

The comets of 1997

Jonathan Shanklin

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

This report is the eighth 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} or on the JPL *Horizons* web site.⁴ The suggestion made by Dan Green of the ICQ to drop the numeric suffix of periodic comets has been adopted in this report.

Comets with discovery letter designations

1997 AI NEAT

The Near Earth Asteroid Tracking (NEAT) team discovered a very faint comet (19th magnitude) on January 10.51, on images obtained by the USAF Ground-based Electro-Optical Deep Space Surveillance (GEODSS) team using the 1m f2.2 Ritchey–Chrétien telescope and CCD on Hawaii [IAUC 6532, 1997 January 11]. It was a distant object and was not observed visually, however Stephen Laurie obtained astrometric CCD images on January 15.

NEAT is an autonomous celestial observatory developed by the Jet Propulsion Laboratory (JPL) and funded by NASA to study asteroids and comets. The NEAT principal investigator is Dr Eleanor F. Helin, with co-investigators Dr Steven H. Pravdo, who is also the project manager, and Dr David Rabinowitz (now of Yale University).

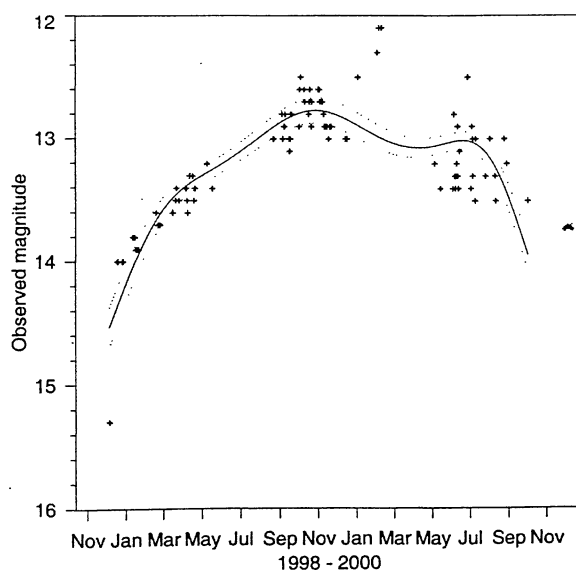


Figure 1. The observed magnitude of comet 1997 BA₆ (Spacewatch). The curve shown is a best fit over the apparition, with no corrections applied. Tick marks indicate the first of each second month from 1998 November.

NEAT was first located at the GEODSS site on Haleakala, Maui, Hawaii. JPL designed, fabricated and installed the NEAT camera and computer system on a 1m GEODSS telescope. NEAT began observing in 1995 December and observed for twelve nights each month centred near the New Moon until 1996 December. Beginning in 1997 January, NEAT observed for six nights each month, starting six nights prior to the New Moon. NEAT's last observations on GEODSS were in 1999 February.

1997 BI P/Kobayashi

S. Nakano reported an asteroid discovered by Takao Kobayashi on January 30.71 to the Central Bureau for Astronomical Telegrams (CBAT), but subsequent observations showed that it was in a cometary orbit and further observations by W. Offutt showed it to have a coma and tail [IAUC 6553, 1997 February 4]. The nuclear magnitude of the comet was around 18. This is the first amateur CCD discovery of a comet and is also the faintest amateur discovery, showing that the field is not lost to the professional search teams. With a period of around 25 years the comet is beyond Saturn at aphelion. It has made no recent close approaches to the ringed planet or to Jupiter, though it has approached both to around 1 AU in the last century.

1997 BA₆ Spacewatch

Details of the orbit of an unusual asteroid, 1997 BA₆, were given on MPECs 1997-C05 and C13. The initial orbit was very eccentric, with a period near 4500 years and a semi-major axis of several hundred AU. This is more typical of a long period comet and subsequent observations with large telescopes showed a small faint coma [IAUC 6561, 1997 February 19]. Discovered on January 31, with pre-discovery images on January 11, it was near opposition in Leo and still 9 AU from the Sun. It reached perihelion at 3.4 AU, at high southern declination, in 1999 December when it was around 12th magnitude.

The comet being almost exclusively the preserve of southern hemisphere observers, Andrew Pearce made the first visual observation on 1998 December 18 when it was 14th magnitude in his 0.41m reflector. It slowly brightened and reached 12.6m in October and November 1999. It may have undergone a small outburst just after perihelion as

Table 1. Orbital data for the comets of 1997^{3,4,5,6}

Comet		<i>T</i>	<i>q</i>	<i>e</i>	<i>P</i>	ω	Ω	<i>i</i>
1995 O1	Hale-Bopp	1997 04 01.1373	0.914141	0.995069		130.5887	282.4707	89.4300
1995 M1	C/Shoemaker-Levy	1997 01 12.1950	2.021244	0.420477	6.51	301.9866	152.0973	8.4734
1996 R2	P/Lagerkvist	1997 01 19.3857	2.609480	0.310222	7.36	334.0908	40.2462	2.6053
1997 A1	NEAT	1997 06 19.5914	3.157204	1.002055		40.0129	135.7668	145.0717
B1	P/Kobayashi	1997 03 02.3470	2.054550	0.760753	25.2	183.3401	329.0641	12.3495
B2	SOHO (Biesecker)	1997 01 26.95	0.0070	1.0		70.41	352.68	144.82
B3	SOHO (Danaher)	1997 01 22.71	0.0071	1.0		72.67	354.29	145.11
BA ₆	Spacewatch	1999 11 27.5845	3.436343	0.998867		285.9392	317.6638	72.7149
C1	P/Gehrels	1996 01 29.2065	3.565219	0.468823	17.4	211.3428	225.9230	2.8679
D1	Mueller	1997 10 11.6117	2.247640	1.001108		184.9605	279.1715	141.8888
E1	55P/Tempel-Tuttle	1998 02 28.0982	0.976577	0.905531	33.2	172.4988	235.2583	162.4860
G1	P/Montani	1997 04 06.7366	4.214270	0.416602	19.4	213.4885	267.8756	3.9898
G2	Montani	1998 04 16.3457	3.084746	0.994233		239.8561	55.8039	69.8384
G3	SOHO (Oates)	1997 04 04.44	0.0050	1.0		78.19	359.49	143.18
G4	SOHO (Oates)	1997 04 05.79	0.0050	1.0		79.49	358.58	144.08
G5	SOHO (Oates)	1997 04 06.17	0.0049	1.0		80.43	358.56	143.82
G6	SOHO (Oates)	1997 04 11.56	0.0050	1.0		79.54	358.15	144.27
G7	SOHO (Kracht)	1997 04 08.97	0.0351	1.0		55.36	73.94	70.33
H1	130P/McNaught-Hughes	1998 02 23.7839	2.116292	0.404113	6.69	224.3683	89.9724	7.3033
H2	SOHO (Stezelberger)	1997 05 03.17	0.1361	1.0		201.47	225.82	18.32
H3	SOHO (Biesecker)	1997 04 26.70	0.0083	1.0		60.24	335.99	138.71
H4	SOHO (Kracht)	1997 04 21.36	0.0356	1.0		57.53	72.33	73.13
H5	SOHO (Kracht)	1997 04 29.27	0.0371	1.0		56.95	69.13	79.18
J1	Mueller	1997 05 03.8022	2.302149	0.990893		98.9542	277.0749	122.9687
J2	Meunier-Dupouy	1998 03 10.4426	3.051136	1.000611		122.6742	148.8447	91.2733
J3	SOHO (Oates)	1997 05 10.75	0.0085	1.0		60.73	334.41	146.83
J4	SOHO (Oates)	1997 05 10.84	0.0094	1.0		89.37	23.14	138.93
K1	SOHO (St Cyr)	1997 06 01.58	0.0058	1.0		80.84	1.54	143.58
K2	SOHO (SWAN)	1997 06 26.16	1.5463	1.0		246.10	173.87	127.94
K3	SOHO (Oates)	1997 05 26.35	0.0077	1.0		83.71	4.71	144.45
K4	SOHO (Hamer)	1997 06 01.24	0.0056	1.0		89.31	12.54	142.75
K5	SOHO (Oates)	1997 05 20.60	0.0090	1.0		67.60	346.20	137.60
K6	SOHO (Oates)	1997 05 31.54	0.0057	1.0		86.63	8.82	143.19
K7	SOHO (Oates)	1997 06 01.24	0.0089	1.0		72.09	356.14	139.41
L1	Zhu-Balam	1996 11 22.7089	4.899263	0.998157		346.3427	233.2991	72.9859
L2	SOHO (Stezelberger)	1997 06 10.87	0.0381	1.0		57.30	72.62	71.69
L3	SOHO (Stezelberger)	1997 06 13.83	0.0082	1.0		60.48	335.94	138.69
L4	SOHO (Lewis)	1997 06 15.88	0.0051	1.0		78.08	358.09	143.96
L5	SOHO (Leprette)	1997 06 12.55	0.0080	1.0		76.37	356.96	146.13
M1	SOHO (St Cyr)	1997 06 30.91	0.0086	1.0		58.50	334.34	138.64
M2	131P/Mueller	1997 11 22.2015	2.412129	0.343904	7.05	179.6390	214.2849	7.3554
M3	SOHO (Leprette)	1997 06 28.94	0.0056	1.0		73.08	354.23	146.10
M4	SOHO (Leprette)	1997 06 18.07	0.0063	1.0		51.70	331.22	145.98
M5	SOHO (Leprette)	1997 06 20.00	0.0059	1.0		71.88	351.32	127.42
N1	Tabur	1997 08 15.4788	0.395697	1.000134		344.1853	147.6112	85.9634
N2	132P/Helin-Roman-Alu	1997 11 10.0920	1.910020	0.531652	8.24	220.9584	178.4797	5.7756
N3	SOHO (Leprette)	1997 07 04.94	0.0059	1.0		80.45	2.61	142.75
O1	Tilbrook	1997 07 13.4188	1.371795	0.984219	810	336.1867	231.2460	115.8023
P1	SOHO (Biesecker)	1997 08 05.82	0.0055	1.0		84.44	5.46	144.35
P2	Spacewatch	1997 08 31.1595	4.263334	1.028407		24.5019	302.9167	14.5834
P3	SOHO (Biesecker)	1997 08 08.43	0.0067	1.0		67.79	340.57	139.35
Q1	SOHO (Biesecker)	1997 09 01.40	0.0078	1.0		73.48	356.40	144.13
Q2	SOHO (Schenk)	1997 08 24.12	0.0048	1.0		88.38	9.41	144.16
R1	SOHO (Biesecker)	1997 09 08.89	0.0063	1.0		76.18	356.27	144.03
R2	SOHO (Biesecker)	1997 09 15.69	0.0054	1.0		76.57	358.49	144.01
R3	SOHO (Stezelberger)	1997 09 17.03	0.0054	1.0		81.89	4.00	144.45
S1	SOHO (Biesecker)	1997 09 30.83	0.0074	1.0		76.06	359.58	144.01
S2	SOHO (Biesecker)	1997 09 26.45	0.0078	1.0		68.85	358.73	143.81
S3	SOHO (Leprette)	1997 09 24.75	0.0053	1.0		85.44	2.78	146.05
T1	Utsunomiya	1997 12 10.1450	1.359107	0.998525		95.9656	53.7032	127.9926
T2	SOHO (Lewis)	1997 10 04.32	0.0044	1.0		84.24	3.76	144.58
T3	P/Lagerkvist-Carsenty	1998 03 11.2712	4.240254	0.365443	17.3	334.2069	63.1989	4.8354
T4	SOHO (Biesecker)	1997 10 06.89	0.0058	1.0		87.64	4.35	144.63
T5	SOHO (Biesecker)	1997 10 07.99	0.0051	1.0		78.80	359.77	143.67
T6	SOHO (Oates)	1997 10 02.30	0.0050	1.0		85.14	4.75	144.40
T7	SOHO (Leprette)	1997 10 08.66	0.0051	1.0		84.40	4.16	144.64
T8	SOHO (Oates)	1997 10 09.04	0.0052	1.0		81.49	3.31	142.27
U1	SOHO (Biesecker)	1997 10 29.05	0.0052	1.0		48.51	317.55	130.65
U2	SOHO (Oates)	1997 11 17.53	0.0051	1.0		80.59	359.00	143.79
U3	SOHO (Oates)	1997 11 20.60	0.0052	1.0		85.93	7.91	144.43
U4	SOHO (Oates)	1997 11 22.29	0.0050	1.0		81.89	358.73	145.62
U5	SOHO (Oates)	1997 11 27.20	0.0051	1.0		82.31	2.87	142.93
U6	SOHO (Oates)	1997 11 27.21	0.0051	1.0		82.32	2.12	143.65
U7	SOHO (Oates)	1997 11 28.02	0.0051	1.0		84.90	6.94	144.23

Table I. (continued)

Comet			T	q	e	P	ω	Ω	i
1997 V1	P/Larsen		1997 09 15.1305	3.293373	0.332323	11.0	132.8633	234.8419	12.0894
V2	SOHO (Lewis)		1997 11 09.56	0.0067	1.0		83.91	6.11	143.89
V3	SOHO (Oates)		1997 11 02.20	0.0075	1.0		49.66	323.19	136.47
V4	SOHO (Oates)		1997 11 03.94	0.0050	1.0		83.34	3.37	144.10
V5	SOHO (Oates)		1997 11 08.90	0.0085	1.0		65.49	342.67	138.34
V6	SOHO (Oates)		1997 11 09.23	0.0054	1.0		77.78	356.55	144.37
W1	SOHO (Stezelberger)		1997 11 23.43	0.0055	1.0		83.23	4.09	144.52
W2	SOHO (Biesecker)		1997 11 20.05	0.0050	1.0		92.18	12.75	142.35
W3	SOHO (Leprette)		1997 11 25.22	0.0073	1.0		94.71	22.77	138.77
X1	SOHO (Stezelberger)		1997 12 02.96	0.0051	1.0		78.84	359.01	143.91
X2	134P/Kowal–Vavrova		1998 11 18.8550	2.575322	0.587192	15.6	18.7125	202.2856	4.3453
X3	SOHO (Leprette)		1997 12 03.40	0.0055	1.0		79.38	0.23	144.57
X4	SOHO (Leprette)		1997 12 03.47	0.0054	1.0		84.87	6.09	142.93
X5	SOHO (Leprette)		1997 12 06.74	0.0058	1.0		72.81	355.15	145.46
X6	SOHO (Leprette)		1997 12 10.77	0.0066	1.0		71.61	351.41	146.21
Y1	SOHO (Leprette)		1997 12 21.20	0.0054	1.0		82.34	3.55	141.83
Y2	SOHO (Leprette)		1997 12 21.72	0.0054	1.0		88.36	9.52	143.32
Y3	SOHO (Leprette)		1997 12 23.21	0.0066	1.0		67.17	348.04	146.84
1998 M4	LINEAR		1997 12 10.4241	2.601692	1.0		106.3635	92.9151	154.5807
1999 S2	McNaught–Watson		1997 11 22.4814	6.465885	1.007318		223.4662	74.4280	65.8129
	2P/Encke		1997 05 23.5967	0.331395	0.850014	3.28	186.2720	334.7215	11.9296
	25D/Neujmin		1997 11 01.3433	1.274286	0.584043	5.36	213.0061	309.6556	5.8375
	26P/Grigg–Skjellerup		1997 08 30.3035	0.996810	0.663806	5.11	359.3318	213.3092	21.0868
	43P/Wolf–Harrington		1997 09 29.2167	1.581824	0.543978	6.46	187.1328	254.7561	18.5103
	46P/Wirtanen		1997 03 14.1501	1.063769	0.656770	5.46	356.3419	82.2051	11.7224
	48P/Johnson		1997 10 31.8492	2.308302	0.367261	6.97	207.9913	117.3538	13.6644
	69P/Taylor		1997 12 12.2607	1.947834	0.465982	6.97	355.3724	108.8575	20.5468
	78P/Gehrels		1997 08 07.0425	2.000261	0.463582	7.20	192.7683	210.6273	6.2577
	81P/Wild		1997 05 06.6279	1.582616	0.540222	6.39	41.7700	136.1546	3.2428
	91P/Russell		1997 11 19.2068	2.510102	0.344085	7.49	353.4270	248.6713	14.0958
	94P/Russell		1997 02 03.4981	2.229286	0.365095	6.58	93.2700	70.9694	6.1881
	100P/Hartley		1997 05 28.5169	1.818681	0.450610	6.02	178.9328	38.9030	25.7233
	103P/Hartley		1997 12 22.0171	1.031730	0.700364	6.39	180.7214	219.9543	13.6189
	117P/Helin–Roman–Alu		1997 03 26.8824	3.714832	0.175700	9.57	215.0775	73.4730	9.7423
1995 M1	118P/Shoemaker–Levy		1997 01 12.1126	2.021132	0.420512	6.51	301.9799	152.0963	8.4734
1996 S1	127P/Holt–Olmstead		1997 02 06.6606	2.153499	0.370472	6.33	6.2569	14.0611	14.4068
1996 S2	128P/Shoemaker–Holt (A)		1997 11 20.2731	3.047028	0.321274	9.51	210.2139	214.5274	4.3615
1996 S2	128P/Shoemaker–Holt (B)		1997 11 20.2943	3.047038	0.321272	9.51	210.2187	214.5270	4.3617
	D/Haneda–Campos		1997 08 15.7953	1.266976	0.631975	6.39	307.0508	66.6094	4.9473
	A/1997 MD ₁₀		1997 11 09.4092	1.536326	0.943313	139	68.9122	281.6642	59.1463
	A/1997 SE ₅		1997 09 24.1441	1.237627	0.667375	7.18	56.3835	288.0619	2.6144

The epoch of the elements for each comet is the Julian Date ending in zero and exactly divisible by 40, closest to the date of perihelion. The time of perihelion of 25D/Neujmin is uncertain.

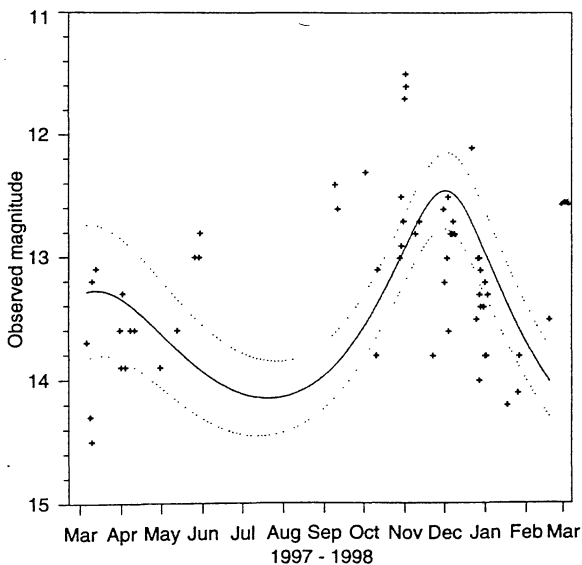


Figure 2. The observed magnitude of comet 1997 D1 (Mueller). The curve shown is a linear best fit over the apparition, with no corrections applied. Tick marks indicate the first of each month from 1997 March.

Stuart Rae estimated it nearer 12th magnitude in early February 2000. It became a difficult early morning object and was not observed again until early May, when both Pearce and Michael Mattiazzo estimated it at 13th magnitude, close to that expected from the light curve. The comet remained at this magnitude until July, then began to fade, with Mattiazzo making a final observation with his 0.20m reflector $\times 160$ on October 1.54 when it was 13.5m, with a 1.0' diameter coma of DC 4.

The coma was around 130,000km across throughout the apparition. The reported DC (degree of condensation) was mostly 2–3.

1997 C1 P/Gehrels

Tom Gehrels discovered a comet by eye during the course of the Spacewatch survey on February 1.36 [IAUC 6549, 1997 February 1]. The comet is a periodic one, belonging to the Saturn family, with a period near 17 years. It approached to within 0.14 AU of Saturn in May 1987. It was found near opposition and faded from its discovery magnitude of 18. Stephen Laurie made an early astrometric observation, which was used in the initial orbit determination.

Table 2. List of contributors to the light curves

The AGEO Survey Team	Japan
Jose Guilherme de Souza Aguiar	Brazil
Alexandr R. Baransky	Ukraine
Sally Beaumont	Windermere, Cumbria
Nicolas Biver	Hawaii
John E. Bortle	USA
Reinder J. Bouma	The Netherlands
Matyas Csukas	Romania
Alfons Diepvens	Belgium
Mario Frassati	Italy
Guus Gilein	Holland
Bjoern Haakon Granslo	Norway
Stephen Getliffe	Haverhill, Suffolk
Steven Goldsmith	Gillingham, Kent
Werner Hasubick	Germany
Roberto Haver	Italy
Guy M. Hurst	Basingstoke, Hampshire
Albert F. Jones	New Zealand
Andreas Kammerer	Germany
Graham Keith	Manaton, Devon
Attila Kosa-Kiss	Romania
Heinz Kerner	Germany
Martin Lehky	Czech Republic
Haldun I. Menali	Turkey
Herman Mikuz	Slovenia
Mexborough Astronomical Society	Mexborough, South Yorks.
Bob Neville	Greens Norton, Northants
Gabriel Oksa	Slovak Republic
Andrew R. Pearce	Australia
Rok Palcic	Slovenia
Stuart T. Rae	New Zealand
Jonathan D. Shanklin	Cambridge
Josep Ma Trigo i Rodriguez	Spain
Vince Tuboly	Hungary
Seiichi Yoshida	Japan

Table 3. List of astrometric, CCD and photographic observers

Observer	Site	IAU Station No.
AGEO Survey Team	Japan	349
Ron Arbour	South Wonston, Hants.	979
Mark Armstrong	Rolvenden, Kent	960
Denis Buczynski	Conder Brow, Lancs	978
F. J. Clarke & Fiona Vincent	St Andrews	482
Luis Hernandez Concepcion	Tenerife	
Maurice Gavin	Worcester Park, Surrey	
Nick James	Chelmsford, Essex	970
Stephen Laurie	Church Stretton, Shropshire	966
John Mackey	Werrington, Peterborough	963
Nick Martin <i>et al.</i>	COAA, Portugal	965
Herman Mikuz	Slovenia	106
Martin Mobberley	Galleywood, Essex	477
	Cockfield, Suffolk	480
Bob Neville	Greens Norton, Northants.	967
David Strange	Worth Matravers, Dorset	
Alex Vincent	Worthing, West Sussex	
Roderick Wilstrop	Cambridge	503

The tables of observers exclude those who only observed 1995 O1 (Hale-Bopp) who will be listed in the paper on that comet.

1997 D1 Mueller

A new comet was discovered on plates taken by Jean Mueller for the 2nd Palomar Sky Survey with the 1.2m Oschin Schmidt Camera on Feb 17.47 [IAUC 6562, 1997 February 19]. The object was reported as 16th magnitude, but appeared nearly three magnitudes brighter to visual observers.

The light curve suggests that initially the comet should have faded as its distance from Earth increased, however the observations suggest a possible slight brightening.

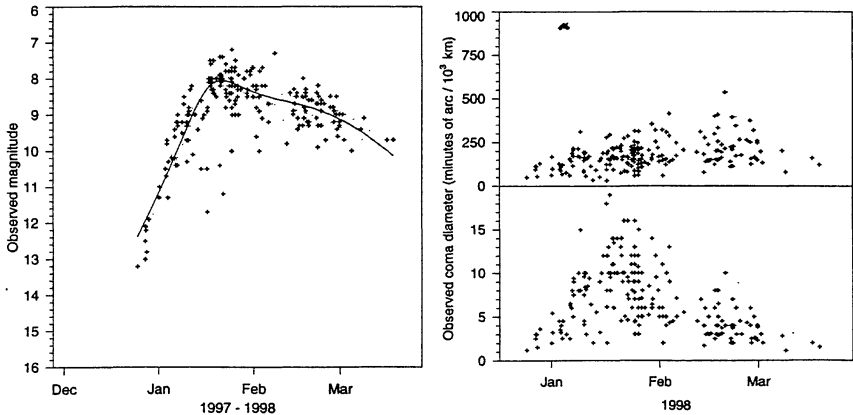


Figure 3. a) (left). The observed magnitude of comet 1997 E1 (55P/Tempel-Tuttle). The curve shown is a linear best fit over the apparition, with no corrections applied. Tick marks indicate the first of each month from 1997 December. b) (right). The coma diameter of comet 55P/Tempel-Tuttle. The lower panel shows the observed coma diameter in arc minutes and the upper panel the true diameter in 100,000km.

Jonathan Shanklin observed it with the Northumberland refractor at Cambridge on March 6.11 and put it at mag 13.7, DC4, diameter 0.4'. An observation with the same instrument $\times 170$ on May 12.94 made it very similar in appearance and magnitude 13.6. After solar conjunction the comet brightened and was brightest towards the end of 1997, but was difficult to see because it was very diffuse. Reinder Bouma recovered it on September 11.13, estimating it at 12.6m in his 0.25m Jones-Bird reflector, with a 0.8' diameter and DC2 coma [A Jones-Bird reflector has a spherical mirror and an achromatic lens to correct the spherical aberration]. On December 3.77 Andrew Pearce estimated it at 12.5 in his 0.20m reflector with the coma 1' in diameter and DC1. Observations continued into February 1998 with Werner Hasubick estimating it at mag 13.5 in his 0.44m reflector $\times 226$ on Feb 18.

The observations are poorly fitted by a standard light curve and a better fit is given by a linear equation. The coma was around 90,000km across throughout the apparition, with a DC of 2-3.

1997 E1 55P/Tempel-Tuttle

The parent comet of the Leonid meteors was recovered by observers using the Keck 10m telescope on March 4.63 and confirmed using the ESO 3.5m NTT on March 7.31 at magnitude 22. The predicted time of perihelion was out by around -0.1 day [IAUC 6579, 1997 March 10].

The comet was discovered on 1865 December 19 by William Tempel in Marseilles and on 1866 January 6 by Horace Tuttle from Harvard. The comet was then around 6th magnitude and reached perihelion on 1866

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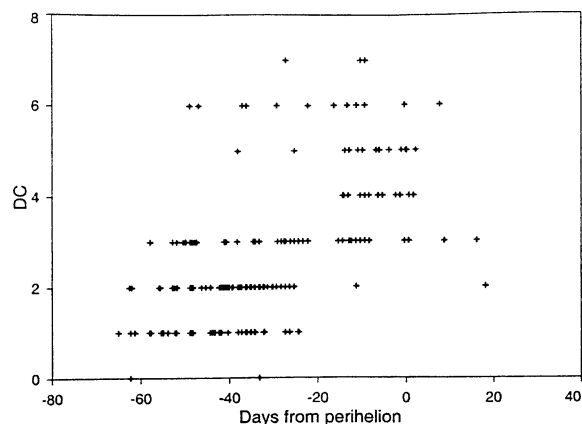


Figure 4. The Degree of Condensation (DC) of comet 55P/Tempel-Tuttle.

January 12 when it was 5m. It faded and was last seen on February 9. Once the orbit was calculated it was realised that it was very similar to that of the Leonids and previous returns of the comet were found in 1366 (when it made a very close approach to Earth, 0.0229 AU, and reached 3m) and 1699. It was not really looked for in 1899, and could not be found in 1932. It was eventually recovered some three months after perihelion in 1965 June.

At this return the comet became visible to amateur observers towards the end of 1997 at 13th magnitude. Jonathan Shanklin picked it up early on Christmas morning when he made it mag 13.2 in his 0.20m LX200.

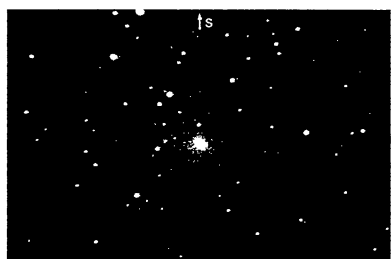
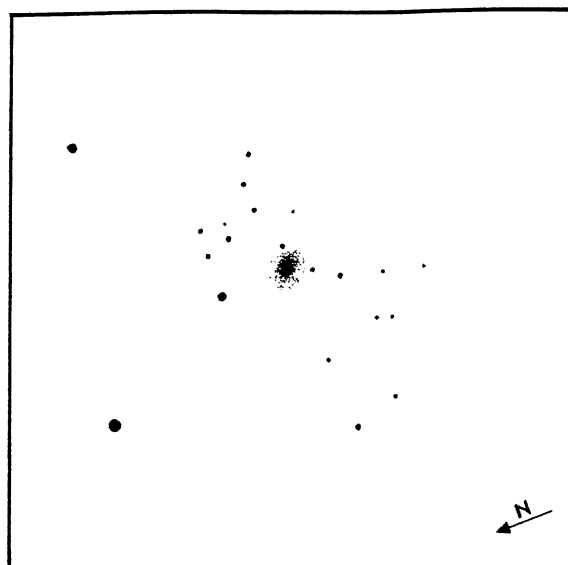


Figure 5. 55P/Tempel-Tuttle imaged by Martin Mobberley on 1998 January 31 at 20.53 UT, using a 60 sec. exposure with an ST7 CCD and a 0.3m Newtonian reflector.

By New Year's morning it was 11.3m in the same instrument. It was initially a morning object and brightened rapidly as it headed towards a relatively close approach of 0.35 AU to the Earth in mid-January,

when it passed within 8° of the pole and reached 8m. Now an evening object, Gabriel Oksa estimated it at 8.1 m 20×80B on January 17.79. It was a similar magnitude when Werner Hasubick observed it on January 28.76 in 10×50B. Intrinsically it is quite a faint comet and it had faded by the time it reached perihelion at the end of February when it was over 1 AU from the earth. Attila Kosa-Kiss estimated it at 9.3 in his 0.06m refractor ×52 on February 28.74. It was moving rapidly back into solar conjunction and Nicolas Biver was the last to observe it, making it about 9.7 on March 18.24 from the clear skies of Hawaii. Several people imaged the comet including David Strange (January 6),⁷ Nick James (January 15)⁸ and Martin Mobberley (January 31).⁹

The light curve is slightly better fitted by a linear equation than the standard equation, but peak brightness still occurred close to perihelion. Initially very diffuse, the



A.R. $1^h 53^m$ DEC. $+60^\circ 47'$ UT 00h 06m

Figure 6. 55P/Tempel-Tuttle drawn by Mario Frassati using a 0.32m f5 Newtonian reflector ×127 on 1998 January 22.0 at Crescentino, Italy.

comet became more condensed as it approached perihelion. Most observers estimated a DC of 1–2 until mid-January. Estimates of 3–4 were more typical in February, increasing to 5 by the time of perihelion. The coma became quite large at and just after closest approach, with several observers giving diameters around 0.25° . Martin Lehky estimated $19'$ in 10×80B on January 17.72. Generally the observations suggest that the coma grew to a diameter of around 300,000km just before perihelion.

A professional group of European observers reported that images of the nuclear region of the comet taken in late January showed a jet of matter whose brighter inner section (within $4''$ of the nucleus) moved with an amplitude of $25''$. This yielded possible rotation periods of 15.31 ± 0.03 and 14.79 ± 0.02 hours [IAUC 6816, 1998 January 30].

The Leonid rates themselves in 1997 seem to have peaked at a ZHR of around 50–60 between 06.00–10.00 UT on November 17. Many of the meteors were bright, which is similar to what was seen prior to the big display in 1966. In 1998 they put on a very strong display, with

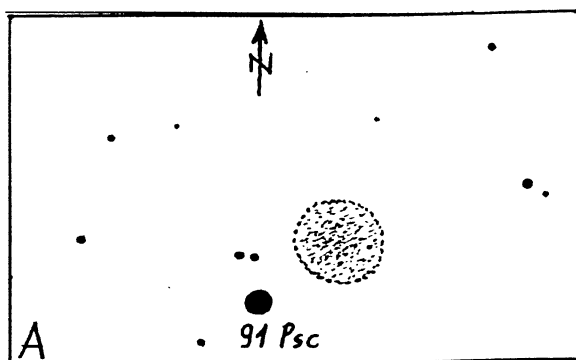


Figure 7. 55P/Tempel-Tuttle drawn by Attila Kosa-Kiss using a 63mm f13 refractor ×52 on 1998 February 1.75 at Salonta, Romania.

Table 4. Magnitude parameters of comets observed by the Comet Section

Standard magnitude parameters									
Comet	No. obs	R (AU)	H1	Dev	K1	H10	Dev	H15	Dev
1995 O1 Hale–Bopp	798	0.9 – 11.4	−0.6±0.0	0.4	7.5±0.1				
1997 BA ₆ Spacewatch	97	3.4 – 4.7	2.7±0.4	0.3	10.9±0.8	3.2±0.0	0.3	0.3±0.0	0.4
1997 D1 Mueller	57	2.2 – 3.3	10.6±0.8	0.8	−0.1±1.9	6.5±0.1	0.9	4.5±0.1	1.1
1997 E1 55P/Tempel–Tuttle	218	1.0 – 1.4	8.1±0.1	0.7	24.3±1.1	8.8±0.1	0.9	8.6±0.1	0.8
1997 J1 Mueller	25	2.3 – 2.4				6.2±0.1	0.7	4.4±0.2	0.8
1997 J2 Meunier–Dupouy	429	3.1 – 4.2	4.8±0.5	0.6	6.5±0.9	2.9±0.0	0.6	0.2±0.0	0.7
1997 N1 Tabur	11	0.7 – 1.0	9.3±0.1	0.3	6.2±1.8	9.5±0.1	0.4	9.8±0.2	0.6
1997 N2 132P/Helin–Roman–Alu	7	1.9 – 2.0				10.1±0.1	0.4	8.6±0.1	0.4
1997 O1 Tilbrook	4	1.4				7.5±0.1	0.2	6.8±0.1	0.2
1997 T1 Utsunomiya	146	1.4 – 2.7	6.4±0.2	0.6	13.0±0.8	7.0±0.0	0.6	6.1±0.0	0.6
1997 X2 134P/Kowal–Vavrova	2	3.1				7.1±0.2	0.3	4.7±0.2	0.3
2P/Encke	15	0.5 – 1.0	11.7±0.1	0.3	18.6±1.0	10.8±0.2	0.7	11.3±0.1	0.4
29P/Schwassmann–Wachmann	13	6.3				0.5±0.2	0.8	−3.5±0.2	0.8
43P/Wolf–Harrington	38	1.6 – 2.1	9.9±0.5	0.5	5.8±1.9	8.9±0.1	0.5	7.7±0.1	0.6
46P/Wirtanen	52	1.1 – 1.5	8.1±0.2	0.8	12.0±2.5	8.3±0.1	0.8	7.9±0.1	0.8
48P/Johnson	2	2.3 – 2.4				7.5±0.1	0.2	5.6±0.1	0.1
69P/Taylor	73	2.0 – 2.5	8.9±1.1	0.7	5.0±3.3	7.3±0.1	0.8	5.6±0.1	0.8
78P/Gehrels	85	2.0 – 2.8	11.6±1.0	0.9	−2.4±2.7	7.1±0.1	1.0	5.3±0.1	1.1
81P/Wild	217	1.6 – 2.1	6.9±0.3	0.6	11.4±1.3	7.2±0.0	0.6	6.1±0.0	0.6
103P/Hartley	331	1.0 – 2.0	8.0±0.1	0.8	15.0±0.7	8.4±0.0	0.9	8.0±0.0	0.8
118P/Shoemaker–Levy	29	2.0 – 2.1				8.7±0.1	0.4	7.2±0.1	0.4
128P/Shoemaker–Holt	5	3.1				7.0±0.4	0.9	4.6±0.4	0.8

Linear magnitude parameters						
Comet	No. obs	Days	H1	K1	ΔT	Dev
1997 E1 55P/Tempel–Tuttle	218	−65 – 18	7.9±0.1	0.0689±0.0033	3.3±1.4	0.7
103P/Hartley	334	−141 – 125	7.9±0.1	0.0351±0.0012	−16.7±1.1	0.7
1997 D1 Mueller	57	−219 – 130	9.6±0.3	0.0079±0.0027	79.3±14.0	0.7

The magnitude of the comets can be calculated from the standard equation: $m = H1 + 5.0 * \log(\Delta) + K1 * \log(r)$
For most comets there are insufficient observations to calculate K1 accurately and so a value of 10 or 15 is assumed, which gives the constant H10 or H15 respectively.
Some comets do not follow the standard equation and are better fitted with a linear equation: $m = H1 + 5.0 * \log(\Delta) + K1 * \text{abs}(t - T + \Delta T)$
where t is the Julian Date, T the Julian Date of perihelion and ΔT an offset.
Some well documented CCD V observations have been used to augment the visual light curves. A correction for aperture of 0.0033 mm^{−1} and the observer corrections derived in previous papers^{12,13} have been applied, and the H values are reduced to zero aperture.
The magnitude equations for 1997 D1 (Mueller), 69P/Taylor and 78P/Gehrels are poor fits to the light curves. The fit for 69P/Taylor is improved by an offset of 1.5 magnitudes prior to 1998 February 10 and this is used here.
The figure under ‘observations’ for comet Hale–Bopp is the number of days with observations.

ZHR of around 1000.¹⁰ The 1999 display reached storm proportions with 40 meteors per minute seen by BAA observers in the Sinai Desert.¹¹

1997 G1 P/Montani

Joe Montani, of the Spacewatch team, discovered this 19th magnitude object on April 9.14 with the 0.9m Spacewatch telescope at Kitt Peak [IAUC 6622, 1997 April 10]. It was a distant object, with a perihelion distance of 4.3 AU and did not become any brighter. It is another member of Saturn’s family, with a period of 19 years, and although it can approach moderately close to Jupiter has not done so recently.

1997 G2 Montani

Montani discovered a second comet a few days later on April 12.46 [IAUC 6626, 1997 April 14]. It was an 18th magnitude object and was predicted to brighten to 16th magnitude at perihelion in April 1998, but was at high southern declination and no visual magnitudes were reported. A few astrometric observations however suggest that it was well within visual range.

1997 H1 130P/McNaught–Hughes

Jim Scotti recovered this comet (P/1991 S1 = 1991y = 1991 IX) with the 0.9m Spacewatch telescope on April 16.45 and it was independently recovered by A. Nakamura with the Kuma Kogen Astronomical Observatory 0.6m f6 Ritchey–Chrétien telescope on April 29.66 [IAUC 6640, 1997 April 30]. The comet was first seen in 1991¹⁴ and the prediction for the return was in good agreement with the recovery observations. The comet did not get much brighter than 18th magnitude. It passed moderately close (0.44 AU) to Jupiter in November 1907.

1997 H2 SOHO

Shane Stezelberger of SOHO–LASCO Operations discovered a bright, Sun approaching comet on images obtained with coronagraphs aboard the SOHO mission on April 29.27 [IAUC 6650, 1997 May 9]. The ephemeris was uncertain because of difficulty in correlating the C2 and C3 positions with the J2000 reference frame, but the comet was expected to fade rapidly and no visual observations were reported. Further details of the SOHO spacecraft are given later in this paper.

The comets of 1997

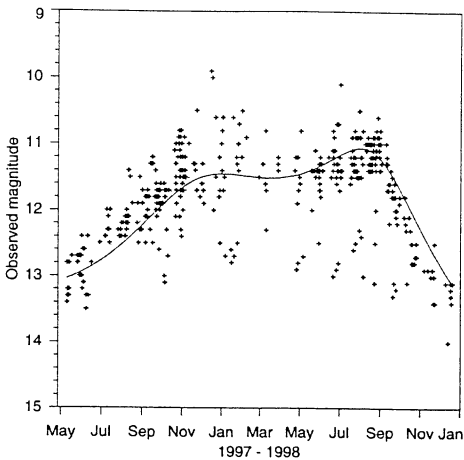


Figure 8. The observed magnitude of comet 1997 J2 (Meunier-Dupouy). The curve shown is a best fit over the apparition, with no corrections applied. Tick marks indicate the first of each second month from 1997 May.

1997 J1 Mueller

Jean Mueller discovered a 13th magnitude comet on a 40-minute IIIa-J exposure by J. D. Mendenhall and herself taken with the 1.2m Palomar Oschin Schmidt telescope in the course of the second Palomar Sky Survey on May 3.24 [IAUC 6642, 1997 May 5]. It did not get much brighter. Reinder Bouma observed it at 13.0 in his 0.25m Jones-Bird reflector on May 9.95. Mark Armstrong imaged the comet on May 12.96¹⁵ with his 0.26m LX200. It was at a similar magnitude in the New Moon period at the end of May and beginning of June. Martin Lehky was the last to see it, when he made it 13.3 in his 0.42m reflector $\times 162$ on July 13.9.

1997 J2 Meunier-Dupouy

French amateur Michel Meunier reported a second comet 6' SW of 1997 J1 on May 7.9, moving more slowly and perhaps 0.5 magnitude brighter. Independently another pair of French amateurs, Philippe Dupouy and Jean-Francois Lahitte, reported it the next day [IAUC 6648, 1997 May 8]. These were chance discoveries as both amateurs were engaged in imaging 1997 J1. The comet was at high northern declination

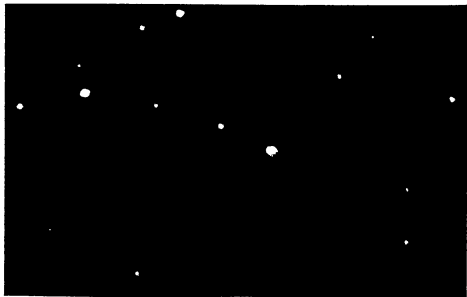


Figure 9. Comet Meunier-Dupouy imaged by David Strange on 1997 September 21.88 using three 40-second exposures with his 0.50m f4 reflector and SX CCD camera.

Table 5. Ephemeris for comet 1997 J2 (Meunier-Dupouy)

Latitude: 53.0°N		Longitude: 0.0°W					
Day	R.A. hh mm.m (2000.0)	Dec ° mm	Mag	Δ AU	R AU	Observable hh.mm to hh.mm	Elong.
1996 December							
02/03	12 21.1	45.19	13.1	5.18	5.26	00.59 to 06.21	89
12/13	12 28.9	47.09	12.9	4.99	5.19	00.09 to 06.31	96
22/23	12 36.0	49.15	12.8	4.81	5.12	23.15 to 06.38	103
1997 January							
01/02	12 42.2	51.37	12.7	4.65	5.05	22.16 to 06.40	109
11/12	12 47.2	54.13	12.6	4.50	4.99	21.11 to 06.37	114
21/22	12 50.5	56.59	12.5	4.38	4.92	19.56 to 06.30	118
31/32	12 51.8	59.51	12.4	4.28	4.85	18.24 to 06.18	120
1997 February							
10/11	12 50.5	62.43	12.3	4.20	4.78	18.26 to 06.02	121
20/21	12 46.0	65.28	12.3	4.15	4.72	18.44 to 05.43	120
1997 March							
02/03	12 37.7	67.60	12.2	4.12	4.65	19.02 to 05.22	117
12/13	12 25.4	70.11	12.2	4.11	4.58	19.21 to 04.59	112
22/23	12 09.4	71.55	12.1	4.12	4.52	19.40 to 04.33	107
1997 April							
01/02	11 50.7	73.10	12.1	4.15	4.45	20.01 to 04.07	101
11/12	11 31.4	73.54	12.1	4.18	4.39	20.23 to 03.39	96
21/22	11 13.9	74.11	12.1	4.21	4.33	20.46 to 03.11	90
1997 May							
01/02	11 00.1	74.05	12.0	4.24	4.26	21.12 to 02.42	84
11/12	10 51.2	73.43	12.0	4.27	4.20	21.39 to 02.13	79
21/22	10 47.5	73.10	12.0	4.30	4.14	22.09 to 01.45	74
31/32	10 48.6	72.30	11.9	4.31	4.08	22.38 to 01.17	70
1997 June							
10/11	10 54.1	71.46	11.9	4.32	4.02	23.05 to 00.54	66
20/21	11 03.4	71.01	11.9	4.31	3.96	23.19 to 00.44	63
30/31	11 16.0	70.14	11.8	4.29	3.90	23.10 to 00.57	61
1997 July							
10/11	11 31.6	69.27	11.7	4.25	3.84	22.48 to 01.23	60
20/21	11 49.8	68.38	11.7	4.21	3.79	22.21 to 01.52	59
30/31	12 10.3	67.48	11.6	4.15	3.73	21.52 to 02.21	59
1997 August							
09/10	12 33.0	66.56	11.5	4.08	3.68	21.23 to 02.48	60
19/20	12 57.8	65.59	11.4	4.00	3.63	20.54 to 03.13	61
29/30	13 24.3	64.58	11.4	3.92	3.58	20.25 to 03.36	63
1997 September							
08/09	13 52.5	63.49	11.3	3.83	3.53	19.58 to 03.57	65
18/19	14 22.0	62.32	11.2	3.74	3.48	19.31 to 04.17	68
28/29	14 52.6	61.04	11.1	3.65	3.44	19.05 to 04.36	70
1997 October							
08/09	15 23.8	59.24	11.0	3.57	3.39	18.41 to 04.54	72
18/19	15 55.3	57.33	10.9	3.50	3.35	18.19 to 05.11	73
28/29	16 26.5	55.30	10.9	3.44	3.31	17.59 to 05.28	74
1997 November							
07/08	16 57.2	53.17	10.8	3.40	3.28	17.43 to 00.14	
						03.22 to 05.45	75
17/18	17 27.0	50.57	10.8	3.37	3.24	17.30 to 23.22	
						03.56 to 06.00	74
27/28	17 55.6	48.34	10.7	3.35	3.21	17.21 to 22.38	
						04.17 to 06.14	73
1997 December							
07/08	18 22.9	46.11	10.7	3.36	3.18	17.17 to 21.60	
						04.32 to 06.26	71
17/18	18 48.6	43.53	10.7	3.37	3.16	17.18 to 21.24	
						04.40 to 06.35	69
27/28	19 12.9	41.43	10.7	3.40	3.13	17.24 to 20.50	
						04.44 to 06.39	66
1998 January							
06/07	19 35.6	39.45	10.7	3.44	3.11	17.33 to 20.17	
						04.43 to 06.39	62
16/17	19 56.9	37.60	10.7	3.49	3.09	17.46 to 19.46	
						04.38 to 06.34	59
26/27	20 16.7	36.29	10.7	3.53	3.08	18.01 to 19.15	
						04.30 to 06.24	55
1998 February							
05/06	20 35.1	35.12	10.7	3.58	3.07	18.17 to 18.45	
						04.18 to 06.11	52
15/16	20 52.3	34.08	10.7	3.61	3.06	04.03 to 05.54	49
25/26	21 08.1	33.17	10.8	3.64	3.05	03.45 to 05.34	47

Table 5. (continued)

Day	R.A.	Dec	Mag	Δ	R	Observable	Elong.
<i>1998 March</i>							
07/08	21 22.7	32.37	10.8	3.66	3.05	03.24 to 05.11	46
17/18	21 36.0	32.07	10.8	3.66	3.05	03.02 to 04.47	46
27/28	21 48.0	31.44	10.8	3.65	3.06	02.36 to 04.21	47
<i>1998 April</i>							
06/07	21 58.8	31.27	10.8	3.62	3.06	02.09 to 03.54	49
16/17	22 08.2	31.13	10.7	3.57	3.07	01.40 to 03.26	53
26/27	22 16.1	31.01	10.7	3.51	3.09	01.09 to 02.57	58
<i>1998 May</i>							
06/07	22 22.5	30.49	10.7	3.43	3.10	00.36 to 02.28	63
16/17	22 27.3	30.33	10.6	3.33	3.12	00.01 to 01.60	69
26/27	22 30.1	30.10	10.6	3.23	3.14	23.26 to 01.31	76
<i>1998 June</i>							
05/06	22 31.0	29.37	10.5	3.11	3.17	22.51 to 01.06	84
15/16	22 29.7	28.49	10.5	2.99	3.20	23.14 to 00.47	92
25/26	22 26.1	27.41	10.4	2.87	3.23	23.18 to 00.48	101
<i>1998 July</i>							
05/06	22 20.2	26.08	10.3	2.75	3.26	23.01 to 01.09	111
15/16	22 12.2	24.03	10.3	2.65	3.30	22.35 to 01.37	121
25/26	22 02.4	21.24	10.2	2.57	3.33	22.07 to 02.06	132
<i>1998 August</i>							
04/05	21 51.3	18.10	10.2	2.51	3.37	21.38 to 02.34	143
14/15	21 39.8	14.26	10.3	2.49	3.42	21.09 to 03.00	151
24/25	21 28.7	10.22	10.3	2.51	3.46	20.40 to 03.24	156
<i>1998 September</i>							
03/04	21 18.7	6.10	10.4	2.58	3.51	20.12 to 03.10	153
13/14	21 10.4	2.06	10.5	2.68	3.55	19.45 to 01.56	145
23/24	21 04.1	-1.41	10.7	2.82	3.60	19.18 to 00.43	135
<i>1998 October</i>							
03/04	21 00.1	-5.03	10.8	2.99	3.65	18.53 to 23.31	125
13/14	20 58.2	-7.58	11.0	3.19	3.71	18.30 to 22.21	114
23/24	20 58.3	-10.25	11.2	3.40	3.76	18.09 to 21.11	104
<i>1998 November</i>							
02/03	21 00.1	-12.29	11.4	3.62	3.82	17.51 to 19.59	93
12/13	21 03.5	-14.10	11.6	3.85	3.87	17.36 to 18.39	84
22/23	21 08.2	-15.33	11.7	4.08	3.93	Not observable	74
<i>1998 December</i>							
02/03	21 14.0	-16.39	11.9	4.30	3.99	Not observable	65
12/13	21 20.7	-17.33	12.0	4.51	4.05	Not observable	56
22/23	21 28.1	-18.16	12.2	4.71	4.11	Not observable	48
<i>1999 January</i>							
01/02	21 36.0	-18.50	12.3	4.88	4.17	Not observable	39
11/12	21 44.3	-19.18	12.4	5.04	4.23	Not observable	31
21/22	21 53.0	-19.41	12.5	5.18	4.29	Not observable	23
31/32	22 01.7	-20.01	12.6	5.30	4.36	Not observable	16
<i>1999 February</i>							
10/11	22 10.6	-20.19	12.7	5.39	4.42	Not observable	10
20/21	22 19.4	-20.36	12.7	5.46	4.49	Not observable	10
<i>1999 March</i>							
02/03	22 28.0	-20.55	12.8	5.50	4.55	Not observable	15
12/13	22 36.5	-21.17	12.8	5.52	4.62	Not observable	22
22/23	22 44.7	-21.42	12.9	5.52	4.68	Not observable	30
<i>1999 April</i>							
01/02	22 52.5	-22.13	12.9	5.50	4.75	Not observable	38
11/12	22 59.9	-22.50	12.9	5.45	4.82	Not observable	46
21/22	23 06.7	-23.36	12.9	5.39	4.88	Not observable	55
<i>1999 May</i>							
01/02	23 12.8	-24.30	12.9	5.32	4.95	Not observable	63
11/12	23 18.2	-25.34	13.0	5.24	5.02	Not observable	72
21/22	23 22.7	-26.49	13.0	5.15	5.09	Not observable	81
31/32	23 26.2	-28.16	13.0	5.06	5.16	Not observable	90
<i>1999 June</i>							
10/11	23 28.5	-29.53	13.0	4.98	5.23	Not observable	99
20/21	23 29.6	-31.42	13.0	4.90	5.29	Not observable	108
30/31	23 29.3	-33.39	13.0	4.83	5.36	Not observable	116
<i>1999 July</i>							
10/11	23 27.5	-35.42	13.0	4.79	5.43	Not observable	125
20/21	23 24.2	-37.48	13.0	4.76	5.50	Not observable	133
30/31	23 19.3	-39.53	13.0	4.76	5.57	Not observable	139

Positions are for midnight UT on the double date given. The observable period is defined for the given location as the time when the Sun is below -13° altitude and the comet above an altitude that depends on its magnitude. The comet may be visible outside this period under good conditions or from a different location. Magnitudes are not corrected for aperture and the comet would appear at least a magnitude fainter in a 0.30m telescope.

in Draco, moving slowly south-west. The comet would have been well placed for discovery several months earlier, but was probably too far north for the search programs then in operation. The comet remained within reach of amateur telescopes until the end of 1998.

Jonathan Shanklin observed it soon after discovery, making it about 13.4 in the Northumberland refractor on May 10.02. The comet passed close to NGC 3403 and John Mackey used his 0.28m SCT to image both objects on May 10.90¹⁶ and Mark Armstrong imaged them on May 12.96¹⁷ with his 0.26m LX200. The comet slowly brightened, Werner Hasubick reporting it at 11.8 in his 0.20m SCT on September 25.82. It did not change much over the next year, though there is quite a scatter in the observations. It was perhaps brightest towards the end of August 1998, when Sally Beaumont estimated it at about 11th magnitude in her 0.13m refractor $\times 20$ on August 21.90. Thereafter it faded quite rapidly, though Werner Hasubick was able to follow it until December 17.73 when it was 13.3 in his 0.44m reflector $\times 156$. The coma was around 240,000km across throughout the apparition, with a DC of around 3.

1997 K2 SOHO (SWAN)

In December 1999 Teemu Makinen, Finnish Meteorological Institute, Helsinki; and J.-L. Bertaux, Service d'Aeronomie, Verrieres-le-Buisson, reported for the SWAN (Solar Wind Anisotropies) team the probable discovery of a comet from its hydrogen Lyman-alpha emission appearing on full-sky images (wavelength range 10–180nm) taken from the SOHO spacecraft during May–July 1997. Makinen made the discovery in the course of a complete survey of visible comets in the SWAN images during 1996 January–1998 June, which recorded 18 comets. The appearance was comparable to that of comet 1997 O1 (Tilbrook) in SWAN images



Figure 10. Philippe Dupouy, founder and director of the Observatoire de Dax, where he co-discovered comet Meunier-Dupouy.

The comets of 1997

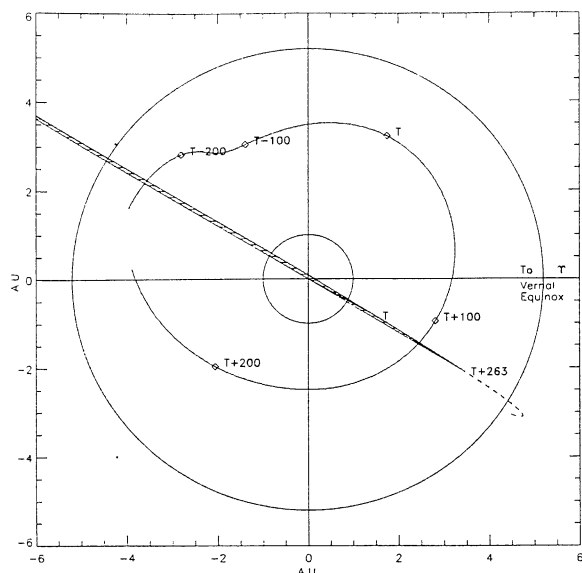


Figure 11. The orbit of comet 1997 J2 (Meunier-Dupouy). a) Viewed from the north ecliptic pole. The orbits of the Earth and Jupiter are shown for scale. The shaded part of the comet's orbital plane lies above the ecliptic. b) Viewed from a rotating reference frame, centred on the Earth with the Sun at top. In this frame the true distance to the comet is shown but the angular elongation from the Sun is viewed from the ecliptic pole; the 6 o'clock position corresponds to the comet at opposition and the 3 o'clock position to the comet at morning quadrature. The path is shown dashed when it lies below the ecliptic. The comet was discovered at T-306; observations used in the analysis cover the range T-304 to T+285.

during 1997 June 17–September 6, suggesting that the total magnitude was roughly 10–12. The object increased in extent from $2^\circ \times 2^\circ$ to $6^\circ \times 4^\circ$ during this time. The resolution of the SWAN detector is 1 square degree. [IAUC 7327, 1999 December 4]. Further details of the discovery were published in *Nature*.^{18,19} The comet probably passed within the LINEAR search areas during early 1998, but was not detected. Although discovered in SOHO imagery the comet has not been given an official IAU name.

1997 L1 Zhu–Balam

J. Zhu reported observations of five objects detected on June 3 and 4 by the Beijing Astronomical Observatory 0.6m Schmidt at Xinglong during a CCD asteroid search program. D. D. Balam of Victoria noted with the 1.8m reflector of the Dominion Astrophysical Observatory that one of them, first detected on June 3.67, was clearly cometary [IAUC 6677, 1997 June 8]. The comet was originally named Xinglong [IAUC 6681, 1997 June 13], but was renamed in 1998 [IAUC 6811, 1998 January 23] after the discoverer and the person who pointed out that the object was cometary. The comet was 17th magnitude and was at perihelion in 1996.

1997 L2 SOHO (Stezelberger)

Shane Stezelberger discovered a second Sun-approaching comet on June 10.59. It was fainter than the first and was also expected to fade rapidly [IAUC 6684, 1997 June 19]. It was not observed elsewhere.

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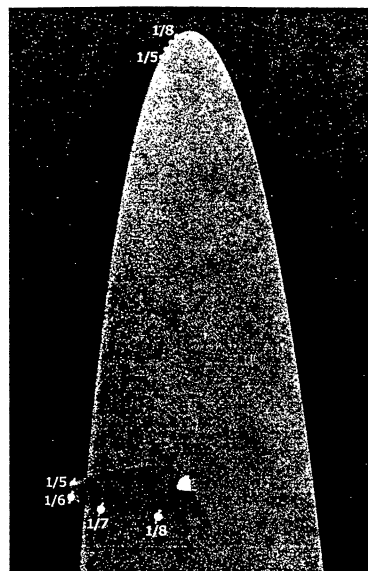


Figure 12. A 3D representation of comet Meunier-Dupouy's orbit produced by Nick James.

1997 M2
131P/Mueller

Japanese observers A. Sugie (June 29.75) and A. Nakamura (July 5.77) independently recovered comet P/Mueller 2 (P/1990 R1 = 1990j = 1990 XXIV) with 0.60m reflectors and CCDs. The comet was around 19th magnitude. The prediction by Kenji Muraoka on MPC 23484 required a correction of $\Delta T = -0.26$ day [IAUC 6695,

1997 July 6]. Details of the discovery apparition were given in an earlier paper.²⁰ The comet has approached moderately close to Jupiter twice in the past century. In 1934 July it passed 0.64 AU from the planet and more recently in 1994 February it passed 0.81 AU from the giant planet.

1997 N1 Tabur

Vello Tabur of Wanniasa, ACT, Australia discovered a 10th magnitude comet with his 0.20m f4.7 reflector on July 2.80. The comet was weakly condensed with a 1.5' diameter coma [IAUC 6692, 1997 July 3]. The comet was moving eastwards on the border of Eridanus and Caelum and brightening as it

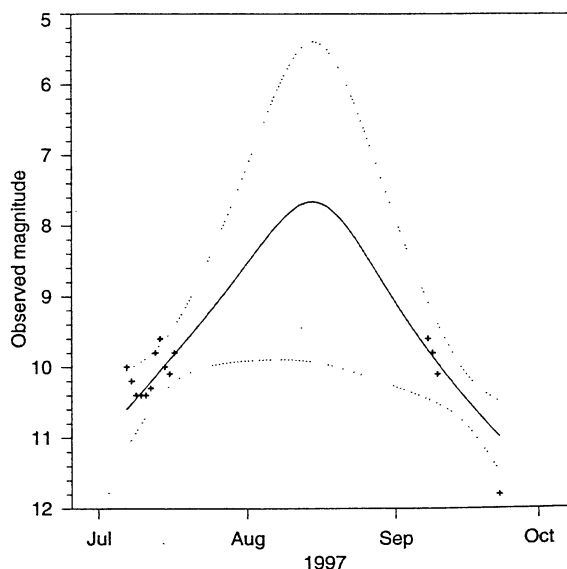


Figure 13. The observed magnitude of comet 1997 N1 (Tabur). The curve is a best fit over the apparition, with no corrections applied. No stellar object brighter than 9m was seen by the SOHO LASCO coronagraphs during August. Tick marks indicate the first of each month from 1997 July.

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Table 6. Ephemeris for comet 1997 N1 (Tabur)

Latitude:	53.0°N		Longitude:		0.0°W			
Day	R.A. hh mm.m (2000.0)	Dec °.mm	Mag	Δ AU	R AU	Observable hh.mm to hh.mm	Elong. °	
1997 June								
10/11	2 38.2	−29.02	11.4	1.61	1.49	Not observable	65	
20/21	3 30.7	−28.55	10.8	1.41	1.32	Not observable	63	
30/31	4 35.5	−27.28	10.1	1.26	1.14	Not observable	59	
1997 July								
10/11	5 49.6	−23.37	9.5	1.17	0.95	Not observable	51	
20/21	7 04.5	−16.53	8.9	1.16	0.76	Not observable	40	
30/31	8 11.6	−7.51	8.2	1.23	0.57	Not observable	27	
1997 August								
09/10	9 09.2	2.56	7.6	1.34	0.42	Not observable	13	
19/20	10 02.0	14.45	7.7	1.42	0.41	Not observable	3	
29/30	10 55.8	24.53	8.5	1.44	0.55	Not observable	17	
1997 September								
08/09	11 54.7	32.10	9.3	1.44	0.74	19.58 to 20.17	29	
18/19	12 58.7	36.42	9.9	1.46	0.93	19.31 to 20.56	39	
28/29	14 03.9	38.41	10.5	1.52	1.12	19.05 to 21.18	47	
1997 October								
08/09	15 05.1	38.37	11.0	1.61	1.30	18.41 to 21.20	54	
18/19	15 59.0	37.13	11.5	1.74	1.48	18.19 to 21.06	58	
28/29	16 44.6	35.13	12.0	1.89	1.64	17.59 to 20.41	60	

approached perihelion. Andrew Pearce observed the comet with his 0.20m reflector between July 6 and 16, estimating it around 10th magnitude, DC 3–4. There was some evidence that the comet became more diffuse and disintegrated as it approached perihelion. [IAUC 6714, 1997 August 8]. No astrometric observations were made after July 30. The comet passed through the SOHO LASCO C2 and C3 fields between August 12 and 24, but no object brighter than 9th magnitude was visible. Jonathan Shanklin attempted observation of it on September 7.84 and September 8.84 with the Thorowgood 0.20m refractor at Cambridge University and suspected an object of around mag 9.5–10.0, and again suspected an object of 11.8 on September 22.82, however few

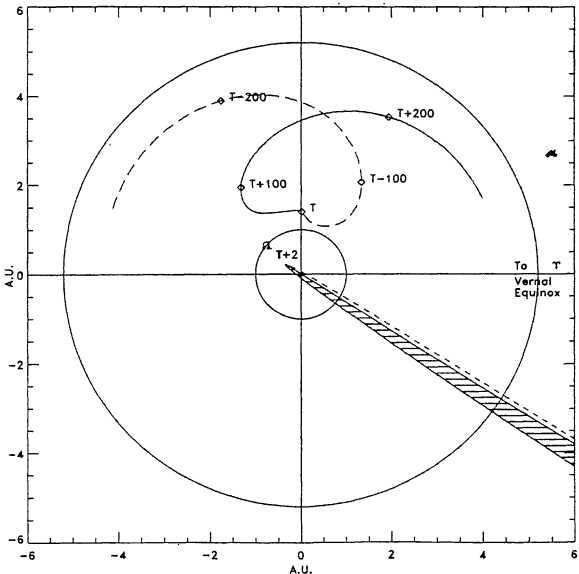


Figure 14. The orbit of comet 1997 N1 (Tabur). The comet was discovered at T-44; observations used in the analysis cover the range T-40 to T+38.

other confirming observations were made. CCD observations made in Japan on September 8.44 showed no stellar object to 15th magnitude.

1997 N2 132P/Helin–Roman–Alu

Comet P/Helin–Roman–Alu 2 (P/1989 U1 = 1989y = 1989 XVI) was recovered by Carl Hergenrother using a CCD camera on the SAO 1.2m reflector on Mt Hopkins on July 13.46. The comet was around 20th magnitude and nearly stellar. The correction to the prediction by B. G. Marsden on MPC 23483 was -0.6 day [IAUC 6704, 1997 July 21]. The comet had made a moderately close approach of 0.3 AU to Jupiter in June 1995, which made significant changes to the angular elements. A previous close approach of 0.6 AU occurred in 1934 March. The comet was discovered by Eleanor Helin and Jeff Alu, assisted by B. Roman and K. Lawrence on plates taken with the 0.46m Palomar Schmidt on 1989 October 26.4.

The 1997 return was one of the best possible, with the comet reaching perihelion when very close to opposition. It performed better than expected, with Martin Lehky estimating it at a little brighter than 15th magnitude in 1997 November and December.

1997 O1 Tilbrook

Justin Tilbrook, Clare, S. Australia accidentally discovered a 10th magnitude comet on July 22.43 with his 0.20m reflector, whilst on a variable star patrol. He described the comet as diffuse with a 2' diameter coma [IAUC 6705, 1997 July 23]. The comet was moving north in Corvus at discovery (he was observing TV Crv), but it never became visible from the UK. The observational circumstances were best for the southern hemisphere, but it was visible from low northern latitudes. Andrew Pearce and Albert Jones estimated it between 10th and 11th magnitude at the end of July, but only a few other observations were reported on IAUC and in the ICQ, including some up to the end of August when the comet was 12th magnitude. The

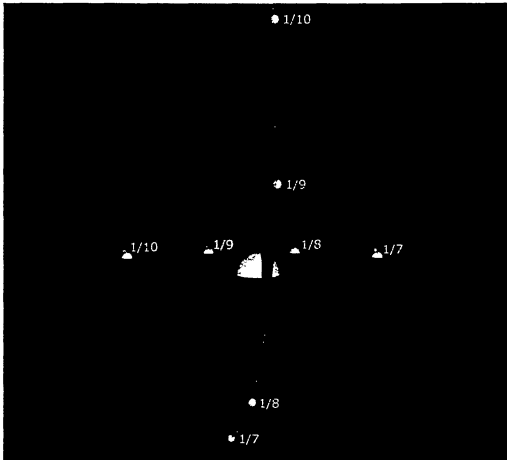


Figure 15. A 3D representation of comet Tabur's orbit produced by Nick James.

The comets of 1997

Table 7. Ephemeris for comet 1997 OI (Tilbrook)

Latitude: 53.0°N		Longitude: 0.0°W					
Day	R.A. hh mm.m (2000.0)	Dec ° mm	Mag	Δ AU	R AU	Observable hh.mm to hh.mm	Elong. °
1997 May							
01/02	1 43.5	-49.34	11.2	1.86	1.72	18.14 to 18.14 03.53 to 05.40	66
11/12	2 08.0	-52.53	10.7	1.63	1.64	18.04 to 18.36 03.01 to 05.48	72
21/22	2 45.7	-57.34	10.2	1.40	1.57	17.57 to 19.34 02.00 to 05.56	79
31/32	3 53.9	-63.29	9.6	1.18	1.50	17.53 to 22.36 23.56 to 06.03	86
1997 June							
10/11	6 11.2	-67.42	9.1	1.01	1.45	17.51 to 06.08	91
20/21	9 07.7	-61.54	8.8	0.92	1.41	17.52 to 06.12	93
30/31	10 51.2	-47.01	8.8	0.94	1.38	17.55 to 00.21	90
1997 July							
10/11	11 43.5	-31.56	9.0	1.06	1.37	17.60 to 23.15	83
20/21	12 14.8	-20.22	9.4	1.25	1.38	18.06 to 22.19	74
30/31	12 36.7	-12.09	9.8	1.47	1.40	18.14 to 21.28	66
1997 August							
09/10	12 53.9	-6.17	10.2	1.69	1.43	18.22 to 20.39	57
19/20	13 08.4	-1.57	10.6	1.91	1.48	18.30 to 19.51	50
29/30	13 21.5	1.23	11.0	2.12	1.53	18.38 to 19.03	42
1997 September							
08/09	13 33.8	4.05	11.4	2.31	1.60	Not observable	36
18/19	13 45.6	6.23	11.7	2.47	1.68	Not observable	30
28/29	13 57.1	8.25	12.0	2.60	1.76	Not observable	26

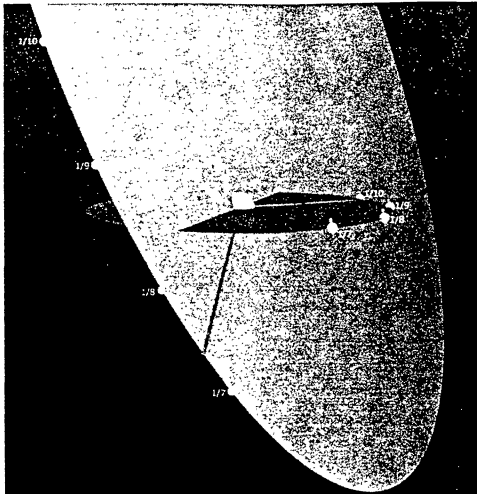


Figure 18. A 3D representation of comet Tilbrook's orbit produced by Nick James.

comet would have been well placed for discovery by southern hemisphere observers throughout June and July and its earlier non-detection illustrates the lack of an effective southern search programme.

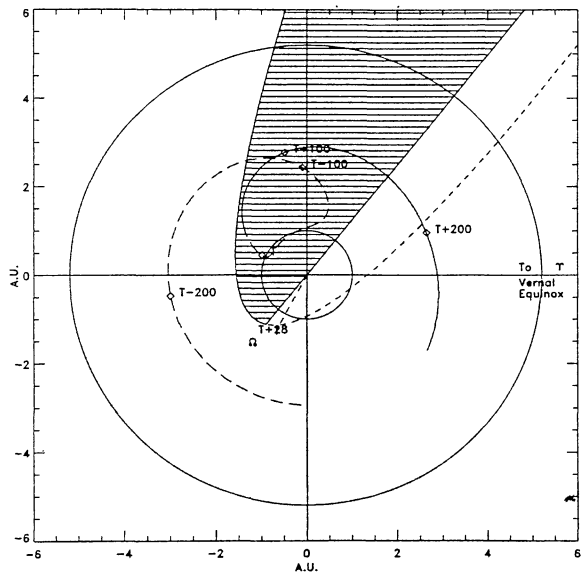


Figure 16. The orbit of comet 1997 OI (Tilbrook). The comet was discovered at T+9; observations used in the analysis cover the range T+12 to T+14.



Figure 17. Justin Tilbrook with his 0.20m reflector.

1997 P2 Spacewatch

The automated search program on the Spacewatch telescope discovered a 19th magnitude comet on August 12.24 [IAUC 6717, 1997 August 13]. It is a distant object and did not become brighter than 18th magnitude. The comet passed within 1 AU of Jupiter at the beginning of 1997 February. The orbit given on MPC 30738 is strongly hyperbolic and is only exceeded by comet 1980 E1 (Bowell) which was also perturbed by Jupiter.

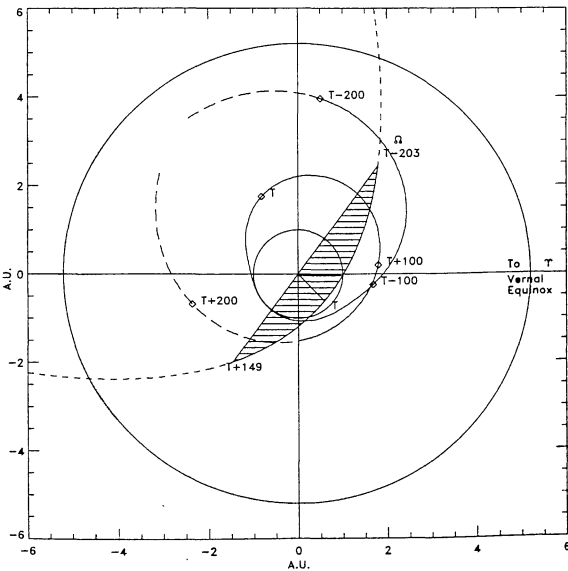


Figure 19. The orbit of comet 1997 T1 (Utsunomiya). The comet was discovered at T-68; observations used in the analysis cover the range T-64 to T+173.



Figure 20. Comet Utsunomiya imaged by Roderick Willstrop on 1997 October 7.79 with the 0.5m, f1.6 three mirror telescope.

1997 T1 Utsunomiya

Syogo Utsunomiya of Minami-Oguni, Kumamoto, Japan visually discovered a magnitude 10.5 comet, strongly condensed with a 2' coma diameter, using 25x150B on October 3.6. [IAUC 6751, 1997 October 5]. At discovery the comet was moving rapidly westwards in Cepheus. This was Utsunomiya's first comet discovery, though he had recovered 122P/de Vico in September 1995. The comet should have been brighter than 12th magnitude throughout September and might be visible on patrol photographs, though no observations have been reported. It was probably too far north and too close to the Sun for the professional search programmes.

Gabriel Oksa observed the comet on October 6.80, estimating it at mag 9.8, diameter 3' and DC3 in 20x80B. Jonathan Shanklin observed it on October 7.84, making it 9.8 in his 0.33m reflector, DC3, diameter 1.1' with a 2' tail in p.a. 113. A CCD image by Roderick Willstrop with his 'Three mirror telescope' showed a strong central condensation and prominent tail as did an image by Denis Buczynski on October 8.09.²¹ Other imagers around this

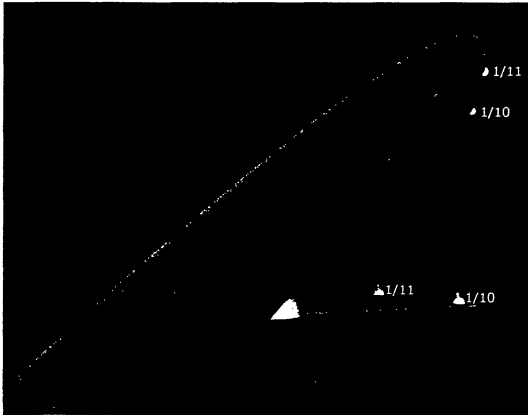


Figure 21. A 3D representation of the orbit of comet Utsunomiya produced by Nick James.

Table 8. Ephemeris for comet 1997 T1 (Utsunomiya)

Latitude: 53.0°N		Longitude: 0.0°W					
Day	R.A. hh mm.m (2000.0)	Dec °mm (2000.0)	Mag	Δ AU	R AU	Observable hh.mm to hh.mm	Elong. °
1997 August							
09/10	4 12.7	36.15	12.6	2.31	2.18	00.54 to 02.48	70
19/20	4 12.6	40.27	12.1	2.03	2.08	23.25 to 03.13	79
29/30	4 07.9	45.55	11.5	1.75	1.99	21.33 to 03.36	88
1997 September							
08/09	3 53.4	53.09	10.9	1.48	1.89	19.58 to 03.57	97
18/19	3 13.4	62.27	10.2	1.25	1.80	19.31 to 04.17	105
28/29	1 11.6	71.38	9.6	1.08	1.71	19.05 to 04.36	110
1997 October							
08/09	21 29.3	68.58	9.2	1.01	1.63	18.41 to 04.54	109
18/19	19 45.6	54.39	9.0	1.04	1.56	18.19 to 05.11	100
28/29	19 10.1	40.26	9.0	1.17	1.49	17.59 to 01.32	87
1997 November							
07/08	18 55.7	29.30	9.1	1.34	1.44	17.43 to 23.08	74
17/18	18 49.5	21.32	9.2	1.54	1.40	17.30 to 21.32	63
27/28	18 47.1	15.42	9.4	1.73	1.37	17.21 to 20.16	52
1997 December							
07/08	18 46.6	11.18	9.5	1.90	1.36	17.17 to 19.10	43
17/18	18 47.0	7.53	9.7	2.05	1.36	17.18 to 18.09	35
27/28	18 48.0	5.08	9.9	2.16	1.38	Not observable	29
1998 January							
06/07	18 48.9	2.51	10.1	2.24	1.42	Not observable	26
16/17	18 49.7	0.55	10.4	2.28	1.47	Not observable	27
26/27	18 49.9	-0.48	10.6	2.28	1.53	Not observable	32
1998 February							
05/06	18 49.1	-2.22	10.8	2.24	1.60	06.04 to 06.11	39
15/16	18 46.8	-3.52	11.0	2.17	1.68	05.40 to 05.54	48
25/26	18 42.4	-5.23	11.2	2.07	1.76	05.13 to 05.34	58
1998 March							
07/08	18 35.0	-6.58	11.3	1.96	1.85	04.46 to 05.11	69
17/18	18 23.6	-8.44	11.5	1.82	1.94	04.17 to 04.47	81
27/28	18 06.7	-10.44	11.6	1.69	2.04	03.49 to 04.21	95
1998 April							
06/07	17 42.8	-13.00	11.7	1.57	2.14	03.28 to 03.54	111
16/17	17 10.9	-15.26	11.8	1.48	2.24	Not observable	128
26/27	16 31.6	-17.45	12.0	1.43	2.34	Not observable	147
1998 May							
06/07	15 48.3	-19.33	12.3	1.45	2.45	Not observable	167
16/17	15 06.6	-20.34	12.6	1.54	2.55	Not observable	173
26/27	14 31.0	-20.55	13.1	1.70	2.66	Not observable	156

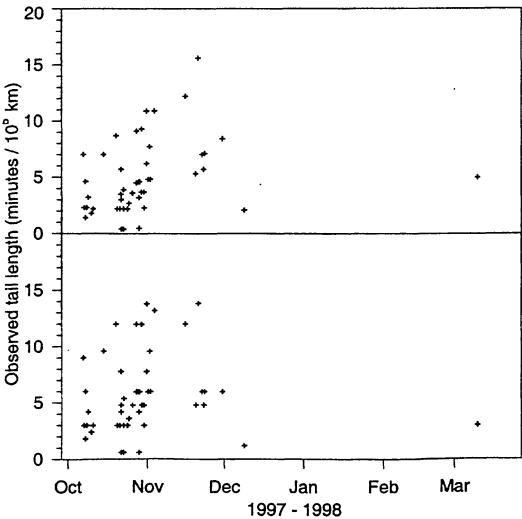


Figure 22. The tail length of comet 1997 T1 (Utsunomiya). The lower panel shows the tail length in minutes of arc and the upper panel the length in 100,000km, assuming a tail pointing along the radius vector.

The comets of 1997

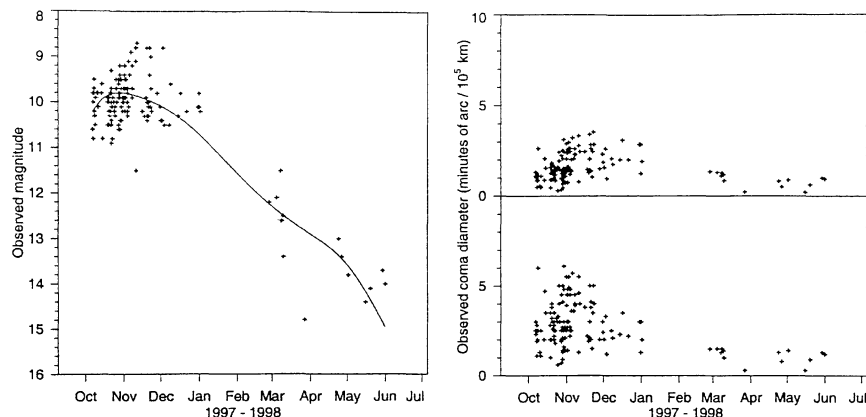


Figure 23. a) (left). The observed magnitude of comet 1997 T1 (Utsunomiya). The curve shown is a best fit over the apparition, with no corrections applied. Tick marks indicate the first of each month from 1997 October. b) (right). The observed coma diameter and size of comet 1997 T1.

time included Herman Mikuz²² and Maurice Gavin.²³ Vince Tuboly observing on October 8.8 made the comet mag 10.5 in his 0.30m reflector, with a 6', DC2 coma. Jonathan Shanklin observing on October 21.7 made it 9.3 in his 0.33m reflector $\times 60$. Martin Mobberley recorded an image on the same date and Nick James imaged it a few days later.²⁴ It was brightest in November; Werner Hasubick estimating it at 9.4 in 25 $\times$ 100B on November 21.75. As it moved into solar conjunction it became much harder to locate; Jonathan Shanklin was one of the last to see it on December 31.73 when he estimated it at about mag 9.8 in his 0.33m Dobsonian reflector $\times 100$. Only a few observations were made after conjunction, but it seems to have faded steadily. Nicolas Biver, observing from Hawaii, picked it up on February 26.61 when it was 12.2 in his 0.26m reflector $\times 84$. Werner Hasubick made it 14.4 on May 15.91 in his 0.44m reflector $\times 156$.

The coma reached a maximum apparent diameter of around 6' at the end of October, but reached its maximum

dimension of around 350,000km a couple of weeks later. The DC observations are highly scattered, particularly in the two months after discovery. Values range from 1 to 7, with the median being around 3–4. Several observers noted a short tail a few minutes long in p.a. 120 in early October. It was longest in late October and November, reaching around 14' in p.a. 60. A few observers reported position angles that were in marked disagreement to the other observers. There are several possible explanations, including: confusion between east and west in a star diagonal, mea-

surement with respect to the terrestrial co-ordinate frame rather than the celestial, or reporting features that were illusory. (Information on the measurement of position angle is given in the Section guide and also on the Section Web page.) The observations show that the tail reached a maximum length of around 1.5 million kilometres in mid November.

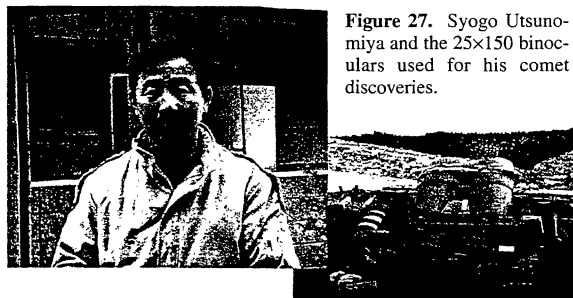


Figure 27. Syogo Utsunomiya and the 25 $\times$ 150 binoculars used for his comet discoveries.



Figure 24. Comet Utsunomiya imaged by Martin Mobberley on 1997 October 21.80 with his 0.49m, f4.5 reflector and SX CCD camera.



Figure 25. Comet Utsunomiya imaged by David Strange on 1997 October 21.85 using a 40-second exposure with his 0.50m f4 reflector and SX CCD camera.



Figure 26. Comet Utsunomiya photographed by Alex Vincent on 1997 October 29.83 using a 2 minute exposure on Fujichrome 400 at prime focus of a 0.3m, f5 reflector.

1997 T3 P/Lagerkvist–Carsenty

Uri Carsenty and Andreas Nathues, of the DLR Institute of Planetary Exploration, Berlin, discovered a 19th magnitude cometary object on October 5.1 during the course of the Uppsala–DLR Trojan Survey, in collaboration with C.–I. Lagerkvist, S. Mottola and G. Hahn. [IAUC 6754, 1997 October 7]. A member of Saturn's family, it is in a distant elliptical orbit with a period of 17 years. The comet was not named until January 1998, when it was named after the discoverer and the person who noted that it had cometary features [IAUC 6811, 1998 January 23]. It passed extremely close to Saturn (0.01 AU) in October 1954 and the encounter turned the former perihelion distance into the aphelion distance of the new orbit.

1997 VI P/Larsen

Jeff Larsen discovered a 17th magnitude comet on images taken with the 0.91m Spacewatch telescope at Kitt Peak on November 3.2. [IAUC 6767, 1997 November 3]. It is a distant, periodic comet of the Jupiter family with a period of 11 years, and made a close encounter to within 0.33 AU of the planet in February 1995.

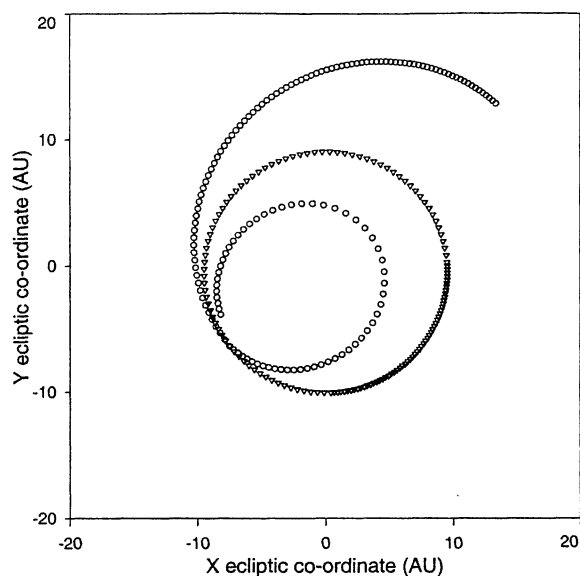


Figure 28. The encounter of P/Lagerkvist-Carsenty with Saturn. The ecliptic paths of the comet and Saturn are shown at 100 day intervals from 1930 January 23 (JD 2426000) to 1971 February 17 (JD 2441000). The mid-point of the encounter occurred around JD 2435030.

1997 X2 134P/Kowal-Vavrova

Jim Scotti recovered the comet (P/1983 J3 = 1983t = 1983 III = 1983 JG) with the Spacewatch telescope at Kitt Peak on December 5.5 when it was 22nd magnitude. The prediction by S. Nakano on MPC 25184 required a correction of +5.3 days [IAUC 6784, 1997 December 10]. The comet is a member of the Saturn family and passed 0.91 AU from the planet in June 1910. It was discovered by Charles Kowal on minor planet plates taken with the Palomar Schmidt on 1983 May 8. It was independently discovered by Zdenka Vavrova on patrol plates taken with the 0.62m Maksutov at Klet Observatory, Czech Republic on 1983 May 15. Due to its nearly stellar appearance it was first announced as an asteroid and designated 1983 JG. The Ageo team of Ken'Ichi Kadota and Seiichi Yoshida imaged the comet twice in 1999 June when it was around 15th magnitude.

The numbered comets at perihelion in 1997

2P/Encke

This was the comet's 57th observed return to perihelion since its discovery by Méchain in 1786. The orbit is quite stable, and with a period of 3.3 years apparitions repeat on a 10-year cycle. This year the comet was best seen from the southern hemisphere as an evening object (it was not observable from the UK). The comet reached perihelion in late May and made a relatively close approach to the Earth around July 4, when it was 0.19 AU distant and moved at over 5° per day. There is some evidence for a secular fading. A possible explanation is that comet Encke may have two active regions, an old one with declining activity

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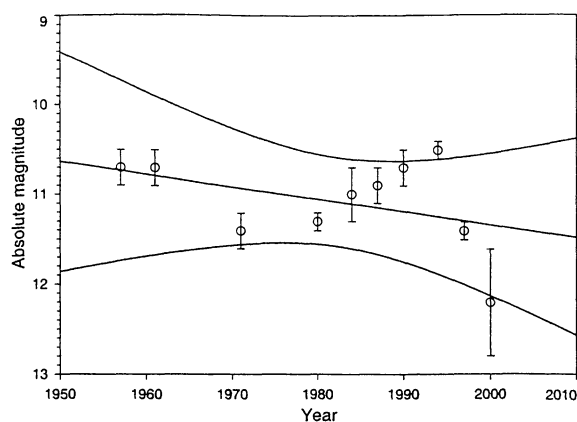


Figure 29. The secular change in the absolute magnitude of 2P/Encke.

which operates prior to perihelion, and a recently activated one present after perihelion. The comet is the progenitor of the Taurid meteor complex and may be associated with several Apollo asteroids.

The comet was recovered by southern hemisphere observers in late June, but was only visible for two weeks. It was a little fainter than expected and faded from 7th to 10th magnitude.

BAA observations of the comet extend back to 1957 and cover nine apparitions, though in many cases there were only a couple of observations. If a log r coefficient of 15 is assumed the plot of absolute magnitude from each apparition shows no significant trend with time. These observations suggest that the absolute magnitude has changed by no more than a few tenths of a magnitude in the last 40 years. The comet is clearly not yet on its death-bed.

43P/Wolf-Harrington

This was the ninth observed return of this comet, which was discovered in 1924, then lost until 1951. The comet is

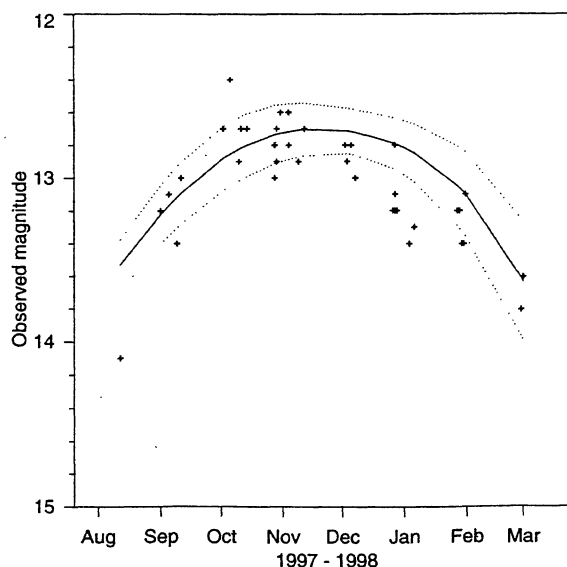


Figure 30. The observed magnitude of comet 43P/Wolf-Harrington. The curve shown is a best fit over the apparition, with no corrections applied. Tick marks indicate the first of each month from 1997 August.

The comets of 1997

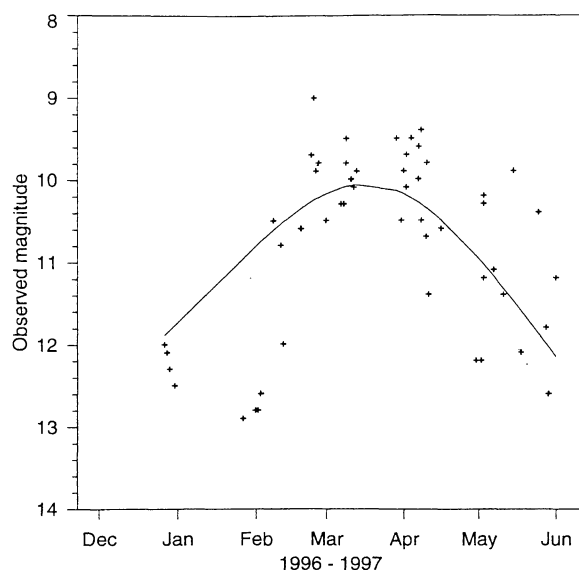


Figure 31. The observed magnitude of comet 46P/Wirtanen. The curve shown is a best fit over the apparition, with no corrections applied. Tick marks indicate the first of each month from 1996 December.

in a chaotic orbit, and made a close approach to Jupiter in 1936 which reduced its perihelion distance from 2.4 to 1.6 AU. It made an exceptionally close (0.003 AU) approach to Jupiter in 1841, which switched its previous perihelion distance into the new aphelion distance. At the last return the comet reached 13th magnitude and was at a similar brightness during this return.

Jonathan Shanklin observed the comet on September 9.14 in his 0.20m LX200, making it about 13.4, coma diameter 0.9' and DC2. On October 10.17 he saw it as a weakly condensed diffuse glow in the 0.30m Northumberland refractor $\times 170$, DC2, diameter 1.0'. On November 4.2 it was 12.6 in the 0.30m refractor. As it moved south it became more easily visible from the southern hemisphere. Andrew Pearce estimated it at 13.2 on December 28.74 using his 0.41m reflector $\times 90$. Nicolas Biver observing from Hawaii made it 13.8 in his 0.26m reflector $\times 169$ on February 28.40. It was imaged by Luis Concepcion from Tenerife on 1998 March 21.05 with his Celestron 11 and ST7 CCD²⁵ when the comet was estimated at mag 14.8.

46P/Wirtanen

Carl A. Wirtanen discovered this comet at Lick in 1948 and this was its 8th return since discovery. It is in a chaotic orbit, and its perihelion distance was much reduced due to approaches to Jupiter in 1972 and 1984. It has been reported to outburst, but BAA data suggests that it has just been rejuvenated after the peri-

helion distance was reduced. It is a target for the *Rosetta* mission. A December perihelion would give a close approach to the Earth, however the present period is exactly 5.5 years so that perihelia alternate between March and September.

P. Lamy, Laboratoire d'Astronomie Spatiale, and his team reported the apparent detection of the nucleus with the Hubble Space Telescope (+WFPC2) on 1996 August 28: 'After removing the small contribution of the (stable) coma to the central pixels, the R magnitude of the nucleus was found to vary from 21.6 to 21.9 over time intervals of 1.5 hr, though a clear rotational pattern is not evident. For a geometric albedo of 0.04, the mean effective radius is 0.58 km.' [IAUC 6478, 1996 September 26]

J.-L. Bertaux, on behalf of the SWAN team at Service d'Aeronomie, Paris, and the Finnish Meteorological Institute, Helsinki, noted [IAUC 6565, 1997 February 22]: 'The Lyman-alpha emission of the hydrogen envelope of comet 46P was observed for the first time on February 10 (at $r = 1.15$ AU) with the SWAN experiment on board the SOHO spacecraft at the L1 Lagrange point (the spacecraft being 1.61 AU from the comet). From the peak intensity of 44 rayleighs in SWAN's 1° field-of-view, the water-production rate is estimated at 7×10^{27} molecules/s, using a comparison with a simple Haser model.'

Martin Lehky began observing the comet at the end of 1996 December, making it mag 12.0 in a 0.20m refractor on December 26.70. It brightened, but aperture, sky conditions and observing method made a huge difference to the magnitude. Bob Neville using a CCD camera on his 0.21m f4 reflector gave a magnitude of 12.1 on February 21.90, whereas Lehky using 25 $\times$ 100 binoculars estimated the magnitude at 9.0 on February 23.76. The overall light curve suggests the comet was brightest in mid-March. Jonathan Shanklin estimated it at 9.5 in his 0.20m LX200 $\times 75$ with coma diameter 2.5' and DC2 on March 28.89. It slowly faded, Andreas Kammerer estimating it at 10.2 in his 0.20m SCT on May 2.89. Lehky made the final observation on May 31.88 when it was 11.2 in 25 $\times$ 100 binoculars. The reported coma diameters correspond to a true diameter of around 150,000km, with a DC of around 2–3.

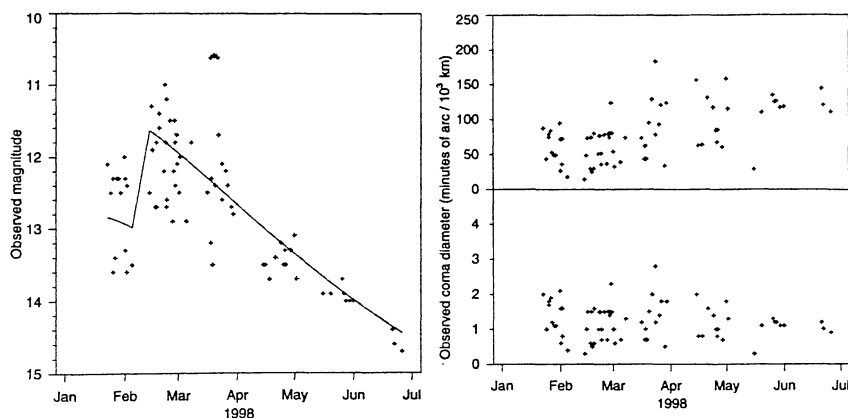


Figure 32. a) (left). The observed magnitude of comet 69P/Taylor. The curve shown is a best fit over the apparition, with no corrections applied. A step of 1.5m is inserted on February 10. Tick marks indicate the first of each month from 1998 January. b) (right). The coma diameter and size of comet 69P/Taylor.

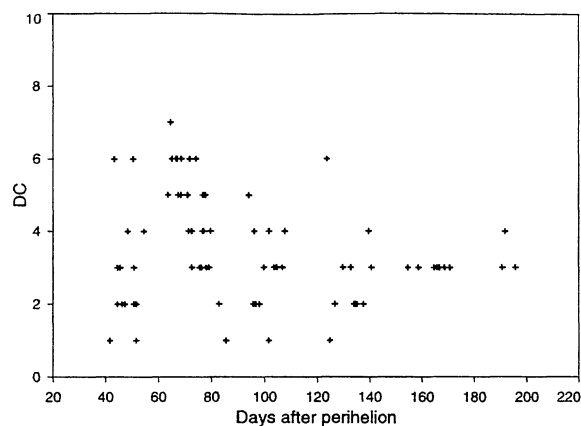


Figure 33. The DC of comet 69P/Taylor.

48P/Johnson

Ernest Leonard Johnson discovered this comet from Johannesburg in 1949. This was its 8th return, and a relatively favourable one. It never approaches particularly closely to the Earth. Despite this, Werner Hasubick made two estimates in August when it was around mag 13.5 in his 0.44m reflector $\times 222$. This was around 3 magnitudes brighter than expected.

69P/Taylor

A series of Jupiter encounters in the 19th century reduced q from 3.1 to 1.6 AU and led to its discovery by Clement Taylor, with a 0.25m reflector from Herschel View, Cape Town, South Africa, in 1915 November. It was quite bright, 9th magnitude at best, and shortly after perihelion, in 1916 February, E. E. Barnard found a double nucleus, each with a short tail. The secondary nucleus became brighter than the primary, but then rapidly faded and the primary also faded more rapidly than expected. The comet was then lost until 1977, when new orbital computations led to the recovery of the 'B' component by Charles Kowal with the Palomar Schmidt. The 'A' component was not found. The comet has had several encounters with Jupiter, the closest recent one being in 1925, and had very close (0.06 AU) encounters in 1807 and 1854.

The comet was not expected to be brighter than 15th magnitude at this return, with opposition occurring in mid-January 1998, about a month after perihelion. With its distance from both the Earth and the Sun increasing it was expected to fade during the opening months of 1998, however it was observed at around 12.5 in mid January. CCD observations reported on the *IAUC* suggest nothing out of the ordinary before Christmas 1997, so an outburst may have occurred between then and mid-January. The observations suggest that a second outburst, of about 1.5 magnitudes, occurred around 1998 February 10, when the comet reached nearly 11th magnitude. At the same time the coma became much more condensed, with the DC increasing from around 2 to 6. The coma diameter apparently increased from around 50,000 to 120,000km between January and June, though this may just reflect the comet's increasing distance from the Earth.

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78P/Gehrels

Tom Gehrels discovered this comet at Palomar in 1973. Its perihelion distance is slowly decreasing and is currently the lowest for 200 years. The eccentricity is slowly increasing, with a marked jump in both following a moderately close approach to Jupiter in 1995.

The comet was a little brighter than expected, reaching around 12th magnitude at the end of 1997 December. Herman Mikuz imaged the comet on August 12.08 when it was 13.1 with CCD and V filter on his 0.36m f7 SCT. Werner Hasubick estimated it at 12.7 in his 0.20m SCT $\times 156$ on September 27.15, with coma diameter 0.4', DC4. On November 4.2 Jonathan Shanklin estimated it at 13.0 in the 0.30m Northumberland refractor. Observing in very transparent conditions on November 21.95 he estimated it at 13.6 in the same instrument $\times 170$. Luis Concepcion imaged the comet on December 8 with a Celestron 11 and ST7 CCD, the image showing a strongly condensed coma with a short tail.²⁶ Seiichi Yoshida, observing on December 27.55 made it mag 11.8 in his 0.46m reflector $\times 69$. The comet slowly faded, Reinder Bouma estimating it at 12.7 in his 0.25m Jones-Bird reflector $\times 100$ on 1998 February 1.01. Martin Lehky made a final observation on April 23.86, reporting it as 12.8 in his 0.42m reflector $\times 162$, with coma diameter 1.5', DC 3.

The comet was only observed after perihelion. The light curve is not well defined by the available observations, with a suggestion that the comet became relatively brighter at the end of the apparition. The coma was around 70,000km across, with a DC of 3–4.

81P/Wild

81P/Wild is a new comet that made a very close (0.006 AU) approach to Jupiter in September 1974. Prior to this it was in a 40-year orbit that had perihelion at 5 AU and

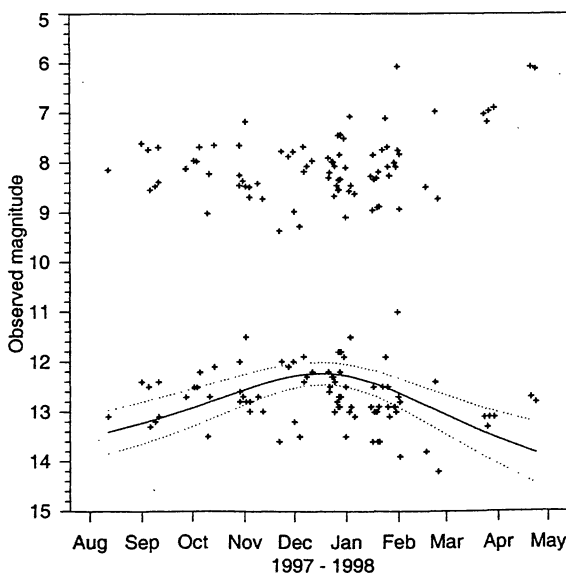


Figure 34. The observed magnitude of comet 78P/Gehrels. The lower curve is a best fit over the apparition, with no corrections applied. Tick marks indicate the first of each month from 1997 August. The upper points are the deviation from the mean curve shifted by +8 magnitudes.

The comets of 1997

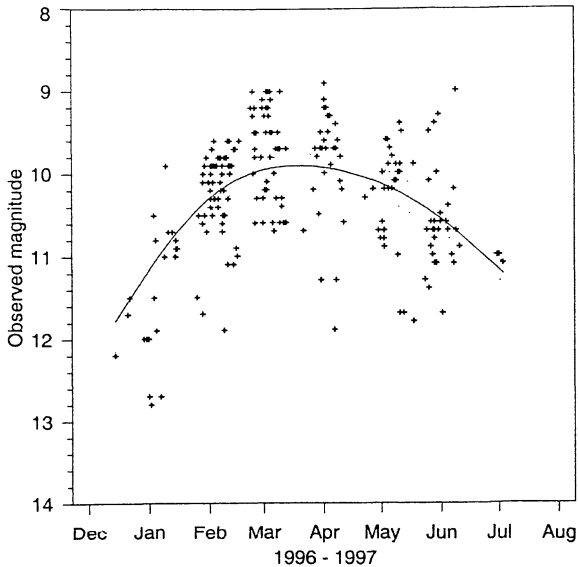


Figure 35. The observed magnitude of comet 81P/Wild. The curve shown is a best fit over the apparition, with no corrections applied. Tick marks indicate the first of each month from 1996 December.

aphelion at 25 AU. The comet was discovered by Paul Wild with the 40/60cm Schmidt at Zimmerwald on 1978 January 6. The *Stardust* spacecraft is due to visit the comet in 2004 and recover material for return to Earth in 2006. Only a few observations were made at the last return in 1991, when it was 13th magnitude. This return was better and the comet peaked at around 10th magnitude in 1998 March.

Seiichi Yoshida made the first observation on 1997 December 14.74, when he estimated that the comet was about magnitude 12.2 in his 0.25m SCT. Stephen Laurie imaged the comet on January 14.99 with his 0.25m LX200 and SBIG ST7 CCD.²⁷ Attila Kosa-Kiss estimated the comet as bright at 9.6 on February 16.79 in his 63mm refractor $\times 52$, with a very diffuse coma of diameter 4'. Luis Hernandez Concepcion imaged the comet on March 8.95 from Tenerife using a Celestron Ultima 11 and ST7.²⁸ By early April it was slowly fading, Gabriel Oksa estimating it at 10.0 in his 80mm refractor $\times 67$ on April 1.85. It was a similar brightness on May 6.93 when Graham Keitch estimated it at 9.8 in 20 $\times$ 100 binoculars. Jonathan Shanklin using the Thornewood 0.20m refractor found it at 10.6 on May 31.94. The final observation was made by Andrew Pearce on July 3.46, when it was 11.1 in his 0.20m reflector $\times 45$. Throughout the apparition the coma was around 150,000km across, with a DC around 4.

85P/Boethin

Leo Boethin discovered this comet visually with a 0.20m reflector at Bangued, Abra, Philippines on 1975 January 4. 1997 was the worst return of the



Figure 36. Comet 81P/Wild imaged by Bob Neville on 1997 March 1.00 with his 0.21m reflector and SX CCD camera.

century and the comet was not recovered. The orbit is evolving in response to encounters with Jupiter and Saturn. The comet will pass 0.046 AU from Jupiter in 2007 May, in an encounter which makes significant changes to the angular elements. The return at the end of 2008 is favourable and the comet could become visible in binoculars.

91P/Russell

This comet was discovered by Ken Russell with the UK Schmidt on 1983 June 14. It was put into its present orbit

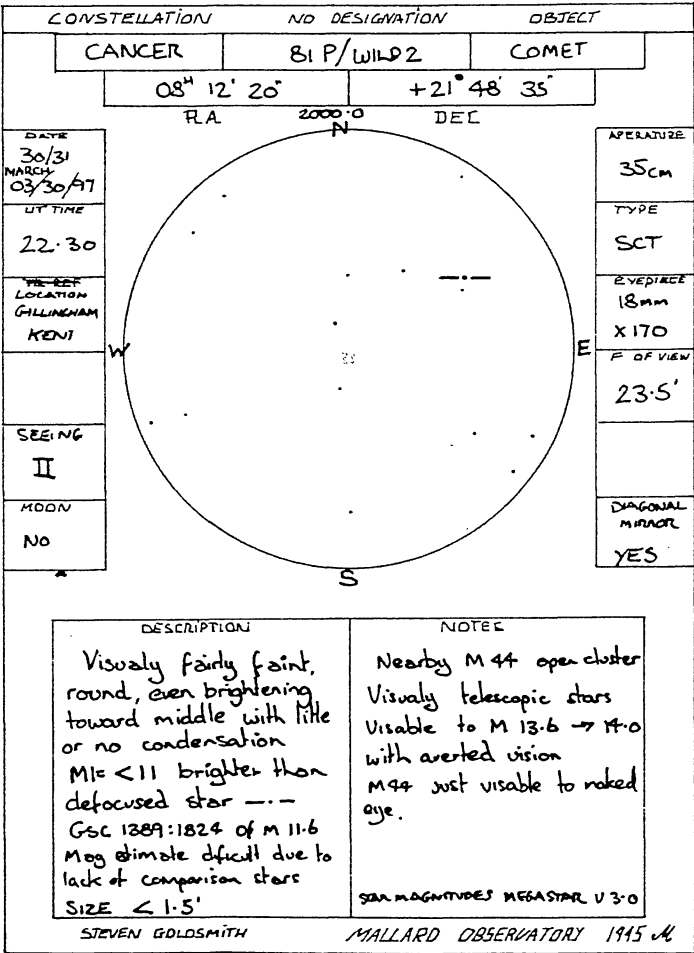


Figure 37. Comet 81P/Wild observed and drawn by Steve Goldsmith on 1997 March 30.94 with his 0.35m SCT $\times 170$.

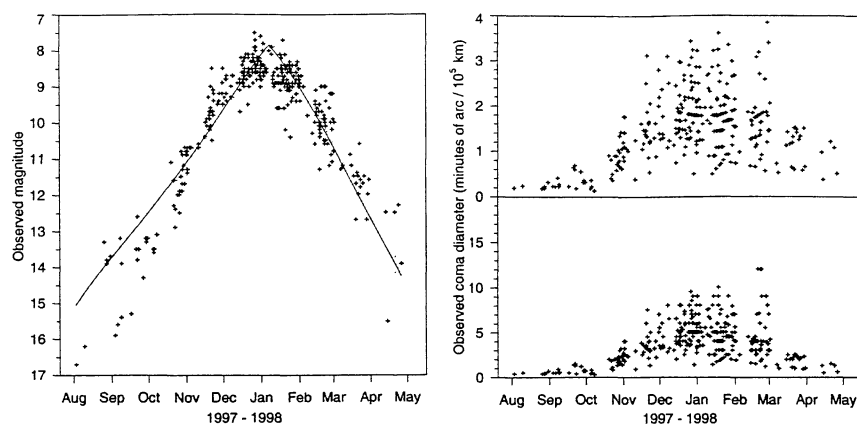


Figure 38. a) (left). The observed magnitude of comet 103P/Hartley. The curve shown is a linear best fit over the apparition, with no corrections applied. Tick marks indicate the first of each month from 1997 August. b) (right). The coma diameter of comet 103P/Hartley.

following a close (0.08 AU) encounter with Jupiter in 1941 December. This return was very similar to the discovery one, which was very poor.

94P/Russell

This was the third return of the comet, discovered in 1984 by Ken Russell. An encounter with Jupiter in 1975 had slightly reduced the perihelion distance. It was a favourable return, with opposition occurring near perihelion. CCD observations submitted to the *ICQ* suggest that it became no brighter than 16th magnitude.

100P/Hartley

This was the third observed return of 100P/Hartley, which was discovered by Malcolm Hartley in 1985 and last seen in 1991. This return was a favourable one, with the comet reaching opposition about a month from perihelion. No observations were received by the BAA, and CCD observations received by the *ICQ* suggest that it got no brighter than 15th magnitude. An encounter with Jupiter in 1999 October has pushed the perihelion distance a little further outwards, so it is unlikely to be seen again visually. The comet can approach Mars, and did so to 0.18 AU in 1951 and 0.39 AU in 1997.

103P/Hartley

In 1982 this comet made a close approach to Jupiter, and it was discovered by Malcolm Hartley four years later, around nine months after perihelion. It was accidentally recovered by T. V. Kryachko of Majdanak, USSR, on 1991 July 9.85, returning 5.6 days earlier than predicted. It was well observed by the Section at that return and observations showed that the brightness peaked around 13 days after perihelion.

The 1997 return was also a good one. The comet was an evening object throughout the apparition and steadily brightened reaching mag 8 in late December when it was at perihelion. The orbit comes close to that of the Earth and it could produce a meteor shower at the descending node in November. Calculations by Harold Ridley for the

1985 orbit gave a radiant of 19h56m +14°, some 5° Nf Altair, with a likely maximum around November 17. An Internet alert from the International Meteor Organisation suggested a radiant in 1997 of 19h42m +31° (near Beta Cygni) with maximum on November 3.04. No significant meteor activity was seen.

Herman Mikuz made the first observation, using his CCD system on August 2.91 when the comet was mag 16.7. Later in the month, Jonathan Shanklin picked it up visually, estimating it at around 13.8 in the Northumberland 0.30m refractor on August

27.91. An observation on October 5.28 by Nicolas Biver made it 13.6 in his 0.26m reflector $\times 169$. By October 22.77 it had brightened to 12.9 according to Shanklin, but was very diffuse and difficult to see. At the end of the month, on October 31.76 it had reached 10.8 in his 0.33m reflector $\times 100$, but was DC2, coma diameter 2.7'. An observation in moonlight on November 10.77 put it at about 10.6, still very diffuse.

Once the Moon had left the sky observations became more abundant. Gabriel Oksa observing with 20 $\times$ 80 binoculars on November 20.71 made the comet 9.6 and the coma 4.5' in diameter, DC1. By November 30.25 it had become a little more condensed at DC4 and was magnitude 8.9 in 7 $\times$ 50 binoculars according to Nicolas Biver. On Christmas night John Bortle estimated the magnitude at 8.2 in 20 $\times$ 80 binoculars. A month later it was fading, Gabriel Oksa estimating it at 9.0 in 20 $\times$ 80 binoculars on January 26.74, with a 2.5' coma of DC 2–3. Werner Hasubick observing on February 18.78, put the comet at 10.1 in 25 $\times$ 100 binoculars,

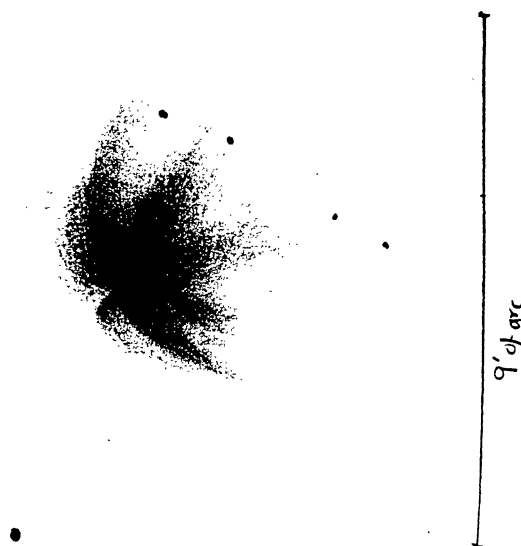


Figure 39. Comet 103P/Hartley drawn by Nick Martin on 1998 January 22.83 with a 0.5m, f4 reflector $\times 248$.

The comets of 1997

with a 2.6' diameter coma of DC4. By March most observers needed a telescope to see the comet; Reinder Bouma used his 0.26m Jones–Bird reflector on March 23.83 and estimated the comet to be 11.8. Nicolas Biver made a final observation on April 26.27 when the comet was about 13.9, with a very diffuse 0.6' diameter coma.

A linear light curve gives a slightly better fit than the traditional power law. This suggests that the brightness of the comet peaked 17 days after perihelion, which is nearly identical to the previous apparition.

The coma increased to a maximum diameter of around 10' in early January, corresponding to a dimension of over 350,000km. The DC was around 3. A tail was reported from time to time, however the reports are not consistent, and in particular the reported position angle was highly variable.

117P/Helin–Roman–Alu

This distant comet was discovered in 1989 and although this was its first return it was not given a year letter assignment because it can be observed most of the way round its orbit. An encounter with Jupiter in May 2002 will reduce the perihelion distance from 3.7 to 3.0 AU.

118P/Shoemaker–Levy

James V. Scotti of the Lunar and Planetary Laboratory recovered comet P/Shoemaker–Levy 4 (P/1991 C2 = 1990 XII = 1991f) with the 0.9m Spacewatch telescope at Kitt Peak on June 22.45 [IAUC 6180, 1995 June 28]. Details of the return are given in the report for 1995.²⁹ Observations were omitted from that report and it was observed visually, reaching around 13th magnitude in a favourable return with perihelion close to opposition. The comet's orbit is slowly changing in response to Jovian perturbations and for the next 30 years or so will become a little easier to observe as the perihelion distance is slightly reduced.

127P/Holt–Olmstead

Jim Scotti recovered this periodic comet (P/1990 R2 = 1990k = 1990 XVIII) with the University of Arizona Spacewatch Telescope on Kitt Peak on 1996 September 19.20 [IAUC 6475, 1996 September 20]. Details of the return are given under the comets of 1996.³⁰

128P/Shoemaker–Holt

On the same night Scotti recovered comet P/1987 U1 (= 1987z = 1988 VII). [IAUC 6477, 1996 September 21] The prediction by S. Nakano on MPC 23484 required a correction of $\Delta T = -0.89$ day. Details of the return are given under the comets of 1996.³⁰

Other comets at perihelion

SOHO sungrazing comets

Comet	Discovery IAUC
1997 B2	6669, 1997 May 23
1997 B3	7560, 2001 January 13

1997 G3, G4, G5, G6	7480, 2000 August 23
1997 G7, H4, H5	7841, 2002 March 4
1997 H3	6811, 1998 January 23
1997 J3, J4	7472, 2000 August 3
1997 K1	6676, 1997 June 6
1997 K3, K4	7472, 2000 August 3
1997 K5, K6	7485, 2000 September 1
1997 K7	7641, 2001 June 6
1997 L3, L4	6685, 1997 June 20
1997 L5	7472, 2000 August 3
1997 M1	6692, 1997 July 3
1997 M3	7472, 2000 August 3
1997 M4	7480, 2000 August 23
1997 M5	7606, 2001 April 2
1997 N3	7480, 2000 August 23
1997 P1	6713, 1997 August 7
1997 P3	6811, 1998 January 23
1997 Q1, Q2	6733, 1997 September 4
1997 R1, R2, R3	6745, 1997 September 22
1997 S1	6750, 1997 October 3
1997 S2	6813, 1998 January 27
1997 S3	7560, 2001 January 13
1997 T2	6754, 1997 October 7
1997 T4, T5	6759, 1997 October 22
1997 T6, T7	7517, 2000 November 6
1997 T8	7519, 2000 November 15
1997 U1	6825, 1998 February 20
1997 U2, U3, U4, U5, U6, U7	7519, 2000 November 15
1997 V2	6771, 1997 November 14
1997 V3, V4, V5, V6	7534, 2000 December 2
1997 W1	6781, 1997 December 5
1997 W2	6837, 1998 March 11
1997 W3	7650, 2001 June 23
1997 X1	6781, 1997 December 5
1997 X3, X4, X5, X6, Y1	7534, 2000 December 2
1997 Y2, Y3	7536, 2000 December 5

The *SOHO* LASCO coronagraphs discovered a large number of sungrazing comets, which were not observed elsewhere as they were not expected to survive perihelion. There are three LASCO (Large Angle Spectroscopic Coronagraphs) on the *SOHO* spacecraft. C1 has a field from 1.1 to 3 solar radii, C2 from 1.5 to 6 and C3 from 3.5 to 30. Brighter comets are often discovered in real time data, but the fainter ones have to wait for the archival data to be searched which runs several months to years behind.

They are among the intrinsically faintest comets ever seen, with an absolute magnitude of between 15 and 20. They represent minor fragments from the Kreutz group of sungrazing comets whose orbital evolution has been described by Brian Marsden.^{31,32} These comets have perihelion distance less than 0.02 AU, longitude of perihelion around 282° and latitude of perihelion around 35°. Only the larger objects survive perihelion, and then only if q is greater than 0.005 AU.

The comets probably originated from the breakup of a comet seen in -371, which was reported to have fragmented into two parts by the Greek historian Ephorus. This breakup seems to have given rise to two main comets, one of which had a period of around 350 years and the other a period of around twice this. The shorter period object returned in the 1st, 4th, 8th and 11th centuries and may be identical with the comet of 1487. The 11th century return seems to have caused further breakup which gave rise to sub-group I of the Kreutz sungrazers. This group includes 1843 D1 (Great March Comet), comet Pereyra (1963 R1) and more recently the *Solwind* and *Solar Maximum Mission* (SMM) objects, and many of the

SOHO objects. The longer period object returned in the 4th century and in 1106 when it also broke up, to give rise to sub-group II comets including 1882 R1 (Great September Comet) and Ikeya–Seki (1965 S1) and a few of the *SOHO* objects. Comet White–Ortiz–Bolelli (1970 K1) appears to belong to a slightly different sub-group of this grouping and may represent an earlier breakup.

Several more cometary groupings have recently been discovered among the other *SOHO* comets, including 1997 G7, H4 and H5, which are all members of the Meyer group. A more complete account of the *SOHO* comets will appear in a future paper in the *Journal*, and a paper on historical sungrazing comets by Kenelm England appeared recently.³³

1995 O1 (Hale–Bopp)

The Great Comet of 1997 reached perihelion during the year. The apparition will be fully described in a forthcoming paper by Nick James, who also prepared a special supplement to *The Astronomer* magazine.³⁴

25D/Neujmin

25D/Neujmin was discovered by G. N. Neujmin at a very favourable return in 1916, when it reached 10th magnitude. A comet was recovered in November 1920, but observations at the next return in 1927 cast doubt on the identity with the original object. It has not been seen since then and the orbit must be regarded as uncertain at best. Searches at favourable returns in the intervening period have failed to reveal the comet and it is possible that it is no longer active.

26P/Grigg–Skjellerup

John Grigg discovered this comet with a 0.09m refractor from Thames, New Zealand in 1902 July. It was lost until recovered by J. F. Skjellerup during a search with a 0.075m refractor at Rosebank, Cape Town in 1922 May. It has been observed at every return since 1922, though the period of visibility is always quite short. In 1984 Kresak showed that an unconfirmed observation of a comet by Pons in 1808 was an early sighting of 26P/Grigg–Skjellerup. This, the 18th observed return, was not a favourable one and the comet was not observed visually.

Its perihelion distance has been increasing for the past 100 years and now lies just outside Earth's orbit. It has encountered Jupiter several times, the most recent encounters being in 1964 and 1999 which made minor changes to the orbit. The comet's orbit passes very close to that of the Earth at the ascending node and hence a meteor shower can be expected when the comet passes the intersection close to the Earth. The shower should occur around April 23 with a radiant in Puppis, and significant displays were observed from Australia in 1977 and 1982.

The *Giotto* spacecraft encountered the comet in 1992 July and following analysis of the data S. M. P. McKenna–Lawlor, National University of Ireland at Maynooth, reported the detection of a possible secondary component in 1999. Energetic-particle observations (about 60–100 keV) on 1992 July 10 by the EPONA instrument aboard

the spacecraft suggested that the possible secondary component was located 9×10^4 km (corresponding to a delay of 40 min along the comet's orbit) from the primary nucleus and appeared to have a diameter 3–4 times smaller. [*IAUC* 7243, 1999 August 25]

79P/du Toit–Hartley

The comet was discovered by D. du Toit on a survey plate taken with the 0.61m f4 Bruce astrograph at Boyden Station, Bloemfontein, South Africa on 1945 April 9 and then lost. The angular elements were significantly changed by a moderately close encounter with Jupiter in 1963 December. Malcolm Hartley discovered a comet on Southern Sky Survey plates taken with the 1.22/1.83 UK Schmidt at Siding Spring NSW on 1982 February 5. The comet was recognised as being identical with du Toit's comet by S. Nakano. It had two components separated by 0.75° . The comet was not recovered at the next return. The 1997 return was unfavourable and the comet was again not recovered.

D/Haneda–Campos

The comet was discovered by T. Haneda with a 0.08m refractor in Fukushima and by J. S. Campos with a 0.12m refractor at Durban on 1978 September 1 at an optimum return. Subsequent returns have not been so favourable. A close encounter with Jupiter in 1981 significantly changed the orbit and its actual location is now uncertain. The 1991 return was very poor and this return was moderate so the comet must be presumed lost.

Predictions were also made for the return of 3D/Biela and 1827 M1 D/Pons–Gambart during the year, but as expected they were not recovered.

Other comets and objects observed during the year

9P/Tempel

P. Lamy, Laboratoire d'Astronomie Spatiale, and his team reported the detection of the nucleus of the comet with the Hubble Space Telescope (+WFPC2) on 1997 December 31 at $\Delta = 3.53$ AU and $r = 4.48$ AU: 'The slightly incomplete lightcurve indicates an elongated body having semi-axes $a = 3.9$ and $b = 2.8$ km (assuming a geometric albedo of 0.04) and a rotational period of about 25 hr. No coma was detected.' [*IAUC* 7000, 1998 August 28]

29P/Schwassmann–Wachmann

This annual comet started the year retrograding in Virgo and stayed near the borders of Virgo, Crater and Corvus. In February and early March the comet was in outburst, peaking at around 12th magnitude. It faded in April, but returned to visibility in early May, rising to 12th magnitude late in the month. Jonathan Shanklin observed it at 13.7: on May 12.95 with the Northumberland 0.30m refractor. On May 29.97 it was 12.0: in his 0.20m LX200 $\times 75$, with coma diameter $1.8'$, DC3. Andrew Pearce

The comets of 1997

reported glimpsing it at around 14th magnitude in his 0.41m reflector at the end of December.

The comet has frequent outbursts and seems to be active more often than not, though it rarely gets brighter than mag 12. The randomly spaced outbursts may be due to a thermal heat wave propagating into the nucleus and triggering sublimation of carbon monoxide inside the comet. In early 1996 it was in outburst for several months and it was also active for most of the first half of 1997. It is possible that its behaviour is changing with the comet quiescent at 14th magnitude and outbursting to 11.5, as in the event which occurred in May. This comet is an ideal target for those equipped with CCDs and it should be observed at every opportunity, though it will remain low for UK based observers until 2003.

A/1997 MD₁₀

Asteroid 1997 MD₁₀ has a very eccentric, high inclination cometary orbit, with a period of 139 years, and reached perihelion at 1.5 AU in November. This 4km-sized object may be one of the many extinct Halley-type comets that are expected on dynamical grounds.

A/1997 SE₅

Another of the 1997 asteroids, 1997 SE₅, is discussed along with 1996 PW in a paper in *Icarus*.³⁵ 1996 PW reached perihelion at 2.5 AU and had no detectable emissions. It is either an extinct (or inactive) comet from the Oort cloud or else an asteroid from the Oort cloud that was placed there early in the history of the solar system. 1997 SE₅ also showed no detectable activity at perihelion at 1.3AU. It has a Jupiter-crossing orbit typical of a short-period comet. Both are moderately red objects, comparable to D-type asteroids. 1997 SE₅ has a triple-peaked light curve with a period of 9.05 hours and an amplitude of 0.4 magnitudes, indicative of a complex shape.

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References

- 1 Shanklin J. D., 'Comet Analyses', *J. Brit. Astron. Assoc.*, **105**(6), 291 (1995)

- 2 Goodman N. J. (ed.), *The Handbook of the British Astronomical Association*, 1997
- 3 Nakano S. & Green D. W. E. (eds.), *ICQ 1997 Comet Handbook*
- 4 JPL *Horizons* (<http://ssd.jpl.nasa.gov/horizons>)
- 5 Marsden B. G. & Williams G. V., *Catalogue of Cometary Orbits 1999*, 13th edition, IAU CBAT (1999)
- 6 Muraoka K. (<http://www.astroarts.com/comets>)
- 7 Strange D., 'Comet 55P/Tempel-Tuttle, 1998 January 6', *The Astronomer*, **34** (405) (1998)
- 8 James N. D., 'Comet 55P/Tempel-Tuttle, 1998 January 15', *The Astronomer*, **34** (406) (1998) and *J. Brit. Astron. Assoc.*, **108**(3), 176 (1998)
- 9 Mobberley M. P., 'Comet 55P/Tempel-Tuttle, 1998 January 31', *The Astronomer*, **34** (405) (1998)
- 10 Bone N. M. & Evans S. J., 'Visual, video & photographic observations of the Leonid meteor shower in 1998' *J. Brit. Astron. Assoc.*, **111**(6), 333 (2001)
- 11 James N. D., '1999 Leonid observations from the Sinai desert' *J. Brit. Astron. Assoc.*, **110**(1), 4 (2000)
- 12 Shanklin J. D., 'Comet Levy 1990c', *J. Brit. Astron. Assoc.*, **105**(6), 295 (1995)
- 13 Shanklin J. D., 'Comet Shoemaker-Levy 1991a₁', *J. Brit. Astron. Assoc.*, **106**(1), 19 (1996)
- 14 Shanklin J. D., 'The Comets of 1991', *J. Brit. Astron. Assoc.*, **107**(4), 186 (1997)
- 15 Armstrong M., 'Comet 1997 J1 (Mueller)', *The Astronomer*, **34** (398) (1997)
- 16 Mackey J., 'Comet 1997 J2 (Meunier-Dupouy) and NGC 3403', *The Astronomer*, **34** (398) (1997)
- 17 Armstrong M., 'Comet 1997 J2 (Meunier-Dupouy) and NGC 3403', *The Astronomer*, **34** (399) (1997)
- 18 A'Hearn M. F., 'The comet no one saw', *Nature*, **405**, 285 (2000)
- 19 Makinen J. T. T. et al., 'Discovery of a comet by its Lyman- α emission', *Nature*, **405**, 321 (2000)
- 20 Shanklin J. D., 'The Comets of 1990', *J. Brit. Astron. Assoc.*, **106**(2), 86 (1996)
- 21 Buczynski D. G., 'Comet 1997 T1 (Utsunomiya)', *The Astronomer*, **34** (402) (1997)
- 22 Mikuz H., 'Comet 1997 T1 (Utsunomiya)', *The Astronomer*, **34** (402) (1997)
- 23 Gavin M., 'Comet 1997 T1 (Utsunomiya)', *The Astronomer*, **34** (402) (1997)
- 24 James N. D., 'Comet 1997 T1 (Utsunomiya)', *The Astronomer*, **34** (403) (1997)
- 25 Concepcion L. H., 'Comet 43P/Wolf-Harrington, 1998 March 21' *The Astronomer*, **35** (410) (1998)
- 26 Concepcion L. H., 'Comet 78P/Gehrels 2' *The Astronomer*, **34** (404) (1997)
- 27 Laurie S. P., 'Comet 81P/Wild 2' *The Astronomer*, **33** (394) (1997)
- 28 Concepcion L. H., 'Comet 81P/Wild 2' *The Astronomer*, **34** (397) (1997)
- 29 Shanklin J. D., 'The Comets of 1995', *J. Brit. Astron. Assoc.*, **110**(6), 311 (2000)
- 30 Shanklin J. D., 'The Comets of 1996', *J. Brit. Astron. Assoc.*, **111**(5), 247 (2001)
- 31 Marsden B. G., 'The Sungrazing Comet Group', *AJ*, **72**(9), 1354 (1967)
- 32 Marsden B. G., 'The Sungrazing Comet Group, II', *AJ*, **98**, 2306 (1989)
- 33 England K., 'Early sungrazer comets', *J. Brit. Astron. Assoc.*, **112**(1), 13 (2002)
- 34 James N. D. (ed.), 'The Great Comet of 1997', *The Astronomer* (1997)
- 35 Hicks M. D. et al., 'Physical Observations of 1996 PW and 1997 SE5: Extinct Comets or D-Type Asteroids?', *Icarus*, **143**, 354 (2000)

Other references and sources

- IAU *Circulars* as indicated
Kronk G., *Cometographia*, Cambridge University Press, 1999
Kronk G., *Comets A descriptive catalogue*, Enslow, 1984
Belyaev, N. A. et al., *Catalogue of short period comets*, Slovak Academy of Sciences, Bratislava, 1986
Carusi, A. et al., *Long-term Evolution of Short-period Comets*, Adam Hilger, 1985

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