near Earth Objects Confirmation Page (NEOCP). CCD observations by P. Kusnirak (Ondrejov, 0.65m f/3.6 reflector) and by M. Tichy & Z. Moravec (Klet, 0.57m f/5.2 reflector) indicated that the object appeared slightly diffuse [*IAUC* 7354, 2000 Feb 1]. The comet was a distant one, past perihelion, and faded.

2000 B3 (194P/LINEAR)

A 19th magnitude object with unusual motion that was reported as asteroidal by LINEAR on Jan 27.24 was found to be cometary in appearance following posting on the NEOCP. CCD observations by P. Kusnirak (Ondrejov, 0.65m f/3.6 reflector) on Feb 1 showed a coma diameter of 63" and a faint tail in p.a. 120°, and F. Zoltowski (Edgewood, NM, 0.3m f/3.3 reflector) reported a small faint tail about 30" long in p.a. 100° and a dense coma about 10"across [*IAUC* 7356, 2000 Feb 2]. The comet was near perihelion and had passed 0.2 AU from Jupiter in 1998, in an encounter that reduced the perihelion distance from 2.0 to 1.7AU and increased the inclination from 8° to 11°. It was numbered following recovery in 2007.

2000 B4 (165P/LINEAR)

Another apparently asteroidal object, also 19th magnitude, was reported by LINEAR on Jan 29.25 and posted on the NEOCP. This object had the orbit of a centaur and was noted as appearing perhaps slightly diffuse (P. Kusnirak, Ondrejov, 0.65m reflector, Feb 10) and 'soft' and slightly larger than star images (D. Balam, Victoria, 1.82m reflector, Feb 11) [*IAUC* 7368, 2000 Feb 18]. The perihelion distance is 6.8AU and the period 76 years, putting it in the centaur class of objects. Although given a cometary designation, and numbered following observation at more than two oppositions, only the two confirming observations reported cometary characteristics. It is possible that the groups were misled by poor seeing as no activity has been seen since.

2000 C1 (175P/Hergenrother)

Carl Hergenrother, Lunar and Planetary Laboratory, reported a 17th magnitude object on 2000 Feb 4.46 that showed an 11" tail in p.a. 300° on one of four CCD images taken with the 0.41m Schmidt telescope at Catalina. Following posting on the NEOCP, numerous CCD observers reported cometary appearance: Feb 5.3 UT, coma diameter about 12", brighter 60" tail in p.a. 290°, extending more faintly to 180" (J. E. McGaha, Tucson, AZ, 0.62m reflector); Feb 5.5, tail about 12" long toward the northwest (G. Billings, Calgary, AB, 0.36m reflector); Feb 5.7, slightly diffuse with very faint tail about 10" long to the northwest (G. J. Garradd, Loomberah, NSW, 0.45m reflector); Feb 6.1, coma diameter 0'.1, tail 0'.3 long in p.a. 290° (P. Pravec & P. Kusnirak, Ondrejov, 0.65m reflector); Feb 6.4, faint tail <10" long in p.a. about 290° (D. T. Durig, Sewanne, TN). Prediscovery observations by LINEAR on Jan 4 and 8 were also identified [*IAUC* 7357, 2000 Feb 6]. The comet was intrinsically quite faint and had perihelion at 2.1 AU. A single CCD observation was reported, putting the comet at 17th magnitude shortly after discovery in February.

The comet was put into something approximating its present orbit in a close encounter with Jupiter in 1725 that reduced the perihelion distance from 4.8 to 2.3AU. More distant encounters in 1951 and 1963 jogged the perihelion distance about a little more, resulting in the present distance of 2.1AU. A further close encounter in 2057 will push the perihelion out and radically change the angular elements.

2000 C2 (SOHO), 2000 C3 (SOHO), 2000 C4 (SOHO) and 2000 C5 (SOHO)

D. A. Biesecker, SM&A Corporation and Goddard Space Flight Center, reported measurements of several comets, which showed no tail, observed with the coronagraphs aboard SOHO. C/2000 C2 (SOHO's 100th comet) first noted by Kazimieras Cernis on Feb 3.70, remained relatively stable in brightness (V= 6.5–6.9) during Feb 3.70–3.84. C/2000 C3, found by Biesecker on Feb 4.56, brightened from V= 6.7 on Feb 4.59 to 5.9 on Feb 4.79, before fading to V= 7.0 on Feb 5.09. C/2000 C4, found by Maik Meyer on Feb 5.16, was on a trajectory closely following that of C/2000 C3, and it was assumed that the orbits are identical with a difference ΔT= 0.60 day. C/2000 C4 brightened from V= 5.9 on Feb 5.17 to 4.9 on Feb 5.30, before fading to V= 6.7 on Feb 5.67. C/2000 C5, found by Michael Oates on Feb 7.79, was at V= 7.5–8.0 on Feb 7 [*IAUC* 7364, 2000 Feb 12].

Subsequent studies showed that 2000 C3 and C4 are members of the Marsden group of sunskirting comets, whilst 2000 C2 and C5 are members of the Meyer group. 2000 C4 is the fourth periodic member of the Marsden group. More details of these groups are given later in this report.

2000 CT_{54} (LINEAR)

Yet another apparently asteroidal LINEAR object, of 19th magnitude, discovered on Feb 2.44, and posted on the NEOCP was noted to have a 15"–16" tail toward the north-northwest on Feb 12 by J. G. Ries, McDonald Observatory (0.76m reflector) [*IAUC* 7368, 2000 Feb 18]. The comet reached perihelion at 3.1 AU in 2001 June and is in a long-period orbit. It just came within visual range and a few observations at around 14.5 were reported around the time of perihelion.

2000 D2 (LINEAR)

An apparently asteroidal object of 18th magnitude, discovered by LINEAR on Feb 25.20 and posted on the NEOCP was observed to be cometary by F. B. Zoltowski (Edgewood, NM; very diffuse image on Feb 28.1 UT; 12" tail in p.a. 270° on March 1.1) and by C. Hergenrother (Catalina 1.54m reflector; 8" coma and very faint 15" tail in p.a. 105° on March 1.3) [*IAUC* 7372, 2000 March 1]. The comet was near perihelion at 2.3AU and is a Halley family comet, with a period of 72 years. As with most such comets it will not receive a number and P designation until it is recovered on a second perihelion passage. Comets with periods between about 20 and 200 years are often referred to as intermediate period comets, nearly isotropic comets or Halley type comets. The Tisserand parameter (T_J) for their orbits, a measure of their energy with respect to Jupiter, is less than 2 and they are therefore not greatly affected by Jupiter, as any encounters are short and swift. Jupiter family comets usually have T_J between 2 and 3 and can undergo longer and slower encounters, whilst asteroids have T_J greater than 3.

2000 ET_{90} (143P/Kowal–Mrkos)

MPS 11479 contained observations on March 9.30 and 13 by LINEAR of an apparently asteroidal, 19th magnitude object presumed to have a moderately eccentric orbit in the inner part of the main belt. Linkage by G. V. Williams to LINEAR

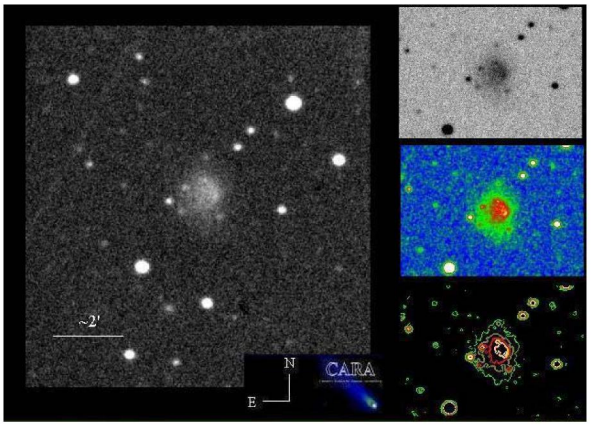

Figure 1. 174P/Echeclus imaged by Giovanni Sostero & Ernesto Guido, Remanzacco Observatory, Italy on 2006 February 2. Average of 10 unfiltered exposures, 180s each, 255mm SCT.

observations on April 4 and 8 demonstrated the cometary nature of the orbit, and the object was placed in the NEOCP. Isolated observations from LINEAR on Feb 7, from the Catalina Sky Survey on March 1 (when observer T. B. Spahr had in fact drawn attention to the object's 'slowish' motion) and from LONEOS on Apr 2 were then also linked. Neither these observers nor those responding to the Confirmation Page made a definite remark about the object's cometary appearance, even in response to specific enquiries from the Central Bureau (although strong moonlight had recently been a factor). Following a suspicion by Brian Marsden and an independent suggestion by C. W. Hergenrother, 2000 ET_{90} was definitively identified with comet D/1984 H1 (Kowal–Mrkos) (*IAUC* 3988, 4001), for which predictions (*ICQ Comet Handbook* for 2000, p. H87; *OAA Comet Handbook* for 2000, p. 37) required correction by ΔT about −125 days.

The comet passed only 0.16AU from Jupiter in 1989 March. There was an unobserved return with T= 1991 Aug 2 [*IAUC* 7403, 2000 Apr 15]. The original orbit was based on only eight observations, so it is perhaps not surprising that the prediction was somewhat in error. The 1989 encounter increased the perihelion distance from 1.95 to 2.55 AU. Over the last few centuries the comet has made several encounters with Jupiter, most of which have shifted the angular elements around. However, another encounter in 2024 will push the perihelion distance out further to 2.99AU.

2000 EC_{98} (174P/Echeclus) = (60558) Echeclus

This object was discovered by Spacewatch on 2000 March 3.41 and originally designated as a Centaur type asteroid. Deep imaging showed a faint coma at the end of 2005 Dec and it was given a parallel cometary designation. Further observations suggested that the coma had detached from the nuclear condensation, suggesting its creation during a transient event.

2000 G1 (P/LINEAR)

F. Shelly, for the Lincoln Near-Earth Asteroid Research project, reported, in connection with the discovery on April 7.45 of a fast-moving 18th magnitude object, that Lisa Brownmanguso noticed that the object showed clear cometary activity [*IAUC* 7396, 2000 Apr 8]. Subsequent observations confirmed that

Table 1. Orbital data for the comets of 2000[9] *(sample)*

Comet		*T*	*q*	*Q*	*e*	*P*	*Tj*	*ω*	*Ω*	*i*
1999 J2	Skiff	2000 4 6.00	7.1098		1.0010			127.14	50.04	86.41
1999 K5	LINEAR	2000 7 4.39	3.2554		1.0017			241.49	106.38	89.47
1999 K8	LINEAR	2000 4 24.30	4.2005		1.0008			164.62	195.39	52.73
1999 L3	LINEAR	2000 1 4.91	1.9889	153	0.9743	681		353.30	140.16	166.10

(The full table is available online at ***www.britastro.org/jbaa_supplement****)*

it was a periodic comet, with a perihelion distance of 1.003 AU and perihelion on March 9.8. The period was 5.4 years. The comet passed only 0.10AU from Earth in late February and early March, when it could have reached 14th magnitude, but was at a high southerly declination. It is intrinsically very faint.

The comet was moved into its present orbit in 1987 Feb when an encounter to within 0.15AU of Jupiter significantly increased the inclination. It makes frequent encounters with the giant planet, but the perihelion distance has been around 1AU since an encounter in 1785. The comet also makes close passes to the Earth and could potentially have an associated meteor shower. This would have a maximum around March 30 and the meteors would appear to radiate from 5h 08m −16°. It will make a very close pass to the Earth in 2016, when it will be only 0.033AU away and could reach 12th magnitude.

2000 G2 (LINEAR)

Another 18th magnitude object with unusual motion that was reported as asteroidal by LINEAR on April 4.39 was noted by other observers, following posting on the NEOCP, as being cometary in appearance. G. Hug, Eskridge, KS, reported a diffuse appearance on several CCD images taken with a 0.3m reflector during Apr 21–29, and Klet CCD observations by J. Ticha, M. Tichy, & Z. Moravec (0.57m reflector) indicated a coma diameter of about 6" on Apr 22.9 UT. A 300s R exposure taken by C. Hergenrother with the Steward Observatory 2.3m telescope on Apr 30 confirmed that the object had a 6" coma and a 20" tail in p.a. 117° [*IAUC* 7411, 2000 May 1]. The comet reached perihelion on 2000 Feb 6.1 with a perihelion distance of 2.72AU. It is a member of the Halley family, with period of 54 years.

2000 H1 (LINEAR)

A 19th magnitude object reported by LINEAR on 2000 Apr 26.39 and posted on the NEOCP was noted to be diffuse at Klet (Apr 27.0 UT), Ondrejov (Apr 27.1), and Modra (Apr 29.0). M. Hicks (Table Mountain Observatory) reported a 7" central condensation and 20" tail in p.a. about 120° on Apr 29.4 [*IAUC* 7410, 2000 Apr 29]. The comet is in a distant parabolic orbit and was just past perihelion.

2000 J1 (Ferris)

An apparently asteroidal object of 19th magnitude reported by LONEOS (observer W. D. Ferris, measurer B. W. Koehn) on May 4.32 that was posted on the NEOCP was found to have a faint 10" tail in p.a. 150° (R= mag 19.6 in a 127mm aperture) on CCD images taken by M. Hicks with the Kitt Peak 2.13m reflector on May 8.3 UT [*IAUC* 7416, 2000 May 8]. The comet was near perihelion at 2.5 AU and faded.

Bill Ferris described how comets are discovered during the LONEOS program:

'All were found while observing for the Lowell Observatory Near-Earth Object Search (LONEOS) project. Brian Skiff, myself and three others use a 0.6 meter Schmidt camera every clear night to conduct the search. We've recently installed a new CCD camera enabling us to image the entire observable sky from Flagstaff each lunation. To date [2000 May], the LONEOS project has discovered 33 near-Earth asteroids and 8 comets.

The sequence of events leading to these discoveries has been pretty much the same, with a few exceptions. Computer analysis of the images produces a list of detections to be checked. Typically, this is done by the observer so that, by the end of the night, any real, unknown, possible near-Earth objects have been reported to the Minor Planet Center. Follow-up observations are made by LONEOS, other professional surveys and a group of dedicated amateurs. These observations allow the MPC to determine an orbit and classification for each object.

Occasionally, we sweep up an unknown comet. Many of the LONEOS comets have been reported as such. However, there are several comets that did not display an appreciable coma or tail on our images. Their cometary natures were discovered by other observers. Our most recent find, 2000 J1, is such an object. Mike Hicks used the 2.1 meter telescope on Kitt Peak to make follow-up observations and these revealed a short tail.'

2000 J2 (SOHO)

D. A. Biesecker, Emergent Information Technologies, Inc. and Goddard Space Flight Center, reported observations of another comet found in LASCO C2 data on May 7.24 by M. Oates via the SOHO website. The comet brightened from V= 7.8 on May 7.254 UT to 7.1 on May 7.368, but had faded to V= 8.3 on May 7.452, and it was not seen in the C3 instrument. No tail was evident. Astrometry (measured by Biesecker, reduced by B. G. Marsden) and orbital elements appeared on *MPEC* [*Minor Planet Electronic Circular*] 2000-J32 and this comet was evidently not a Kreutz sungrazer or member of any other group [*IAUC* 7418, 2000 May 9].

2000 K1 (LINEAR)

F. Shelly, Lincoln Laboratory, Massachusetts Institute of Technology, reported that LINEAR discovered a comet (LINEAR-47), of 18th magnitude on May 26.31 [*IAUC* 7430, 2000 May 26]. It was linked to asteroids LW_{24} and NF_{13} observed by LINEAR in 1999. The comet was a distant one, with perihelion at over 6AU. It faded, though it was several magnitudes brighter to visual observers than its discovery magnitude indicated, and was at around mag 14.5 in early June.

Table 2. BAA and *TA* visual observers

James Abbott	Witham, Essex
Alexander Baransky	Kiev, Ukraine
Sandro Baroni	Italy
Sally Beaumont	Windermere, Cumbria
Neil Bone	Chichester, West Sussex
Reinder Bouma	Groningen, The Netherlands
Matyas Csukas	Romania
Haakon Dahle	Norway
Jose Guilherme de Souza Aguiar	Brazil
Len Entwisle	Elland, West Yorkshire
Fraser Farrell	Australia
Mike Feist	Portslade, Sussex
James Fraser	Alness, Rosshire
Stephen Getliffe	Longstanton, Cambridgeshire
Antonio Giambersio	Italy
Bjorn Granslo	Fjellhamar, Norway
Werner Hasubick	Buchloe, Germany
Guy Hurst	Basingstoke, Hampshire
Albert Jones	New Zealand
Andreas Kammerer	Ettlingen, Germany
Heinz Kerner	Fassberg, Germany
Attila Kosa–Kiss	Romania
Martin Lehky	Hradec Kralove, Czech Republic
Gordon MacLeod	Reay, Caithness
Steve Martin	Lustleigh, Devon
Michael Mattiazzo	Wallaroo, Australia
Cliff Meredith	Prestwich, Manchester
Giannantonio Milani	Italy
Gabriel Oksa	Slovak Republic
Roy Panther	Walgrave, Northampton
Andrew Pearce	Australia
Maciej Reszelski	Poland
Toni Scarmato	Italy
David Seargent	Australia
Jonathan Shanklin	Cambridge, England
Oddleiv Skilbrei	Norway
Melvyn Taylor	Wakefield, West Yorkshire
Graham Wolf	Moera, New Zealand
Mauro Zanotta	Milan, Italy

Note that the lightcurves make use of all observations in the *ICQ* archives, complemented with those from the BAA and *TA*. Thanks are due to the many observers not listed here for their diligence in making the observations, and to Dan Green of the *ICQ* in compiling them into standard format.

Table 3. BAA and *TA* astrometric, CCD and photographic observers

Observer	*Site*	*IAU Station No.*
Denis Buczynski	Conder Brow, Lancashire	978
John Fletcher	Mt Tuffley, Gloucestershire	J93
Roberto Haver	Rome, Italy	157
Nick James	Chelmsford, Essex	970
Geoffrey Johnstone	Burdingbury, Warwicks.	
Martin Lehky	Hradec Kralove, Czech Republic	048
Rolando Ligustri	Italy	235
Brian Manning	Kidderminster, Worcs.	494
Pepe Manteca	Begues, Spain	170
Cliff Meredith	Manchester	
Martin Mobberley	Galleywood, Essex	477
Martin Mobberley	Cockfield, Suffolk	480
Giovanni Sostero	Italy	473
David Strange	Worth Matravers, Devon	
Alex Vincent	Worthing, Sussex	

2000 K2 (LINEAR)

Shelly also reported that LINEAR discovered another comet (LINEAR-48) on the same night. It was a little brighter and showed a tail in p.a. 240°. Ticha reported the comet to be slightly diffuse, and Kusnirak reported a faint tail about 20" long in p.a. 220°; Galad reported cometary appearance [*IAUC* 7430, 2000 May 26]. The comet brightened a little and visual observers reported that it reached 14th magnitude around the time of perihelion.

2000 O1 (Koehn)

B. W. Koehn, Lowell Observatory, reported his discovery of a possible 18th magnitude comet in the course of the Lowell Observatory Near-Earth-Object Survey on July 20.36. The comet was a distant one and did not become brighter than 17th magnitude [*IAUC* 7462, 2000 Jul 23]. Shortly after discovery Brian Marsden was able to identify the comet with the LINEAR 'asteroidal' objects 1998 XA_{70} and 1999 UJ_{10}.

2000 O2 (144P/Kushida)

C. E. Delahodde, European Southern Observatory, reported the recovery by O. R. Hainaut and herself of comet P/1994 A1 with the 3.6m reflector on July 25.33. The indicated correction to the prediction by S. Nakano on MPC 31664 was ΔT= –0.10 day [*IAUC* 7467, 2000 Jul 27].

The comet was moved into approximately its present orbit in a close encounter with Jupiter in 1782. Since then encounters have been more distant and there have only been slow changes in the elements.

2000 O3 (SOHO) [Shanklin]

Jonathan Shanklin discovered another comet at 10:45 (UT) on July 31. He provides this discovery story:

'I had given a lecture in the centre of Cambridge and didn't get into the office until after 10:00 (11:00 BST). First I checked the emails, including several Antarctic ones which had data that needed processing. Then I had a look at various web pages, including the latest MPECs, and finally I had a look at the SOHO real time movies. I first looked at C2; there were no obvious Kreutz objects but I noted something that appeared to be moving opposite to the stars. I quickly found that it was moving consistently and emailed Doug and the group with details of the possible object. I then checked C3 in case it was visible and downloaded the real-time gif images to measure the positions. I found that it came into view at 21:30 on July 30 and was visible until 03:30 on July 31, moving horizontally from right to left just above the level of the occulting disc and below the Beehive cluster. At its brightest (00:06) it was around 7th magnitude. I think the biggest surprise is that no-one else had picked up this object, showing that you see what you expect to see. This object was not moving on a Kreutz track where expected and was not seen despite being fairly obvious. Subsequently the comet came into view again, on images from 05:54 till after 12:00. The apparent fading around 03:30 may be due to phase effects playing a part. If it was then between us and the Sun it would have zero phase and be difficult to see. The phase effect partly explains why many Kreutz comets are seen during May as this is when they are on the far side of the Sun and fully illuminated.'

The orbit was finally published on *MPEC* 2000-Q09 [2000 Aug 19], after Brian Marsden returned to the USA following the IAU meeting in Manchester. (It seems that the IAU had commanded all three senior members of the CBAT to attend the meeting.) The comet had been at perihelion on Jul 30.94

at a perihelion distance of 0.054 AU. Potentially observable from the ground, it was at an elongation of 50° in late August, though at a magnitude of near 20. The orbit shows that it passed on the far side of the Sun, so phase effects do not explain the fading.

Further to *IAUC* 7472, D. Hammer provided measurements of a comet detected by the SOHO C2 and C3 instruments and found by J. D. Shanklin via the SOHO website. The reduced measurements and orbits by B. G. Marsden, together with a search ephemeris, were given on *MPEC* 2000-Q09. G. J. Garradd, Loomberah, NSW, reported that his search for this object around Aug 21.4 UT, out to about 0.5° ahead of its predicted position, yielding nothing to mag about 18 [*IAUC* 7479, 2000 Aug 21].

In 2005 Bo Zhou discovered another comet in the C2 field (2005 W4) and Brian Marsden was able to link the object to Shanklin's discovery. It is another member of what Zdenek Sekanina describes as the 'sunskirter complex' and is the second periodic member of the Kracht group of comets, which is described in more detail later in this report.

2000 OF_8 (Spacewatch)

Details of an unusual asteroid with a 190 year period, a high inclination orbit and a perihelion distance of 2.0AU were given on *MPEC* 2000-P03. The 20th magnitude object was discovered by Spacewatch on July 24.32 when about a year from perihelion. At discovery it was 4.4AU from the Sun and it seemed possible that it would develop cometary activity as it got closer. Further observations did indeed show cometary activity and a parabolic orbit was published on *MPEC* 2000-Q43. The comet reached perihelion in 2001 August at 2.2 AU.

Only one observer reported visual observations, suggesting that it was around mag 14.5 in 2001 June.

2000 P3 (191P/McNaught)

Following the discovery of comet 2007 N1 by Rob McNaught in 2007 July, Syuichi Nakano was able to find pre-discovery images in LONEOS and NEAT observations from 2000 August and November. These allowed a good orbit to be determined and the comet was subsequently numbered. Further details will be given in the report on the comets of 2007.

2000 Q1 (SOHO) [Danaher]

James Danaher discovered a faint non-Kreutz object on C3 images from August 28. It tracked diagonally across the upper left quadrant. The orbit published on *MPEC* 2000-Q42 suggested that it would become visible from the ground, but that it would be a very faint southern hemisphere object. It was not seen.

2000 QJ_{46} (P/LINEAR)

A 19th magnitude asteroid found by LINEAR on 2000 Aug 24.27 was found in 2005 October to show a coma and tail on archival Sloan Digital Sky Survey images taken just over a week later. The comet has a 14.4 year period, with perihelion at 1.93AU in 2000 Dec. The last major change to the orbit was in 1872, following an encounter within 0.35AU of Jupiter, although even this did not affect the perihelion distance very much.

2000 QD_{181} (156P/Russell–LINEAR)

IAUC 8118 (2003 Apr 19) announced the linkage of a comet discovered on UK Schmidt plates in 1986 September, with an asteroid found at the end of 2000 August by LINEAR. Although it only appeared cometary in 1986, the identity is secure. Calculations by Kenji Muraoka show that the perihelion distance has been decreasing over the last 100 years, with significant changes around 1934 and 1970. The next significant change will be around 2017, when the perihelion distance will reduce to 1.33AU from its present 1.60AU.

R. H. McNaught, Siding Spring Observatory, reported observations of a comet found in 1986 Sept by K. S. Russell on a 90min exposure taken by F. G. Watson earlier that month with the U.K. Schmidt Telescope. Unsuccessful attempts were made by Russell, and later by McNaught, to locate the comet on the 30min follow-up exposure by M. Hartley obtained on Sept 25. T. B. Spahr, Minor Planet Center, identified the comet with 2000 QD_{181}, an apparently asteroidal object observed by LINEAR on 2000 Aug 31 and Sept 5 (*cf.* MPS 18353), and itself linked by Spahr (MPO 9348) to another LINEAR discovery, 2000 XV_{43} (observations 2000 Nov–2001 Jan on MPS 23109 and 25364), as well as to 1993 WU, recorded by C. S. Shoemaker *et al.* with the 0.46m Palomar Schmidt telescope on 1993 Nov 19 and 20 (MPS 397), the appearance again being evidently asteroidal. With the knowledge of the clearly cometary orbit, McNaught & M. A. Read located and measured the object on the Hartley follow-up plate. The 1986 observations were given the designation P/1986 R1 [*IAUC* 8118, 2003 Apr 19].

2000 R1 (145P/Shoemaker–Levy)

The LINEAR team reported that one of their objects observed on September 6 was cometary, and T. Spahr and Dan Green noted that this was about 0.6° northwest of the prediction for P/1991 T1 (*MPC* 29882, 39661), corresponding to $\Delta T = -1.4$ day. Following a request from the Central Bureau, D. Balam reported that images taken with the 1.82m Plaskett telescope of the National Research Council of Canada showed the object to have a well-condensed coma and a fan-shaped tail extending 30" in p.a. 250°; his R magnitude of 18 was obtained in a 254mm aperture [*IAUC* 7488, 2000 Sept 7]. Further observations confirmed the identity.

The perihelion distance of the comet wanders around thanks to encounters with Jupiter, the most recent of which changed it from 1.77AU to 2.00AU during a close encounter to 0.11AU in 1933 November. Another more distant encounter in 2007 will bring it back in to 1.90AU. The angular elements show only slow variation in these encounters.

2000 R2 (P/LINEAR)

A 19th magnitude object reported as asteroidal by the LINEAR team on Sept 3.15, and subsequently posted on the NEOCP, was reported as cometary in appearance on various CCD exposures: Sept 7.2 UT, condensed 9" coma (D. Balam, Victoria, 1.82m reflector); Sept 7.9, object seemed diffuse with a faint east-west tail about 10" long (M. Tichy, Klet, 0.57m reflector); Sept 18.51, near- stellar condensation with a fairly narrow 40" tail in p.a. 90° (R. H. McNaught, Siding Spring, 1.0m reflector + 100s R frames) [*IAUC* 7492, 2000 Sept 18]. It has a very faint absolute magnitude of 18.0.

The comet undergoes frequent encounters with Jupiter, which make significant changes to all the orbital elements. For the latter half of the 19th century the perihelion distance was around 1.15AU. Encounters with Jupiter in 1920 and 1932 pushed out the perihelion distance to its present value of 1.39AU. Another encounter, to within 0.2AU of Jupiter in 2003 Nov, will have pushed perihelion out further to 1.46AU and significantly changed the angular elements. It may prove difficult to recover.

2000 S1 (P/Skiff)

B. W. Koehn, Lowell Observatory, reported the discovery by Brian A. Skiff of a comet on images from Sept 24.30 taken in the course of the LONEOS programme [*IAUC* 7496, 2000 Sept 25]. Prediscovery observations made by LINEAR on Aug 26, together with additional astrometry on Sept 26, showed that the comet was periodic with a period of 16.9 years [*IAUC* 7497, 2000 Sept 27]. The comet was reported as being around 15th magnitude, but was perhaps a little brighter visually as a few observations were reported.

There have been no recent approaches to Jupiter, although there were a couple of approaches to around 0.4AU in the 19th century, however neither of these made significant changes to the orbital elements. Despite its being a member of the Saturn family of comets there have been no close approaches to the planet in the last 300 years.

2000 S2 (146P/Shoemaker–LINEAR)

F. Shelly and R. Huber, MIT Lincoln Laboratory, reported the discovery by LINEAR of a 19th magnitude comet with a tail in p.a. about 280°, on Sept 27.44. Confirmation of cometary appearance on Sept 29.1 was received from P. Pravec & P. Kusnirak at Ondrejov (coma diameter 0'.2 with a 0'.2 tail in p.a. 260°) and from J. Ticha and M. Tichy at Klet (object diffuse with 14" tail in p.a. 265°) [*IAUC* 7498, 2000 Sept 29]. S. Nakano, Sumoto, Japan, then identified comet C/2000 S2 with D/1984 W1 (Shoemaker), the comet now being off from his prediction (*cf.* ICQ 2000 Comet *Handbook*) by ΔT= +23.2 days or about 7.5° in sky position [IAUC 7499, 2000 Sept 29].

The comet was discovered after an encounter to within 0.5AU of Jupiter in 1982 July. This actually increased the perihelion distance and another slightly closer encounter in 2006 March will increase it further to 1.42AU.

2000 S3 (LONEOS)

On Oct 1, B. W. Koehn communicated his measurements of a comet, later reported as discovered by B. A. Skiff on images taken on Sept 29.27 by M. E. Van Ness in the course of the LONEOS programme at Lowell Observatory. Skiff described a nearly circular coma of diameter 15" with moderate condensation. Following tentative linkage by B. G. Marsden, Center for Astrophysics, to one of about 2000 asteroidal objects recorded on Sept 20 by LINEAR (magnitude about 19), a tentative ephemeris was provided on the NEOCP. This linkage was confirmed by observations obtained on Oct 2 by J. G. Ries with the 0.76m reflector at McDonald Observatory. Skiff added that observations by L. H. Wasserman with the 1.1m telescope at Lowell Observatory on Oct 2 showed a 14"×11" coma, elongated east–west [*IAUC* 7501, 2000 Oct 2]. The comet is periodic, with a period of 40 years and was at perihelion in mid-July at a distance of 2.66AU.

It is a slightly unusual member of the Jupiter family of comets, having a relatively high inclination orbit, a longer than normal period and a Tisserand invariant of 2.2.

2000 S4 (P/LINEAR–Spacewatch)

Tom Gehrels reported his discovery of a faint (20th magnitude) comet on Oct 2.15 images taken with the Spacewatch telescope at Kitt Peak, noting it to have a 4" tail in p.a. 170°. T. B. Spahr, Minor Planet Center, linked it to an asteroidal object observed on Sept 23 and 26 reported earlier by LINEAR, and then found LINEAR observations made on Sept 1. At the request of Gehrels, P. Massey obtained images of the object in subarcsecond seeing with the 4m Mayall Telescope at Kitt Peak on Oct 3.25 UT, showing the comet to have a fan-shaped structure 4" long spanning p.a. 0–80° [*IAUC* 7502, 2000 Oct 3]. The comet was close to perihelion at 2.3AU and has a period of around 19 years.

Initially un-named, the IAU Committee on Small Bodies Nomenclature later gave the comet the name LINEAR–Spacewatch [*IAUC* 7553, 2000 Dec 31].

The comet is a member of the Saturn family. There have been no significant changes to the orbit over the last 300 years.

2000 S5 [SWAN]

This unusual SOHO discovery was found in 2002 April. The second systematic survey of hydrogen Lyman-alpha emission showed the comet appearing in SWAN images (wavelength range 10–180nm) during 2000 Sept–Nov. The first image to show it, taken on Sept 19.66 put it at around magnitude 11.6. Although having a perihelion distance of 0.60AU and perhaps reaching a peak brightness of 7th magnitude, it remained outside the LASCO field of view and was too far south and/or in the twilight for northern hemisphere comet hunters. Nevertheless it might have been detectable on images taken in Nov or Dec 2000. The comet was reported by Timo Makinen, of the Finnish Meteorological Institute, Helsinki, who noted that all comets brighter than total visual magnitude approximately 11 can be seen on the SWAN full-sky maps [*IAUC* 7885, 2002 Apr 25]. The comet has yet to be given an official name, as under IAU comet naming guideline 6 (**http://cfa-www.harvard.edu/iau/cometnameg.html**) it was not reported until some time after observation and was then no longer observable.

2000 S7 (208P/McMillan)

Robert McMillan discovered a 19th magnitude comet with the Spacewatch 1.8m reflector on 2008 Oct 19.20. Further prediscovery images back to Sept 20 were found in Spacewatch imagery. It was given the preliminary designation 2008 U1. In 2008 Dec, S Nakano linked the comet with previously unreported observations of an 18th magnitude object obtained by LONEOS in Sept and Oct 2000. This return is now designated 2000 S7. The comet passed 0.18AU from Jupiter on 2004 July 8. The encounter made significant changes to the angular elements and reduced the perihelion distance slightly. Prior to a previous encounter in 1945 the perihelion distance had been 3.5AU.

2000 SV_{74} (LINEAR)

An apparently asteroidal 18th magnitude object reported by LINEAR on two nights in Sept (first observation on Sept 24.34), and published on MPS 19881 under the designation 2000 SV_{74}, was found to be cometary (diffuse with 16" coma and 20" tail at p.a. 150°) by M. Tichy on CCD images taken on Oct 19.8 UT with the 0.57m f/5.2 reflector at Klet [*IAUC* 7510, 2000 Oct 19].

The comet has a rather flat light curve, as might be expected from its initial asteroidal designation, although most observers reported it as a diffuse object, albeit of small dimension. It was under observation at three oppositions: 2000 Oct (Pisces), 2001 Oct (Cassiopeia) and 2003 Apr (Bootes/Canes Venatici). Jonathan Shanklin observed it a few times in 2001 Aug, estimating it at between 13th and 14th magnitude in his 20cm LX200. Giovanni Sostero made a lengthy series of CCD observations during the apparition. Werner Hasubick was one of the last to see the comet, making it mag 13.5 in his 44cm reflector on 2002 Sept 12.84.

2000 SO_{253} (148P/Anderson–LINEAR)

An apparently asteroidal 20th magnitude object discovered by LINEAR on Sept 24.35 was found to be cometary (highly condensed 5" coma and a 15" tail in p.a. 45°) on 300s R-band CCD exposures taken on Nov 24.3 UT by C. W. Hergenrother & A. E. Gleason with the Steward Observatory 1.54m reflector [*IAUC* 7524, 2000 Nov 25].

S. Nakano, Sumoto, Japan, reported his identification of comet P/2000 SO_{253} (*cf. IAUC* 7524) with P/1963 W1 (*cf. IAUC* 2013), which had been recorded on four Palomar Schmidt plates taken on 1963 Nov 22–25. The comet made approaches of 0.10 and 0.40AU from Jupiter in 1961 Aug and 1985 April, respectively [IAUC 7548, 2000 Dec 23]. Prior to these encounters, which reduced the perihelion distance to 1.7AU, perihelion was 2.8AU and another moderately close encounter in 2092 will increase it to 2.1AU.

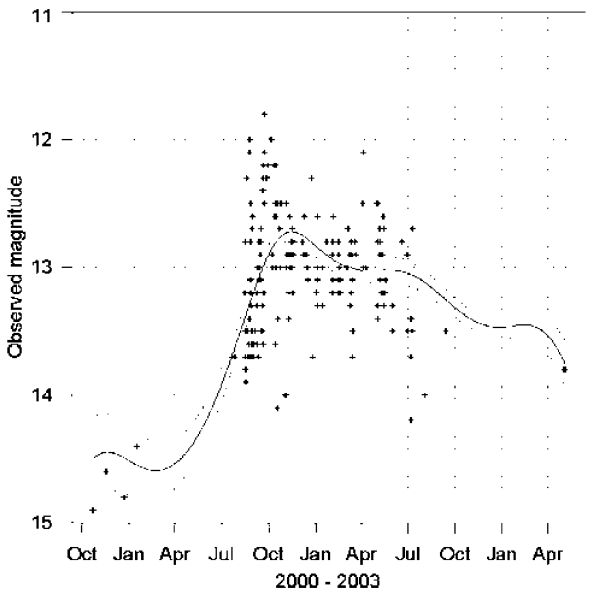

Figure 2. Visual light curve of comet 2000 SV_{74} (LINEAR). The curve is a best fit over the apparition, with no corrections applied. Tick marks indicate the first of each third month from 2000 Oct 1.

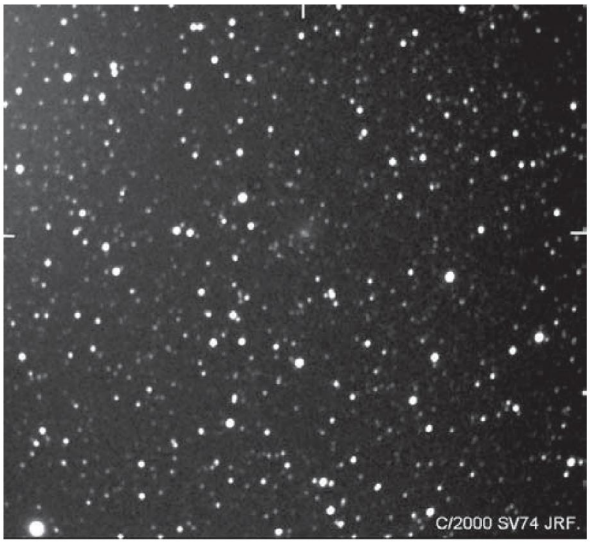

Figure 3. Comet 2000 SV_{74} (LINEAR) imaged by John Fletcher on 2001 Dec 7

2000T2 (147P/Kushida–Muramatsu)

S. Nakano, Sumoto, Japan, reported the recovery by T. Oribe of comet P/1993 X1 on CCD frames obtained with the 1.03m reflector at Saji Observatory on Oct 3.72 and 4. The images were clearly cometary with coma diameter 10". The indicated correction to the prediction by B. G. Marsden on *MPC* 31663 was ΔT= –0.04 day, but neither Nakano nor Marsden were able to obtain a link to the 1993–1995 data without dramatically systematic residuals, particularly in declination. Oribe later found faint images of the comet on frames obtained on Sept 26. C. E. Delahodde, European Southern Observatory, independently recovered the comet (as a pointlike object measured by A. Maury) with the Danish 1.54m reflector on Oct 8. A further orbit computation by Marsden indicated that it was possible to link the 2000 data to the observations made after the 1994 conjunction. This computation revealed that single-night candidates for the comet found by C. W. Hergenrother, Lunar and Planetary Laboratory, with the 2.3m Steward Observatory reflector at Kitt Peak in 1999 Sept and Nov indeed belonged to the comet, which showed a possible 5" tail in p.a. 270° on the first occasion [*IAUC* 7507, 2000 Oct 14].

Professional observations suggest that it is a very small, highly active object, with a diameter of around 400m and a rotation period of around 9.5 hours. The comet was captured into its present orbit in an encounter to within 0.31AU of Jupiter in 1959 Nov/Dec, which reduced the perihelion distance from 4.1AU to its present 2.75AU. A more distant encounter at the end of 2019 will push it out again to 3.2AU. The orbit is Hilda-like, i.e. near the 2:3 mean motion resonance with Jupiter, which has P= 7.91y, a= 3.97AU. The orbits of comets 129P/Shoemaker–Levy and D/Skiff–Kosai (1977 D1) are similar.

2000 U5 (LINEAR)

A 17th magnitude object with unusual motion that was reported as asteroidal by the LINEAR survey on Oct 29.38 and posted on the NEOCP was found to be cometary by other observers. The object seemed diffuse with a 14" coma and

Table 4. Standard magnitude parameters

	Comet	No.	r (AU)	H_1	dev	K_1	H_{10}	dev	H_{15}	dev
A1	Montani	10c	9.8–10.3				2.1±0.1	0.4	–2.9±0.1	0.5
B2	LINEAR	5c	3.9 – 4.0				7.9±0.1	0.1	4.9±0.1	0.1
B3 194P/	LINEAR	13c	1.7 – 2.0				12.2±0.3	1.0	10.9±0.3	1.1
B4 165P/	LINEAR	1c	7.0				5.7	1.5		
C1 175P/	Hergenrother	12c	2.1 – 2.2				11.6±0.2	0.8	9.9±0.2	0.8
CT_{54}	LINEAR	5	3.2				5.8±0.1	0.2	3.3±0.1	0.2
D2	LINEAR	1c	2.3				11.3	9.5		
ET_{90}143P/	Kowal–Mrkos	1c	3.5				9.4	6.6		
G1 P/	LINEAR	8c	1.1 – 1.5				16.3±0.6	1.7	15.8±0.7	1.9
G2	LINEAR	3c	2.8				11.2±0.1	0.2	8.9±0.1	0.2
H1	LINEAR	2c	3.7				7.8±0.2	0.3	4.9±0.2	0.3
J1	Ferris	1c	2.5				12.2	10.1		
K1	LINEAR	16	6.4 – 6.5				1.2±0.0	0.2	–2.9±0.0	0.2
K2	LINEAR	30	2.4 – 2.8	5.9±1.4	0.4	13.8±3.5	7.4±0.0	0.4	5.4±0.0	0.4
O1	Koehn	4c	6.1 – 6.3				4.8±0.1	0.2	0.8±0.1	0.2
OF_8	Spacewatch	5	2.3				8.9±0.1	0.1	7.1±0.1	0.1
R1 145P/	Shoemaker–Levy	9c	2.0 – 2.3				10.6±0.5	1.4	9.0±0.5	1.4
R2	LINEAR	3c	1.4 – 1.6				16.1±0.1	0.1	15.3±0.2	0.3
S1 P/	Skiff	13c	2.6 – 2.9				8.9±0.2	0.9	6.8±0.2	0.9
S2 146P/	Shoemaker–LINEAR	3c	2.0 – 2.3				12.9±0.1	0.2	11.2±0.2	0.3
S3	LONEOS	4c	2.8 – 3.1				10.7±0.2	0.3	8.3±0.1	0.2
SV_{74}	LINEAR	223	3.5 – 6.0	6.9±0.4	0.5	3.5±0.7	3.1±0.0	0.5	0.1±0.0	0.7
SO_{253}148P/	Anderson–LINEAR	1c	2.1				12.0	10.4		
T2 147P/	Kushida–Muramatsu	1c	3.1				11.1	8.7		
U5	LINEAR	13c	4.1 – 4.7				5.9±0.3	0.9	2.8±0.3	1.0
U6 196P/	Tichy	5c	2.2				12.9±0.2	0.3	11.2±0.1	0.3
W1	Utsunomiya–Jones	76	0.4 – 1.4	10.3±0.1	0.5	11.5±0.5	10.0±0.1	0.5	10.8±0.1	0.6
WM_1	LINEAR	1639	0.6 – 3.3	6.9±0.0	0.8	9.0±0.1	6.7±0.0	0.8	6.2±0.0	1.3
WT_{168}150P/	LONEOS	7c	1.8				13.2±0.3	0.7	11.9±0.2	0.6
Y1	Tubbiolo	5c	8.0 – 8.2				4.2±0.1	0.2	–0.4±0.1	0.2
Y2	Skiff	13c	2.8 – 2.9				9.8±0.2	0.9	7.6±0.2	0.8
Y3 P/	Scotti	12c	4.1 – 4.4				7.6±0.2	0.7	4.5±0.2	0.7
Y10 149P/	Mueller	5c	2.7				10.9±0.2	0.5	8.7±0.2	0.5
2P/	Encke	11cv	0.3 – 0.9				11.0±0.4	1.3	12.2±0.6	2.1
9P/	Tempel	12c	2.4 – 3.2				9.7±0.2	0.8	7.6±0.3	0.9
14P/	Wolf	3c	2.4				11.5±0.0	0.0	9.6±0.0	0.0
17P/	Holmes	9c	2.3 – 2.8				10.4±0.3	0.9	8.4±0.3	1.0
33P/	Daniel	5c	2.9 – 3.2				8.3±0.4	0.9	5.9±0.4	0.9
64P/	Swift–Gehrels	2c	2.9 – 3.4				9.7±0.8	1.1	7.2±0.6	0.9
70P/	Kojima	8c	2.1 – 2.7				10.5±0.3	0.9	8.7±0.4	1.0
71P/	Clark	6c	2.3 – 3.0				10.8±0.2	0.4	8.7±0.2	0.4
108P/	Ciffreo	2c	2.2 – 2.8				11.4±1.1	1.6	9.4±1.4	2.0
114P/	Wiseman–Skiff	63	1.6 – 1.9	11.6±0.8	0.5	7.2±3.9	11.0±0.1	0.5	10.0±0.1	0.5

The magnitude of the comets can be calculated from the standard equation: $m = H_1 + 5.0 * \log(\Delta) + K_1 * \log(r)$. For most comets there are insufficient observations to calculate K_1 accurately and so a value of 10 or 15 is assumed, which gives the constant H_{10} or H_{15} respectively. Well documented CCD V observations have been used to determine the magnitude parameters of comets with insufficient visual observations; these are indicated by c after the number of observations. A correction for aperture of 0.0033 mm^{-1} and the observer corrections derived in previous papers have been applied and the H values are reduced to zero aperture.

18" tail in p.a. 170° on CCD images obtained by J. Ticha & M. Tichy (Klet) on Oct 30.0 UT. Images taken on Oct 30.2 by D. A. Klinglesmith III (Socorro, NM) showed slight diffuseness and a tail about 20" long in p.a. 220°; images by Y. Ikari (Moriyama, Japan) also showed a tail in p.a. 220° on Oct 30.6. J. Biggs (Perth Observatory) noted that images of C/2000 U5 were larger than nearby stars and elongated toward the south–southwest on Oct 31.6. D. T. Durig (Sewanee, TN) found a tail about 25" long in p.a. 170° on Nov 1.4 images [*IAUC* 7515, 2000 Nov 1]. The comet was some eight months past perihelion at 1.9 AU.

2000 U6 (196P/Tichy)

An 18th magnitude object found by Milos Tichy on images taken at Klet with J. Ticha & M. Kocer on Oct 23.08, and originally reported as asteroidal, was subsequently noted to be diffuse on Klet images taken during Oct 28.9–29.2 UT; Tichy also noted a 10" coma on Oct 29.8 images. Images obtained on Nov 1 by S. Sanchez & M. Blasco at Mallorca and by D. T. Durig at Sewanee also showed diffuseness [*IAUC* 7515, 2000 Nov 1].

The comet made very close approaches to Jupiter in 1899 April (0.055AU) and 1982 May (0.014AU), which progressively reduced the perihelion distance from 4.7 to 2.2AU and increased the eccentricity from near circular to 0.43. A more distant encounter (0.2AU) at the end of 2041 will reduce the perihelion distance a little further. It was numbered following its recovery in 2008.

2000 V4 (SOHO)

This non-group SOHO comet was discovered by Rainer Kracht on 2005 Apr 14 in archival C3 images from 2000 Nov 10. Kracht noted that this tailed comet (which was at magnitude 7.2 on Nov 10.896 UT) appears related to C/2001 T5 [*IAUC* 8515, 2005 Apr 18].

Figure 4. Albert Jones with the telescope used for his discovery of 2000 W1 (Utsunomiya–Jones).

2000 W1 (Utsunomiya–Jones)

On Nov 19, S. Nakano, Sumoto, Japan, reported the visual discovery on Nov 18.82 by Syogo Utsunomiya (Aso, Kumamoto; 25×150 binoculars) of a possible 9th magnitude comet with coma diameter 5" moving rapidly southeastward in Vela. Attempts by several observers (including A. Hale, D. Seargent, J. Biggs, T. Urata, and J.Kobayashi) to confirm the object, at the request of Nakano and the Central Bureau, were unsuccessful. On Nov 25, A. C. Gilmore (Mount John University Observatory) reported the visual discovery of an apparent 8th magnitude comet by Albert F. Jones (Nelson, New Zealand, 0.078m f/8 refractor, ×30) while observing the variable star T Apodis at dawn on Nov 25.64; Jones reported the comet as being diffuse with coma diameter about 4" in morning twilight. The possibility that Jones' object might be the same as that reported by Utsunomiya was explored by the Central Bureau, and a search ephemeris from plausible parabolic orbital elements fitted to the Nov 18 and 25 approximate positions was circulated to numerous southern-hemisphere observers. Confirming CCD astrometry was made by Gilmore with the 1.0m f/7.7 reflector at Mt. John [*IAUC* 7526, 2000 Nov 28].

This was Albert Jones' second comet discovery; his first was made in 1946! The comet had a perihelion distance of 0.3AU, but was intrinsically faint. At discovery by Jones it was at a high southerly declination, moving very rapidly eastwards.

Albert described his discovery thus: '*On the morning of Nov 26, I was up early (as I do on clear mornings) observing variable stars before dawn, then as I was pointing the telescope to view a faint variable star south of the Southern Cross and Pointers, I noticed a fuzzy object that was new to the region and recognising that it was a comet and not permanent celestial scenery like a nebula, star cluster or galaxy, I noted its position and other details. Then I phoned Alan Gilmore at the Mount John University Observatory (by Lake Tekapo) and told him about it and asked if he knew about it and its name, but he had no information about it so he emailed a message to the International Central Bureau for Astronomical Telegrams (CBAT) at Cambridge, Mass. USA. At breakfast that morning Carolyn wondered why I did not get back to bed before bright daylight – I replied that I had been on the phone to Alan about a comet asking about whether it was a known one. After breakfast a message came from the CBAT saying that it might be the same object that a Japanese comet hunter had seen a week beforehand but which had not been seen again because it was moving south so fast and was thus unconfirmed. Using the Japanese positions for the comet and mine, they determined that it was the same object, to be known as Comet 2000 W1 Utsunomiya–Jones. It has quickly moved towards the west and is moving north again. Dec 5 was the last evening that I saw it, as it was too low in the sky and behind trees the next night. Next January when the comet's motion brings it into the eastern sky before dawn, it will be much fainter as it races away to the outer reaches of the Solar System. Over 50 years ago, I spent some time looking for unknown comets, and now I find one while pointing the telescope to a variable star! The moral of the story is to keep looking and you never know what you might see. You just need to be lucky enough to look at the right place at the right time! By the way, I am told that I am the oldest person to have discovered a comet.*'

Alan Gilmore & Pam Kilmartin provided another version of how the comet was discovered:

'On Nov 18 UT Japanese comet hunter Syogo Utsumoniya saw a possible comet in Vela, very low in his southern sky. Utsunomiya watched the eighth magnitude comet through his 25×150mm binoculars for 40 minutes as dawn approached. During that time the comet moved southeastward about 10 minutes of arc, one third of a fullmoon's diameter. Utsunomiya passed the information onto the International Astronomical Union's Central Bureau. They asked a few southern hemisphere observers (none in NZ!) to confirm the discovery. They were unable to locate the comet.

A week later, on Sunday morning Nov 26 NZ date, Albert Jones of Nelson found the sky had cleared. He got out his 78mm refractor with the 30× eyepiece and aimed it at the variable star T Apodis. He had intended to observe T Aps two mornings earlier but 'ran out of dark sky' before he got to it. Just 50' northwest of the variable Albert saw a

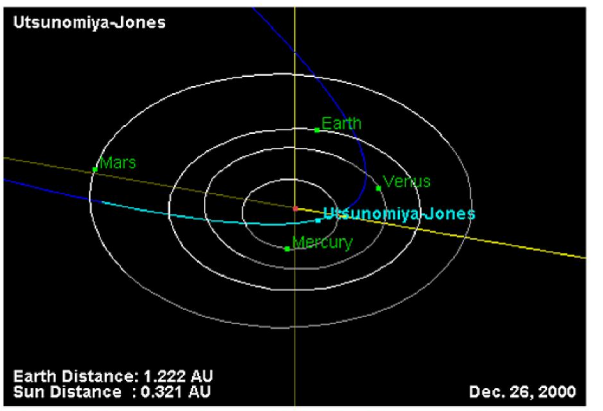

Figure 5. The orbit of comet 2000 W1 (Utsunomiya–Jones). Snapshot from *OrbitViewer* at **http://www.users.on.net/~dbenn/Astronomy/OrbitViewer/comet_ov.html**. The comet was discovered at T–31; observations used in the analysis cover the range T–31 to T+56.

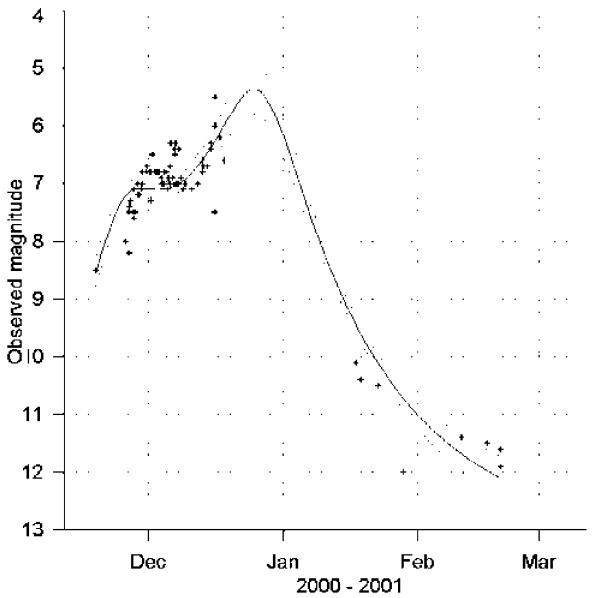

Figure 6. Visual light curve of comet 2000 W1 (Utsunomiya–Jones). The curve is a best fit over the apparition, with no corrections applied. Tick marks indicate the first of each month from 2000 Dec 1.

hazy spot which he instantly recognised as a comet. He made position and magnitude estimates as dawn came up and phoned them to the University of Canterbury's Mt John Observatory. We immediately emailed Albert's discovery position to the IAU Bureau.

At the Bureau Brian Marsden and Dan Green surmised that the two fast-moving eighth magnitude comets were one and the same object. Brian fitted a parabolic orbit to the two positions and emailed search ephemerides to a few southern hemisphere observers. (The Bureau is very cagey about a suspected comet lest an unscrupulous person 'discovers' it.)

As luck would have it, Mt John had a CCD camera on its 1m telescope. Glen Bayne was taking direct images of Magellanic Cloud eclipsing binary stars as part of his PhD project. (The same CCD is in frequent use on the 1m but attached to a large spectrograph, not available for direct picture taking.) Glen was happy to get pictures of the comet in the twilight.

Using a 15cm finder 'scope on one of Mt John's other telescopes, Alan Gilmore located the comet in the twilight. This allowed quick setting of the 1m onto the comet and CCD images to be taken. Alan measured these and sent the results off to the IAU Bureau. Three hours later another set of CCD images was obtained by Glen and Alan and the further positions sent off.

Brian Marsden was then able to fit a semi-accurate orbit to the three nights' observations and show conclusively that the comets seen by Utsunomiya and Jones were indeed the same object. IAU Circular 7526 appeared a few hours later, announcing the discovery and designating the comet 2000 W1. Numerous CCD measurements over the next four days allowed a more accurate orbit to be calculated. This appeared in Minor Planet Electronic Circular 2000-W62 on Nov 30.

At 80 years old, Albert Jones is the oldest person ever to discover a comet. The next nearest was Lewis Swift who was 79 when he found his last comet in 1899. Albert also holds the record for the longest interval between comet discoveries. His previous comet, also found in a variable star field, was 1946 P1 found in October 1946.

At discovery Comet Utsunomiya–Jones was about 50 million km from earth, hence its rapid movement across the sky. Perspective slows the apparent movement as the comet moves directly away from us and on toward the sun. The angle between the comet and the sun will shrink, causing the comet to sink into the south-west evening twilight. Counterbalancing this, to a greater or lesser degree, is the comet's expected increase in brightness as it nears the sun. So nobody can predict how long the comet will remain visible. It is likely to have disappeared by Dec 22 when it will be just 19 degrees from the sun.'

Michael Mattiazzo observed the comet with 7×50B on Nov 28.52, estimating it at mag 7.0, DC4, diameter 5'. It displayed a faint ion tail in 25×100B. Jonathan Shanklin was in the Southern Ocean on board the RRS Ernest Shackleton and made several attempts to observe the comet. These were generally foiled by bright skies or cloud, but he successfully glimpsed it in 10×50B on Dec 6.09 when it was 6.3, and again the following night. Few further observations were made, and Mattiazzo saw it for a final time on Dec 18.46 before it moved into solar conjunction. It was then magnitude 6.6 in his 40×100B. The comet transited the SOHO LASCO C3 field at the end of Dec and early Jan, when it was around 8th magnitude. By the time it moved out of conjunction it was fading rapidly, but there were scattered CCD and visual observations during 2001 Jan and Feb. Mattiazzo was able to recover it in late January, by which time it had faded to 12th magnitude and had become extremely diffuse. Professional observations suggest that it completely disintegrated, as images on Feb 19 at La Palma show only a diffuse cloud with no central condensation.

2000 WM_1 (LINEAR)

An apparently asteroidal 18th magnitude object with unusual motion reported by the LINEAR team on Dec 16.07 was posted on the NEOCP. Subsequent astrometry permitted a linkage to another set of observations by LINEAR on Nov 16.14 and 18, designated 2000 WM_1 on MPS 22800. An observation of 2000 WM_1 by T. B. Spahr (Smithsonian Astrophysical Observatory 1.2m reflector at Mt Hopkins) on Dec 20.148 UT showed the object to have a 10" coma and a broad, faint tail some 10"–20" long in p.a. 45° [*IAUC* 7546, 2000 Dec 20].

The comet was far from perihelion, which was in 2002 January. Visual observers first picked it up in 2001 Aug, when it was around 14th magnitude. A month later it had reached 12th magnitude, and Jonathan Shanklin was able to pick it up mid-month with his 20cm LX200, observing from a dark site. Other observers began to see it in Oct, with Gabriel Oksa estimating it at 9.7 in his 15cm refractor on Oct 27. By mid Nov it was an easy binocular object, with Roy Panther estimating it at 6.7 in 14×70B on Nov 14. It appeared to peak in brightness towards the end of the month, Guy Hurst estimating it at 5.7 in 10×50B on Nov 26. It was now rushing southwards, but Hurst was able to make a final observation on Dec 10 when he estimated it at 5.8 in 15×80B. The slow decline in brightness

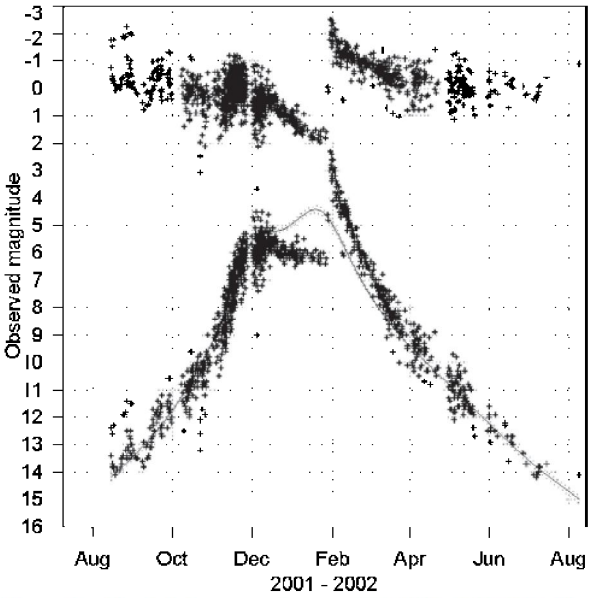

Figure 7. Visual light curve of comet 2000 WM_1 (LINEAR). The curve is a best fit over the apparition, with no corrections applied. Tick marks indicate the first of every other month from 2001 Aug 1.

continued until late January when a major outburst took place. On Jan 26 observers reported it at 6th magnitude, but the next night it was 5th, and by Jan 31 was 2.5. Thereafter it faded, barely departing from a normal lightcurve. The most likely explanation for the event is that a vent became choked, and was cleared in a sudden explosion and thereafter reverted to its previous behaviour. Following the event a tail of several degrees length developed.

As the comet moved north again, European observers in favourable locations were able to recover it. Atilla Kosa–Kiss observing with his 63mm refractor on March 24.13 estimated the comet at 10.0, rather fainter than the better placed southern hemisphere observers, who found it over a magnitude brighter. Werner Hasubick made a final observation of the comet on Aug 8.88 when it was 14.1 in his 44cm reflector.

2000 WT_{168} (150P/LONEOS)

After the publication (MPS 23043) of the initial observations of the apparently asteroidal 17th magnitude object 2000 WT_{168} by LONEOS on Nov 25.44 and LINEAR on Nov

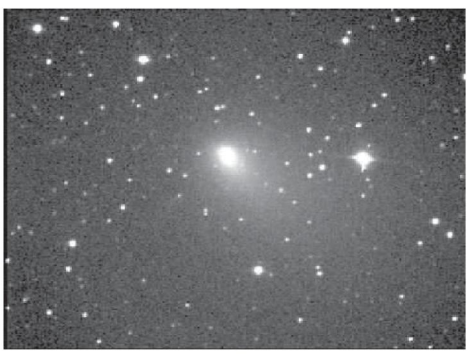

Figure 8 (above). Comet 2000 WM_1 (LINEAR) imaged by Brian Manning on 2001 Nov 9.

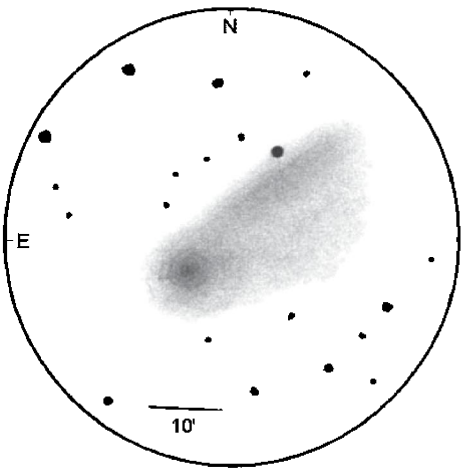

Figure 9 (right). Comet 2000 WM_1 (LINEAR) drawn by Gabriel Oksa on 2001 Nov 9.

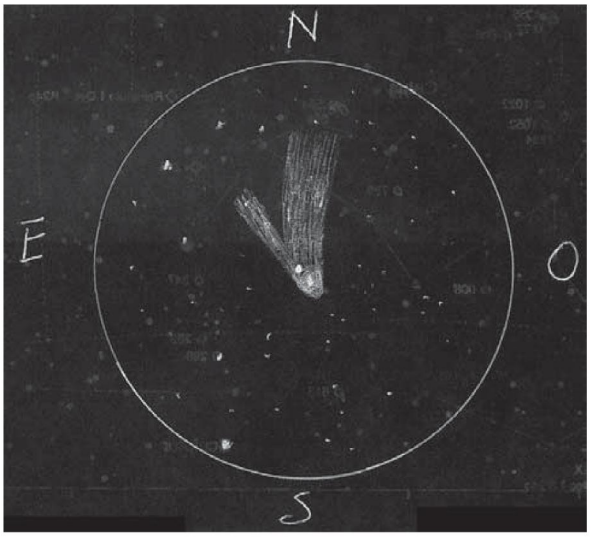

Figure 10. Comet 2000 WM_1 (LINEAR) drawn by Toni Scarmato on 2001 Dec 3

27.37, linkage to further observations (including prediscovery data) showed the orbit to be cometary, although observations did not show cometary activity in December (*cf. MPEC* 2000-Y21). CCD exposures taken with the 1.5m reflector at Catalina on 2001 Feb 13.3 UT by C. W. Hergenrother, however, did show the object to be cometary (highly condensed 9".7 coma with red mag 16.3 and 8".0 tail in p.a. 110°). Confirmation of cometary activity was obtained in CCD observations by J. Ticha & M. Tichy at Klet on Feb 16.9 (0.57m reflector; 9" tail in p.a. 155° and faint asymmetric coma) and by M. Hicks & B. Buratti at Palomar on Feb 17.2 (1.5m reflector; faint teardrop-shaped tail about 15" long in p.a. 60°). The comet has a 7.7 year period, with perihelion at 1.76AU on 2001 March 23 [*IAUC* 7584, 2001 Feb 17].

R. M. Stoss, Starkenburg–Sternwarte, Heppenheim; and R. H. McNaught, Siding Spring Observatory, reported the identification with P/2000 WT_{168} of two asteroidal trails appearing on UK Schmidt plates taken by M. R. S. Hawkins and P. R. Standen on 1978 March 6 and 1986 March 14. Astrometric measurements by McNaught, M. Read, and Stoss appeared on *MPEC* 2001-F17, together with orbital elements by B. G. Marsden from 190 observations spanning 1978–2001 (T= 1978 January 21, 1985 Oct 22, 1993 Jul 18, and 2001 March 23) [*IAUC* 7600, 2001 March 20].

The comet can approach to within 0.2AU of Jupiter. Apart from a small decrease in the perihelion distance, the orbit has shown little change over the last couple of hundred years.

2000 YI (Tubbiolo)

R. S. McMillan, Lunar and Planetary Laboratory, reported the discovery by

Andrew F. Tubbiolo of a faint 19th magnitude comet with the 0.9m Spacewatch telescope at Kitt Peak on Dec 16.18. The object showed a 20"–30" tail on Dec 16 and 17 [*IAUC* 7544, 2000 Dec 18]. The comet is another with a very large perihelion distance of nearly 8AU.

2000 Y2 (Skiff)

B. Skiff, Lowell Observatory, reported the discovery of a 17th magnitude comet by the LONEOS programme on Dec 27.34. Confirming CCD images by L. Wasserman (1.07m Lowell Observatory telescope) showed a coma diameter of about 9" and a tail about 14" long toward the southwest [*IAUC* 7549, 2000 Dec 27]. The comet is in a parabolic orbit and was approaching perihelion at 2.8AU. It did not come within visual range.

2000 Y3 (P/Scotti)

J. V. Scotti, Lunary and Planetary Laboratory, reported his discovery of a 19th magnitude comet with the 0.9m Spacewatch telescope on Dec 30.16. The comet showed a coma diameter of 7" and a 0'.93 tail in p.a. 269°; he also measured m_2= 19.7 [*IAUC* 7552, 2000 Dec 30].

Additional astrometry, including prediscovery observations by LINEAR on Nov 29 and Dec 21 identified by B. G. Marsden, appeared on *MPEC* 2000-Y47, together with orbital elements showing it to be a short-period comet. Further to *IAUC* 7552, J. V. Scotti noted that the comet showed a 7" coma and a 1'.16 tail in p.a. 270° on a Spacewatch CCD image taken on Dec 31.174 UT. An image obtained at Klet on Dec 30.79 showed a coma diameter of 8" and m_1 = 17.5 [*IAUC* 7553, 2000 Dec 31]. The comet faded.

The comet passed within 0.05AU of Jupiter in 1998 October, in an encounter that reduced the perihelion distance from 5.1 to 3.9AU.

2000 Y6 (SOHO) and 2000 Y7 (SOHO)

These SOHO non-group comets were discovered by Maik Meyer and Sebastian Hoenig respectively in real time C2 images on Dec 20.

Further to *IAUC* 7565, D. Hammer reported his measurements for two comets that appear to be two components of an earlier single comet. D. Biesecker provided V magnitudes for C/2000 Y6: Dec 20.463 UT, 7.8; 20.504, 7.8; 20.580,7.5; 20.588, 7.6; 20.604, 8.0; 20.646, 8.3 [*IAUC* 7567, 2001 January 19].

2000 Y10 (149P/Mueller)

S. Nakano, Sumoto, Japan, reported the recovery of P/1992 G3 by T. Oribe (Saji Observatory) on CCD images taken with a 1.03m reflector. The comet was faint and of stellar appearance on 2000 Dec 22.85 (m_2= 20.5). The indicated correction to the orbital elements on MPC 31663 (ephemeris on MPC 41213) was $\Delta T = +0.23$ day [*IAUC* 7577, 2001 Feb 1].

The comet can approach to within 0.1AU of Jupiter, however these encounters have only made relatively small changes to the orbit over the last couple of hundred years. It will approach Jupiter to 0.097AU in 2021 July, but again this makes relatively little difference to the orbit.

2000 YN_{30} (212/NEAT)

I had originally identified this object as an unusual asteroid that had a cometary orbit with a period of 7.8 years and perihelion at 1.7AU. It appeared as such until the final version of this paper was about to be submitted to the Papers Secretary. Then *IAUC* 9010 announced that Alex Gibbs had recorded a coma and tail on 2009 January 2.53, while imaging it with the Catalina 0.68m Schmidt. Other observers confirmed the cometary nature, and it was immediately numbered as it had been observed at two returns. There have been no close approaches to Jupiter over the last century, however more distant encounters (most recently to 0.64AU in 1996 and 0.68AU in 1972) have been slowly reducing the perihelion distance and this will continue in the next century. The transformation into a comet demonstrates that it is well worth imaging some of the asteroids with more unusual orbits to see if they show any cometary characteristics.

The numbered periodic comets at perihelion in 2000

2P/Encke

2000 saw comet 2P/Encke's 58th observed return to perihelion since its discovery by Mechain in 1786. The orbit is quite stable, and with a period of 3.3 years apparitions repeat on a 10 year cycle. The comet is the progenitor of the Taurid meteor complex and may be associated with several Apollo asteroids. It is a member of the Jupiter family of comets, but is currently decoupled from the planet and does not undergo significant perturbations.

This year the comet was not particularly well seen, but there were short observing windows from the Northern Hemisphere prior to perihelion, which was in September, and in the Southern Hemisphere after the comet reached perihelion. A few observers spotted the comet in early August, estimating it at around 11th magnitude. Pepe Manteca imaged it on Aug 10 and Aug 14. The comet was visible in the SOHO C3 coronagraph, but was fainter than expected and was only 8.8 on Sept 7.1. It suddenly brightened on Sept 14 at around 15:00 UT to 6.5. After perihelion, Michael Mattiazzo made a couple of observations in early Oct when it was fading around magnitude 10.5.

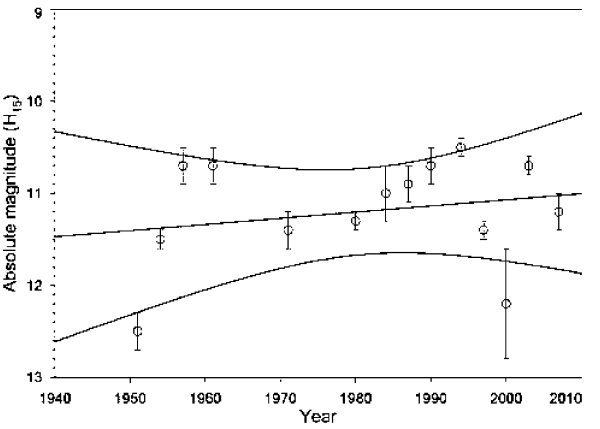

Figure 11. The absolute magnitude of comet 2P/Encke derived from BAA observations.

A secular fading of the comet has been suggested in the literature, but BAA observations over the last 50 years show little evidence of this. An alternative suggestion is that Encke has two active regions, an old one with declining activity, which operates prior to perihelion and a recently activated one present after perihelion.

9P/Tempel

The comet was first observed in 1867, but was lost between 1879 and 1967 following an encounter with Jupiter in 1881 which increased the perihelion distance from 1.8 to 2.1AU. Further encounters in 1941 and 1953 put q back to 1.5AU and calculations by Brian Marsden allowed Elizabeth Roemer to recover it in 1967. Alternate returns are favourable, but perturbations will once again increase the perihelion distance in the middle of the next century. This return was an unfavourable one and no observations were made. It was an important comet to observe as it was the target for the *Deep Impact* mission, which culminated in spectacular success in 2005 July.

14P/Wolf

The comet was fairly bright (mag 7) at its discovery apparition in 1884, which occurred after a close approach to Jupiter in 1875 reduced the perihelion distance from 2.7AU to 1.6AU. A further encounter in 1922 put q back to 2.4AU and apart from in 1925 the comet has not been brighter than mag 18 since then. No visual observations were reported at this return.

17P/Holmes

When discovered in 1892 by E. Holmes while observing M31 with a small reflector from London, the comet was brighter than M31 which was close by. It was evidently in outburst and one photograph showed a double nucleus, perhaps showing a similar event to that which occurred in 73P/Schwassmann–Wachmann in 1995. In 1899 and 1906 it was only 14–15 magnitude and was lost for the next seven returns until recovered by Elizabeth Roemer following a prediction by Brian Marsden. The orbit is relatively stable at the moment with occasional distant encounters with Jupiter changing the perihelion distance a small amount. For the last few returns it has been no brighter than 17th magnitude. Pepe Manteca imaged the faint comet on August 10.

Some time after perihelion it spectacularly outburst, however this will be documented in a later report.

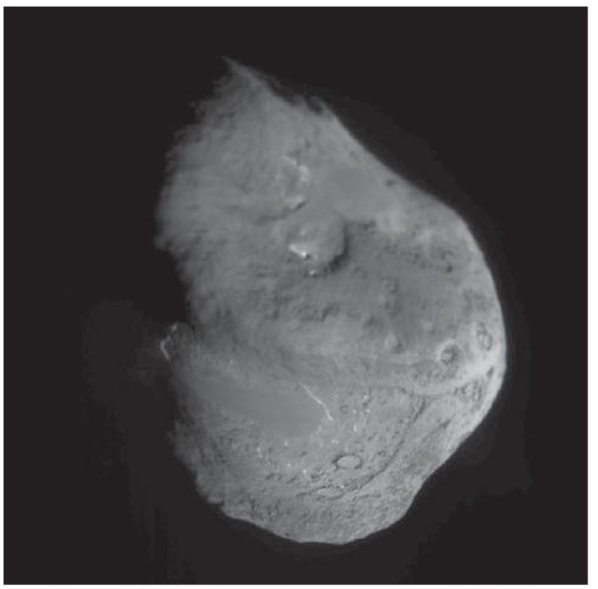

Figure 12. *Deep Impact* image of 9P/Tempel. *(NASA)*

33P/Daniel

This is another comet that has had its perihelion distance changed by encounters with Jupiter. It was discovered in 1909 as a 9th magnitude object after q changed from 1.5 to 1.4AU. It was next seen in 1937 after q had been increased to 1.5AU again and although it has reached mag 12 at a favourable apparition, most have been unfavourable. An encounter with Jupiter in 1995 increased q to 2.2AU, and it was not observed visually. The CCD lightcurve is not a particularly good fit to a standard magnitude law, and it seems to have faded unusually rapidly.

64P/Swift–Gehrels

The comet was discovered in 1889 and then lost until it was recovered by chance by Tom Gehrels in 1973. Only CCD observations were reported at this apparition, with the comet around 19th magnitude. The last favourable apparition was in 1981 when it reached mag 11.

70P/Kojima

The orbit of the comet is chaotic, oscillating between the 1:2 and 3:4 resonances with Jupiter. An encounter in 1962 reduced the perihelion distance to 1.6AU and it was discovered in 1970. A further encounter in 1973 increased q to 2.4AU, but another encounter with Jupiter in 1996 reduced q to 2.0AU. There were no visual observations at this return and the brightest CCD images are around 17th magnitude.

71P/Clark

Michael Clark of Mount John Observatory, New Zealand discovered this comet on a variable star patrol plate in 1973 June. At discovery the magnitude reached 13, but alternate returns are unfavourable and it is then 5 magnitudes fainter, though it hasn't been missed. An encounter with Jupiter in 1954 put it into its present orbit, which is such that it can approach quite closely to Mars, passing within 0.09AU in 1978. This was the comet's 6th return since discovery.

76P/West–Kohoutek–Ikemura

The comet was discovered in 1975 following a very close encounter with Jupiter in 1972 which produced one of the largest reductions of perihelion distance on record, reducing q from 5.0 to 1.4AU. Lubos Kohoutek was actually taking a confirmation plate for a second comet (75P/Kohoutek) discovered 18 days earlier and then lost. Although mag 12 at the discovery apparition, this is another comet which has not done so well on subsequent returns.

87P/Bus

When discovered at Siding Spring in 1981, on a UK Schmidt plate taken for asteroid search purposes, the comet was

mag 16.5. It was a fairly favourable return, and similar to the present one. The comet was perturbed into its present orbit following a very close approach to Jupiter in 1952 which swapped the perihelion of the previous orbit to the aphelion of the new one. After a few more returns a further encounter with Jupiter will increase the perihelion distance from 2.2 to 3.6AU. The orbits of comets 94P/Russell and 116P/Wild have similarities, with a= 3.5, e= 0.37 and a Tisserand invariant of just over 3.

108P/Ciffreo

Jacqueline Ciffreo discovered the comet in 1985 with the Caussols 0.9m Schmidt, not far from 1P/Halley in the sky. The comet had made a close approach to Jupiter in 1983, putting it into its present orbit.

112P/ Urata–Niijima

The comet was discovered at a very favourable return in 1986, following an encounter with Jupiter in 1982/83, although this in fact increased the perihelion distance. Further encounters will take place, and by the end of the century perihelion will be down to 1.3AU. This return was a poor one, and the comet was not seen by amateur observers.

114P/Wiseman–Skiff

A close approach to Jupiter in 1984 diverted the comet into its present orbit and it was discovered in 1986 December. The 6.5 year period means that alternate returns are unfavourable and the previous one was poor.

The comet was under visual observation from 1999 Oct to 2000 Feb. It was near peak brightness in early 2000. On Dec 7.8 Jonathan Shanklin made it 14.0: in the Northumberland refractor, but it was only visible with averted vision. On January 5 he could see it clearly at 14th magnitude. Werner Hasubick observed it on Feb 27.8, estimating it at 14.0 in his 44cm reflector.

137P/Shoemaker–Levy

This comet was recovered as 1998 K6 and was described with the comets of that year.[4]

1999 RE_{70} = 176P/LINEAR

The discovery of this comet was described in the paper on the comets of 1999.[5]

184P/Lovas

The comet was discovered by Miklos Lovas at the Piszkesteto Observatory, Hungary, on 1986 Nov 28 as a 14th magnitude object. The initial orbit was a little uncertain and it was not recovered at returns in 1993 or 2000. It was poorly placed during the 2000 return. It was finally accidentally recovered in 2007, some 19 days from its ephemeris position and with a significantly fainter absolute magnitude than at discovery. The comet makes regular encounters with Jupiter, most recently in 1957 (0.2AU), 1968 and 2004, which have made significant changes to the orbit such that the perihelion distance has reduced from 1.6AU in 1950, to the present 1.4AU.

Other comets at perihelion in 2000

Many comets were discovered with the SOHO LASCO coronographs and were not observed elsewhere. The majority were sungrazing comets of the Kreutz group and these did not survive perihelion. This group of comets was discovered by Henry Kreutz at the end of the nineteenth century from study of the exceptionally bright comets of that century that grazed the solar photosphere. A few more were seen from the ground during the twentieth century, most notably comet 1965 S1 (Ikeya–Seki). With the advent of solar imaging spacecraft many more members of the group were detected, albeit as much smaller fragments. The SOHO satellite has been outstandingly successful in discovering them, with over 1300 to its credit.

C/2000 C6 was first noticed by Terry Lovejoy on SOHO web images on Feb 9.22, and Biesecker noted that its brightness ranged from V= 8.7 on Feb 9.43 to 7.7 on Feb 9.68 UT, and the comet showed a tail at 13 solar radii on C3 images [*IAUC* 7364, 2000 Feb 12]. Some of the comets show no tail at all and it is possible that some supposed observations of Vulcan were actually tiny Kreutz group comets. (Some support for this idea came in 2008, when a Kreutz sungrazer was imaged during the total solar eclipse. This showed it as a small disk-like object, very reminiscent of some of the nineteenth century eclipse sightings of the mythical planet.) Table 5 lists the *IAUC* announcing the Kreutz comets and those of the Kracht, Marsden and Meyer groups.

These three groups have more distant perihelia than the Kreutz group and many objects survive perihelion. The Kracht and Marsden groups are linked, forming part of the Machholz complex which originated several thousand years ago, although it is clear from the rate of fragmentation that the Kracht and Marsden groups themselves are very young. The complex also includes several meteor showers, and comet 96P/Machholz. The comets in the two groups are periodic, but progressive fragmentation makes the linkages complex to determine. The Meyer group has a much larger inclination, and its members have not yet been shown to be periodic, though they too may be linked to the complex.

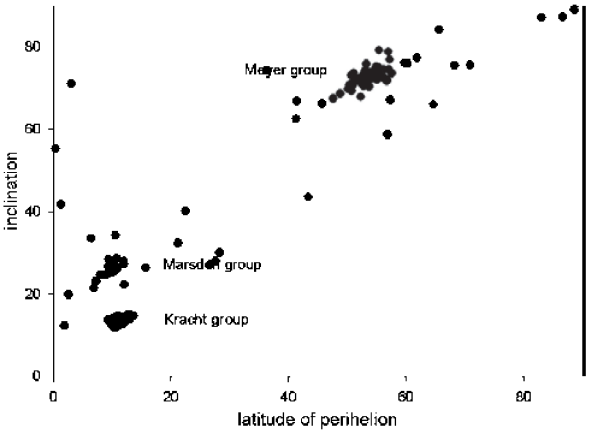

Figure 13. Orbital details of the Kracht, Marsden and Meyer groups of SOHO comets.

Table 5. SOHO comets

Comet	IAU Circular	Comet	IAU Circular
a). Kreutz group			
		2000 P1	7479, 2000 Aug 21
2000 A2	7562, 2001 Jan 14	2000 P2	7479, 2000 Aug 21
2000 B1	7349, 2000 Jan 24	2000 S6	8546, 2005 Jun 7
2000 B5	7386, 2000 Mar 24	2000 T1	7506, 2000 Oct 10
2000 B6	7386, 2000 Mar 24	2000 T3	7508, 2000 Oct 16
2000 B7	7386, 2000 Mar 24	2000 T4	7508, 2000 Oct 16
2000 C6	7364, 2000 Feb 12	2000 T5	7919, 2002 Jun 14
2000 D1	7370, 2000 Feb 29	2000 T6	7919, 2002 Jun 14
2000 D3	7386, 2000 Mar 24	2000 U1	7514, 2000 Nov 1
2000 E1	7376, 2000 Mar 07	2000 U2	7514, 2000 Nov 1
2000 F1	7393, 2000 Apr 04	2000 U3	7514, 2000 Nov 1
2000 F2	7919, 2002 Jun 14	2000 U4	7514, 2000 Nov 1
2000 F3	7919, 2002 Jun 14	2000 V1	7520, 2000 Nov 17
2000 G3	8073, 2003 Feb 14	2000 V2	7520, 2000 Nov 17
2000 H2	7412, 2000 May 01	2000 V3	7536, 2000 Dec 05
2000 H3	7572, 2001 Jan 25	2000 W2	7548, 2000 Dec 23
2000 H4	7572, 2001 Jan 25	2000 W3	7548, 2000 Dec 23
2000 H5	7572, 2001 Jan 25	2000 W4	7562, 2001 Jan 14
2000 H6	7899, 2002 May 13	2000 W5	7562, 2001 Jan 14
2000 H7	7899, 2002 May 13	2000 X1	7562, 2001 Jan 14
2000 J3	7422, 2000 May 11	2000 X2	7562, 2001 Jan 14
2000 J4	7426, 2000 May 19	2000 X3	7562, 2001 Jan 14
2000 J5	7433, 2000 May 30	2000 X4	7562, 2001 Jan 14
2000 J6	7567, 2001 Jan 19	2000 X5	7562, 2001 Jan 14
2000 J7	7572, 2001 Jan 25	2000 X6	7562, 2001 Jan 14
2000 K3	7433, 2000 May 30	2000 X7	7562, 2001 Jan 14
2000 K4	7433, 2000 May 30	2000 X8	7572, 2001 Jan 25
2000 K5	7433, 2000 May 30	2000 Y4	7562, 2001 Jan 14
2000 K6	7433, 2000 May 30	2000 Y5	7567, 2001 Jan 19
2000 K7	7567, 2001 Jan 19	2000 Y8	7567, 2001 Jan 19
2000 K8	7567, 2001 Jan 19	2000 Y9	7567, 2001 Jan 19
2000 L1	7439, 2000 Jun 14		
2000 L2	7439, 2000 Jun 14	*b). Marsden group*	
2000 L3	7439, 2000 Jun 14		
2000 L4	7445, 2000 Jun 29	2000 C3	7364, 2000 Feb 20
2000 L5	7445, 2000 Jun 29	2000 C4	7364, 2000 Feb 20
2000 L6	7572, 2001 Jan 25	2000 C7	7919, 2002 Jun 14
2000 M1	7445, 2000 Jun 29		
2000 M2	7450, 2000 Jul 08	*c). Meyer group*	
2000 M3	7452, 2000 Jul 11		
2000 M4	7452, 2000 Jul 11	2000 B8	7853, 2002 Mar 14
2000 M5	7452, 2000 Jul 11	2000 C2	7364, 2000 Feb 20
2000 M6	7453, 2000 Jul 13	2000 C5	7364, 2000 Feb 20
2000 M7	7453, 2000 Jul 13	2000 J8	7899, 2002 May 13
2000 M8	7453, 2000 Jul 13	2000 N4	7899, 2002 May 13
2000 M9	7454, 2000 Jul 14	2000 X9	7919, 2002 Jun 14
2000 N1	7454, 2000 Jul 14		
2000 N2	7459, 2000 Jul 20	*d). Kracht group*	
2000 N3	7572, 2001 Jan 25		
		2000 O3	7479, 2000 Aug 21

Matthew Knight gives some of the latest theories of these comet groups in his PhD dissertation,[6] which supplements the work of Sekanina.[7] He suggests that the number of Kreutz comets seen by SOHO has been increasing over the duration of the SOHO mission, and that this may be a precursor to the return of a major component of the family. Fragmentation is a common feature of all the groups, and this, combined with the small size of the fragments (less than 50m) suggests that we live at an unusual epoch, where many Kracht and Marsden comets can be seen.

Information about the latest SOHO discoveries is available from the SOHO comet web page at **http://ares.nrl.navy.mil/sungrazer/.** SOHO experienced a malfunction on 1998 Jun 25 and contact with it was lost. It was located by radar on July 29, communication was re-established in early August and it resumed pointing at the Sun in mid September. The LASCO cameras were reactivated in October but further problems were encountered and the spacecraft did not return to action until 1999 February. Further control problems were encountered in late 1999 and early 2000, but these were overcome and SOHO continues in operation at the time of writing.

There were three LASCO (Large Angle Spectroscopic Coronographs) on the SOHO spacecraft, which orbits the Sun at the earth's L1 Lagrangian point, 1.5 million km ahead of the Earth. C1 had a field from 1.1 to 3 solar radii, but is not functional, C2 from 1.5 to 6 and C3 from 3.5 to 30. Brighter objects were often discovered in real-time data, but fainter ones had to wait for the archival data to be searched, which ran three or four months behind and was not that efficient. The introduction of amateurs into the search process greatly increased the detection rate; however even in 2006 some comets were still being found in archival data from the 1990s.

Several of the Kreutz comets have discovery stories associated with them. Jonathan Shanklin recounts some tales:

'The evening of [2000] January 24 was clear and I went straight to the University of Cambridge Observatories after work to observe some known, but faint comets with the Northumberland refractor. Having completed the cometary observations I observed a few variable stars and then decided to have a quick look on the Starlink computer system to see if there were any new discoveries (there weren't). While logged on I downloaded the latest SOHO coronagraph images and immediately noticed a moderately bright sungrazer heading on its kamikaze path. It was so obvious that I assumed that someone else must have spotted it, but notified Doug Biesecker anyway. Later that evening I checked his web page and found that nobody else had found it and I had my third (2000 B1) to demonstrate that the first two weren't flukes.

I gave a short talk about the Kreutz comets and my discovery at the Saturday SPA meeting on January 29 and encouraged people to give this method of comet hunting a go. Michael Oates took me at my word, downloaded a series of the high resolution images from the C3 coronagraph and put them into a movie loop himself. He soon spotted a moving object (2000 B6) and gave me a call on Sunday afternoon. Maik Meyer, a German amateur astronomer, had already spotted this one on the lower resolution real-time movie loops and I had posted the information on the web that morning but Michael was still credited as a co-discoverer. Persistence pays off, and Michael picked up one of his own on Feb 7 (2000 C5). This is a rather unusual object which may be a fragment of a split comet as three other similar finds were made around the same time. Michael deserves congratulations for his ingenuity in putting together his own movie sequence and discovering both comets. This technique allowed him to discover

further comets as he could see fainter objects than everyone else using the real-time movies.

I left for a trip to Antarctica on Feb 14 and whilst I was away Michael discovered two more comets on archival SOHO imagery and a third on live images (2000 E1). One of the archival objects was another Kreutz sungrazer (1999 E2) that had been missed because the spacecraft was in an unusual orientation. The other was a Marsden group object (1999 J6). His live discovery was also a Kreutz group object. Two days after my return from Antarctica on March 30 I discovered another Kreutz group comet (2000 F1) at the Institute of Astronomy, this time whilst I was preparing material for the Spring issue of The Comet's Tale.

By the end of July, Michael Oates was THE leading comet discoverer with a record of over 60 SOHO comets and has gone on to record 145 objects.

I found another as well (2000 L5), as a second discoverer. Unfortunately I have been unable to re-find the discovery story that I wrote at the time. I think the comet was discovered as I was preparing material for the BAA Exhibition Meeting and listening to the test match commentary on the radio. Outside a thunderstorm was in progress and I was wondering if I should shut down my computer in case of a power surge. Memory is rather dim of the precise sequence of events, but for some reason I logged in to get the latest SOHO images. The test match was coming to an exciting conclusion and just as exciting I spotted a moving object on the SOHO images. I think I just about managed to get out a report before the expected power cut occurred, and later found that I was the second person to report the comet.'

1999 S4 (LINEAR)

One of the more notable comets seen during 2000 was discovered the year before, and was therefore described with the comets of that year.[5] It peaked at around 6th magnitude at the time of perihelion, but by then its intrinsic brightness was declining as the comet disintegrated.

Other comets and objects observed during the year

29P/Schwassmann–Wachmann

The comet was not well placed for observation from the UK, as it was in Scorpius when at opposition in June. Southern Hemisphere observer Jose Aguiar reported it as possibly being in outburst on July 1, however no other positive reports were received.

This annual comet normally has frequent outbursts and for a number of years seems to have been more often active than not. It rarely gets brighter than mag 13 in outbursts, however even this is remarkable for an object that is more distant than Jupiter from the Sun. It is possible that its pattern of behaviour is changing. In the first half of 1998 it was in outburst on several occasions and this also occurred in 1999. 2000 was exceptional for the apparent lack of outbursts, whereas it was in almost continuous outburst in 2004. The randomly spaced outbursts may be due to a thermal heat wave propagating into the nucleus and triggering sublimation of CO inside the comet. This comet is an ideal target for those equipped with CCDs and should be observed at every opportunity.

A/2000 AB_{229}

Details of an unusual asteroid with a 400 year period, a high inclination orbit and a perihelion distance of 2.3AU were given on *MPEC* 2000-B20. The 18th magnitude object was discovered by LINEAR on January 5.38 and was just past perihelion. It was only observed over a 64 day arc and is classed as a cubewano or scattered disk object. Assuming a standard albedo it is around 10km in diameter.

A/2000 AC_{229}

The next *MPEC* gave details of another unusual object, which has a period of 8.5 years, an inclination of 52° and a perihelion distance of 1.8AU. This was discovered by LINEAR on January 8.24 and has an estimated diameter of 3km.

(137924) A/2000 BD_{19}

MPEC 2000-C09 reported the discovery by LINEAR of a sun-skirting asteroid on January 26.26. The 18th magnitude object has a period of 0.8 years, and a perihelion distance of 0.09AU. If entirely asteroidal it would be 12th magnitude at perihelion, but if it shows cometary activity it could reach 6th and be visible on SOHO LASCO images. It was at perihelion on 1999 Oct 17.3 and has now been observed over 7 oppositions between 1997 and 2008. Classed as an Aten asteroid it has an estimated diameter of 2km.

A/2000 DG_8

This unusual asteroid has a retrograde orbit, with a period of 35 years and perihelion at 2.2AU. It may be an extinct cometary nucleus.

A/2000 EJ_{37}

This unusual asteroid has a period of 10.1 years, with perihelion at 1.4AU.

A/2000 GQ_{132}

MPEC 2000-J19 reported a cometary asteroid discovered by NEAT on Apr 12.51. The object, of 18th magnitude, is in a 5.9 year orbit with inclination of 30° and a perihelion distance of 1.5AU [2000 May 06].

A/2000 GH_{147}

Asteroid 2000 GH_{147} was discovered by NEAT on 2000 Apr 12. It was subsequently followed up by many observers worldwide, including J. Ticha & M. Tichy at Klet, P. Kusnirak at Ondrejov, M. Hicks, and D. Deaver at Table Mountain. This 2km asteroid is unusual with a high-inclination (48°), high-eccentricity (0.42) orbit that takes it from near Mars' orbit to inside Jupiter's. It is therefore an extinct comet candidate.[8]

A/2000 HE_{46}

This unusual asteroid has a retrograde orbit with a period of 115 years and perihelion at 2.4AU. It must therefore be considered as an extinct cometary nucleus.

(118624) A/2000 HR_{24}

Details of unusual asteroid 2000 HR_{24}=1995 XH_5=(118624) appeared on *MPEC* 2000-J50. The object was first spotted by Spacewatch in 1995 Dec, and then independently discovered by LONEOS in late 2000 April. Prediscovery images were found in LINEAR and NEAT data. The asteroid has an 11.1 year period, with a perihelion distance of 4.1AU. The 18th magnitude object, which appears stellar, will fade [*MPEC* 2000-J50, 2000 May 13]. It is classed as a Jupiter Trojan asteroid, with an estimated diameter of 17km.

A/2000 HD_{74}

Details of unusual asteroid 2000 HD_{74} appeared on *MPEC* 2000-J56. The object has a high inclination (49°) short period (5 year) cometary type orbit, but shows no cometary activity. The 18th magnitude object was discovered by LONEOS on Apr 30.38. It was closest to Earth in late May, and reached perihelion at 1.19AU in July when it was at a high southern declination [*MPEC* 2000-J56, 2000 May 15]. It is classed as an Amor asteroid.

(105140) A/2000 NL_{10}

This asteroid approaches the Sun to 0.17AU and has an eccentric orbit which takes it out to 1.67AU. It was discovered by LINEAR on July 10 [*MPEC* 2000-N28, 2000 Jul 12]. Further observations from Palomar from 1952 and 1992 were discovered and an improved orbit was given on *MPEC* 2000-O17 [2000 Jul 23]. It was numbered 105140, and is classed as an Aten asteroid, with an estimated diameter of 5km.

A/2000 XO_8

This unusual asteroid has a period of 8.7 years, with perihelion at 1.5AU.

The Edgar Wilson Award

The 2000 Award was divided between: Daniel W. Lynn, Kinglake West, Victoria, Australia, for C/1999 N2; Korado Korlevic, Visnjan, Croatia, for P/1999 WJ_7; and Gary Hug and Graham E. Bell, Eskridge, KS, USA, for P/1999 X1.

Acknowledgments

Thanks are due to Guy Hurst for the long hours spent in preparing cometary material for publication in *TA* magazine. Acknowledgment is also given to the British Antarctic Survey and the Institute of Astronomy, Cambridge for the use of computing facilities. The freeware software *Ephemeris Tool 4* by Manfred Dings was most helpful in computing the circumstances of planetary encounters. Michael Oates provided magnitude estimates from SOHO LASCO data.

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Received 2008 November 13; accepted 2009 March 25