The Comets of 1991

J. D. Shanklin

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

This report is the second in the annual series which gives for each comet: the discovery details, orbital data and general information, magnitude parameters and BAA comet section observations. It continues the series which last appeared in the Journal in 1950[1], with irregular notes appearing until the early 60s. Observational reports were published in the comet section newsletter *Isti Mirant Stella* from 1973 to 1987 and a couple of papers were published in the Journal in the early 1980's[2,3]. Further details of the analysis techniques used in this report are given in an earlier paper[4]. Ephemerides for the comets predicted to return during the year can be found in the ICQ Handbook[5].

Table 1. Orbital data for the comets of 1991[6]

		Comet		T	q	e	P	ω	Ω	i
a	A1	97P/Metcalf-Brewington	1991 I	91 Jan 5.6146	1.591466	0.593843	7.76	208.0425	187.7869	13.0277
b	A2	Arai	1990 XXVI	90 Dec 10.8873	1.434161	0.990507		337.6388	115.5226	70.9783
c		64P/Swift-Gehrels	1991 II	91 Feb 22.7248	1.355134	0.691601	9.21	84.8159	314.4426	9.2550
d	B1	Shoemaker-Levy	1991 XXIV	91 Dec 31.1804	2.265035	0.993508		74.3650	145.1295	77.2881
e	C1	P/Shoemaker-Levy 3	1990 XXVII	90 Dec 12.7559	2.810419	0.249844	7.25	181.7749	303.7637	5.0170
f	C2	118P/Shoemaker-Levy 4	1990 XII	90 Jul 14.4592	2.019302	0.420902	6.51	302.3098	152.0857	8.4667
g	C3	McNaught-Russell	1990 XIX	90 Oct 18.1990	4.777087	1.001769		320.8865	161.7096	113.4304
h	D1	98P/Takamizawa	1991 XIII	91 Aug 17.9155	1.589779	0.574592	7.22	147.6789	124.9190	9.4795
i	D2	99P/Kowal 1	1992 VI	92 Mar 13.0957	4.672742	0.232387	15.0	174.6998	28.7726	4.3919
j	E1	100P/Hartley 1	1991 VII	91 May 17.6784	1.818370	0.450693	6.02	178.7576	38.9489	25.7245
k	F1	124P/Mrkos	1991 IV	91 Mar 18.9706	1.410452	0.554754	5.64	180.4107	1.6875	31.4868
l	F2	Helin-Lawrence	1992 I	92 Jan 20.0270	1.517721	1.000431		271.1592	11.8349	95.4565
m		21P/Giacobini-Zinner	1992 IX	92 Apr 13.2279	1.034003	0.706489	6.61	172.5168	195.3843	31.8218
n		4P/Faye	1991 XXI	91 Nov 16.1937	1.593386	0.578185	7.34	203.9369	199.5952	9.0850
o	L1	101P/Chernykh	1992 II	92 Jan 25.4502	2.356292	0.593633	14.0	263.2458	130.3919	5.0777
p	L2	102P/Shoemaker 1	1991 XXIII	91 Dec 18.2121	1.985743	0.470349	7.26	18.7668	339.9517	26.2429
q	L3	P/Levy	1991 XI	91 Jul 8.1932	0.982524	0.928807	51.3	41.4686	329.4305	19.1904
r	L4	Helin-Alu	1992 V	92 Feb 19.9305	4.849913	1.000083		30.7913	253.6535	49.2952
s		46P/Wirtanen	1991 XVI	91 Sep 20.6867	1.083286	0.652254	5.50	356.1788	82.2805	11.6829
t	N1	103P/Hartley 2	1991 XV	91 Sep 11.6516	0.953312	0.719484	6.26	174.8968	226.7844	9.2519
u		50P/Arend	1991 VIII	91 May 26.0220	1.850061	0.537033	7.99	47.0688	356.1947	19.9354
v	Q1	McNaught-Russell	1992 XI	92 May 3.4521	3.193910	0.994587		257.2328	120.4639	90.5063
w	R1	McNaught-Russell	1990 XXII	90 Nov 12.2567	6.986421	0.999335		149.2425	150.1176	104.5092
x	R2	125P/Spacewatch	1990 XXIX	90 Dec 22.0383	1.543100	0.508752	5.57	87.1525	153.4238	9.9673
y	S1	P/McNaught-Hughes	1991 IX	91 Jun 16.1197	2.125343	0.402350	6.71	224.4274	89.9816	7.3002
z	T1	P/Shoemaker-Levy 5	1991 XXII	91 Dec 13.2218	1.984899	0.529804	8.67	6.0433	29.6656	11.7653
a1	T2	Shoemaker-Levy	1992 XIX	92 Jul 24.5069	0.836250	0.999862		145.2402	49.0506	113.4979
b1	V1	P/Shoemaker-Levy 6	1991 XVIII	91 Oct 13.8585	1.132346	0.705642	7.54	333.1274	37.9330	16.8548
c1		62P/Tsuchinshan 1	1991 XIV	91 Aug 30.5315	1.497517	0.576321	6.65	22.7908	96.8486	10.5019
d1	V2	P/Shoemaker-Levy 7	1991 XIX	91 Oct 27.5267	1.630092	0.542754	6.73	91.9534	312.9564	10.2799
e1		60P/Tsuchinshan 2	1992 XII	92 May 20.0935	1.782157	0.504409	6.82	203.1093	288.3433	6.7176
f1	X1	104P/Kowal 2	1991 XX	91 Nov 4.4256	1.499744	0.564336	6.39	189.5477	247.7878	15.8305
g1	Y1	Zanotta-Brewington	1992 III	92 Jan 31.9915	0.643969	1.000058		197.8730	254.9074	50.0287
h1	X2	Mueller	1992 VIII	92 Mar 21.2000	0.198771	1.000175		306.9902	288.7848	95.5664
		49P/Arend-Rigaux	1991 XVII	91 Oct 2.7180	1.437822	0.600052	6.82	329.0758	122.1343	17.8839
		96P/Machholz 1	1991 XII	91 Jul 21.9825	0.125546	0.958369	5.24	14.5363	94.5175	60.1461

The epoch of the elements for each comet is for the Julian Date ending in zero closest to the date of perihelion. New style designations for the comets are also given.

Table 2. List of visual observers

Karl-Gustav Andersson,	Sweden
Clara Andrade e Silva,	Portugal
Sally Beaumont,	Windermere, Cumbria
Peter Birtwhistle,	Birmingham
Bjorn Davidsson,	Sweden
Andrea Boattini,	Italy
John E. Bortle,	U.S.A.
Steve Brincat,	Malta
Robert Bullen,	Bognor Regis, Sussex
Haakon Dahle,	Norway
Jorgen Danielsson,	Sweden
H. A. Davies,	Cirencester
Francisco Garcia Diaz,	Spain
Steve Evans,	Towcester, Northants
Bjoern Haakon Granslo,	Norway
Werner Hasubick,	Germany
Roberto Haver,	Italy
Guy M. Hurst,	Basingstoke, Hampshire
Jost Jahn,	Germany
Albert F. Jones,	New Zealand
Timo Karhola,	Sweden
Graham Keitch,	Manaton, Devon
Mark Kidger,	Canary Islands
Stefan Korth,	Germany
Attila Kosa-Kiss,	Romania
Martin Lehky,	Czech Republic
Jose Carvajal Martinez,	Spain
Oernulf Midtskogen,	Norway
Herman Mikuz,	Slovenia
Roy W. Panther,	Walgrave, Northampton
Mieczyslaw L. Paradowski,	Poland
Andrew R. Pearce,	Australia
Alfredo Jose Serra Pereira,	Portugal
Jose Ripero Osorio,	Spain
Patrick Schmeer,	Germany
Jonathan D. Shanklin,	Cambridge
David Storey,	Witney, Oxfordshire
Tony Tanti,	Malta
Maura Tombelli,	Italy
Johan Warell,	Sweden
Mauro Vittorio Zanotta,	Italy

Table 3. List of astrometric, CCD and photographic observers:

Observer	Site	IAU Station No
Denis G. Buczynski,	Conder Brow, Lancashire	978
Maurice Gavin	Worcester Park, Surrey	
Werner Hasubick,	Buchloe, Germany	

Michael J. Hendrie,	Colchester, Essex	502
Brian Manning,	Stakenbridge, Worcs	494
Herman Mikuz,	Crni vrh, Slovenia	106
Martin Mobberley,	Cockfield, Suffolk	480
Terry Platt,	Binfield, Berkshire	
Harold B. Ridley	Eastfield, Somerset	984
Jonathan D. Shanklin,	Cambridge	503

Table 4. Magnitude parameters of comets observed by the comet section.

A correction for aperture of 0.0033 mm^{-1} and the observer corrections derived in previous papers[4,7,8,9] have been applied and the H1 value is reduced to zero aperture. No comet had a sufficiently large coma to warrant including the coma correction.

	Comet	No	ΔR AU	H1	K1	H10	H15
a	97P/Metcalf-Brewington	43	1.6 - 1.7			5.6ñ0.1	4.6ñ0.1
b	Arai	16	1.5 - 1.6			9.5ñ0.2	8.6ñ0.2
d	Shoemaker-Levy	22	1.6 - 3.0			7.3ñ0.3	5.9ñ0.3
j	100P/Hartley 1	1	1.8			10.1	8.8
k	124P/Mrkos	2	1.4			12.5	11.7
l	Helin-Lawrence	4	1.6 - 3.9			5.3ñ0.8	2.9ñ1.2
n	4P/Faye	162	1.6 - 1.9	6.0ñ0.4	20.4ñ2.1	8.3ñ0.0	7.2ñ0.0
o	101P/Chernykh	3	2.7			5.5ñ0.3	3.3ñ0.3
q	P/Levy	55	1.0 - 1.5	7.6ñ0.1	8.1ñ1.3	7.6ñ0.1	7.4ñ0.1
s	46P/Wirtanen	13	1.1 - 1.5			8.8ñ0.2	8.5ñ0.1
t	103P/Hartley 2	145	1.0 - 1.8	8.4ñ0.0	9.6ñ0.9	8.4ñ0.0	8.3ñ0.0
a1	Shoemaker-Levy	137	0.8 - 1.5	7.9ñ0.1	6.0ñ0.5	8.0ñ0.1	8.1ñ0.1
b1	P/Shoemaker-Levy 6	4	1.3 - 1.5			12.1ñ0.4	11.4ñ0.4
f1	104P/Kowal 2	5	1.6 - 1.8			11.2ñ0.3	10.1ñ0.4
g1 pre	Zanotta-Brewington	103	0.6 - 1.0	8.8ñ0.1	5.2ñ0.8	9.2ñ0.1	9.7ñ0.1
g1 post	Zanotta-Brewington	18	0.6 - 1.6	9.3ñ0.1	7.1ñ1.0	9.4ñ0.1	9.7ñ0.2
h1	Mueller	24	0.6 - 1.6	10.1ñ0.1	12.6ñ0.6	10.0ñ0.1	10.2ñ0.1
	96P/Machholz 1	2	0.4 - 0.6			12.0ñ0.5	13.6ñ0.8

The magnitude of the comets can be calculated from the 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.

The comets assigned year letters

a 97P/Metcalf-Brewington (1991 A1, 1991 I)

Howard J Brewington of Cloudcroft, New Mexico discovered a comet of magnitude 9.8 with his 0.41-m reflector on January 7.18. [IAUC 5155, January 7]. This was subsequently found to be the first observed return of P/Metcalf (1906 V2, 1906 VI) which had been lost since 1907,

though a good prediction for its return in 1975 had appeared in the Journal[10]. A prediscovery image on January 5.5 showed the comet at about 15^m suggesting that it was found during an outburst. The ephemeris suggests that it could have been discovered as early as August 1990 if it had been at the magnitude suggested by the light curve. The failure to find it during its first few returns and also in 1975 and 1983 indicate that it is normally inactive. A close approach to Jupiter in 1993 has drastically altered the orbit and q is now 2.6 AU which will make it a difficult object to observe in the future.

At discovery the comet was in the evening sky on the border of Pisces and Cetus, a couple of days past perihelion. It moved slowly north west, remaining on the borders of Pisces and Cetus, with the solar elongation slowly decreasing (Fig 1).

Albert Jones observed it on January 9.40, making it 9.9 in his 0.32-m reflector. Photographs taken by Brian Manning on January 12.75 and Harold Ridley on January 17.78 appeared in TA[11,12] and one taken by Martin Mobberley on January 13.77 appeared in the Journal[13]. The comet steadily faded and generally became less condensed and by mid February Jones made it 11.6. No visual observations made after February 17 were received, but Harold Ridley took an astrometric plate on March 3 and Jonathan Shanklin obtained one on March 19 with the University of Cambridge 0.45-m Schmidt camera.

Table 5. Ephemeris for comet 97P/Metcalf-Brewington 1991a

Magnitudes calculated from m = 4.6 + 5.0 * Log(Δ) + 15.0 * Log(r)
Latitude: 53.0øN Longitude: 0.0øW

Day	R.A. (1950.0) hh mm.m	Dec ø.mm	Mag	Δ A.U.	R A.U.	Observable hh.mm to hh.mm	Elong ø
1990 August							
6/ 7	21 37.0	3.55	10.1	1.22	2.19	21.33 to 2.39	158
16/17	21 30.4	2.55	9.8	1.14	2.13	21.03 to 3.05	163
26/27	21 23.2	1.25	9.5	1.09	2.07	20.35 to 3.29	162
1990 September							
5/ 6	21 16.7	-0.30	9.3	1.05	2.01	20.07 to 2.52	154
15/16	21 12.3	-2.39	9.1	1.04	1.95	19.39 to 1.60	145
25/26	21 11.1	-4.50	8.9	1.05	1.90	19.13 to 1.10	136
1990 October							
5/ 6	21 13.6	-6.51	8.8	1.07	1.85	18.49 to 0.23	126
15/16	21 20.1	-8.34	8.6	1.11	1.80	18.26 to 23.41	118
25/26	21 30.5	-9.53	8.6	1.15	1.76	18.06 to 23.05	110
1990 November							
4/ 5	21 44.6	-10.46	8.5	1.19	1.72	17.48 to 22.35	103
14/15	22 1.7	-11.10	8.5	1.25	1.68	17.34 to 22.11	97
24/25	22 21.5	-11.07	8.4	1.30	1.65	17.24 to 21.52	91

1900 December							
4/ 5	22 43.5	-10.37	8.4	1.36	1.63	17.18 to 21.38	86
14/15	23 7.1	-9.42	8.4	1.42	1.61	17.17 to 21.28	82
24/25	23 32.1	-8.25	8.5	1.48	1.60	17.21 to 21.21	78
1991 January							
3/ 4	23 58.0	-6.50	8.6	1.54	1.59	17.30 to 21.16	74
13/14	0 24.5	-4.59	8.7	1.61	1.59	17.41 to 21.13	71
23/24	0 51.5	-2.58	8.8	1.69	1.60	17.56 to 21.10	68

1991 February							
2/ 3	1 18.8	-0.50	9.0	1.77	1.62	18.12 to 21.07	65
12/13	1 46.1	1.20	9.2	1.85	1.64	18.29 to 21.03	62
22/23	2 13.4	3.27	9.4	1.94	1.67	18.47 to 20.59	59
1991 March							
4/ 5	2 40.6	5.29	9.6	2.03	1.70	19.05 to 20.52	57
14/15	3 7.7	7.21	9.9	2.13	1.74	19.23 to 20.45	54
24/25	3 34.5	9.03	10.1	2.24	1.79	19.43 to 20.35	51
1991 April							
3/ 4	4 0.9	10.31	10.4	2.35	1.83	20.04 to 20.23	48
13/14	4 27.0	11.44	10.7	2.46	1.88	Not Observable	45
23/24	4 52.5	12.42	11.0	2.57	1.94	Not Observable	42

Fig 1
Obs plot

Fig 2
Light curve

b Arai (1991 A2, 1990 XXVI)

Discovered photographically at magnitude 12 by Masaru Arai of Yorii, Japan using a 0.16-m reflector on January 5.63. [IAUC 5157, January 7]. A prediscovery image on 1990 December 23 showed it to be similar in brightness, so that it could have been discovered several weeks earlier.

At discovery the comet was in Cancer, some 5ø from Jupiter. It was 26 days past perihelion and rapidly moving north towards opposition on January 22nd. It passed through Lynx in mid January and into Camelopardalus in early February (Fig 3).

Roy Panther was able to observe the comet on the same day the IAUC announcing its discovery was issued, making it 11.7 in his 0.20-m reflector. A photograph taken by Martin Mobberley on January 11.95 appeared in the Journal[13]. Observers noted little change in the comet's brightness, but no observations were made after mid February when the ephemeris suggests that it would have faded rapidly.

Fig 3
Obs plot

c 64P/Swift-Gehrels (1991 II)

Recovered by Tsutomo Seki at Geisei, Japan with his 0.6-m reflector at photographic magnitude 16.5 on January 7.39 in Aquarius as the comet approached conjunction. [IAUC 5164, January 15]. The apparition was an unfavourable one and no BAA observations were reported, though

observations reported in the IAUC by Alan Hale put it at 12.5^m in mid March. The previous apparition, in 1981, was more favourable and it reached 11^m. The comet was discovered in 1889 and then lost until it was recovered by chance by Tom Gehrels in 1973.

d Shoemaker-Levy (1991 B1, 1991 XXIV)

Discovered by the team of Carolyn S and Eugene M Shoemaker and David H Levy (SLT) with the 0.46-m Schmidt on Mt Palomar (PS) on January 22.43 at photographic magnitude 15.5. [IAUC 5175, January 28]. When discovered the comet was at opposition in Hydra, moving very slowly north east. In early March 1991 it entered Cancer and resumed prograde motion in late April, moving into Leo in late June. It now started moving west more rapidly, passing along the borders of Leo Minor, Ursa Major, Coma, Canes Venatici and into Bootes in mid November. It passed into Hercules in mid January 1992 and Cygnus in mid March, slowing and resuming retrograde motion in mid May then moving into Vulpecula in mid August.

A photograph taken by Martin Mobberley on 1991 February 16.90 showing the comet at 15^m appeared in the Journal[13]. Several observers estimated the comet at around 13.5 in April. It entered conjunction from May to October and had brightened to 12^m when recovered in mid November. It was 10^m at its brightest when near perihelion at the end of December 1991. It slowly faded, reaching 12.5 in August 1992, though few observers were following it.

e P/Shoemaker-Levy 3 (1991 C1, 1990 XXVII)

Discovered by the SLT with the PS on February 7.34 at photographic magnitude 16.5, when it was at opposition on the borders of Leo and Cancer, two months past perihelion. [IAUC 5183, February 8].

f 118P/Shoemaker-Levy 4 (1991 C2, 1990 XII)

Discovered by the SLT with the PS on February 9.45 at photographic magnitude 17, when it was near opposition in Virgo, seven months past perihelion. [IAUC 5185, February 11].

g McNaught-Russell (1991 C3, 1990 XIX)

Discovered by Rob H McNaught and Kenneth S Russell with the UK Schmidt at Siding Spring (UKS) on February 12.66 at photographic magnitude 16.5, when it was near opposition in Crater, four months past perihelion. [IAUC 5187, February 13].

h 98P/Takamizawa (1991 D1, 1991 XIII)

Recovered by James V Scotti of the Lunar and Planetary Laboratory, University of Arizona with the 0.91-m Spacewatch CCD telescope at Kitt Peak (SWT) on February 17.49 at a magnitude of 19.6 when it was nearing opposition in Virgo. [IAUC 5192, February 20]. This was the first predicted return of the comet. On its discovery in 1984 it was 9^m, but this turned out to be an outburst and its normal brightness was some 6^m fainter. At this return it was best placed for observers in the southern hemisphere, but no visual observations were reported. Brian Manning obtained an astrometric plate on May 14.95 with a 20 minute exposure on Kodak 4415 with his 0.26-m reflector.

i 99P/Kowal 1 (1991 D2, 1992 VI)

Recovered by Jim Scotti with the SWT on February 21.41 at a magnitude of 18.4, when the comet was at opposition in Leo. At this first observed return, the comet was some 3ø from its predicted position. [IAUC 5195, February 23]. The return was a favourable one, but the perihelion distance is large (4.6 AU) and although the comet is intrinsically quite bright it never comes within visual range.

j 100P/Hartley 1 (1991 E1, 1991 VII)

The SLT discovered a 16.5 magnitude comet on Mar 12.49 with the PS, which was confirmed through TA by Herman Mikuz. This turned out to be the first observed return of P/Hartley 1 which was some 16ø from the predicted position; the comet had made a close approach (0.36 AU) to Jupiter in 1988 February which changed its period from 5.61 to 6.02 years. [IAUC 5209, March 16]. At discovery the comet was near opposition in Bootes, moving into Virgo in April. The return was a favourable one, but the only visual observation was made by Pearce on April 16, when it was near 14^m. Harold Ridley obtained an astrometric plate on March 17.97.

k 124P/Mrkos (1991 F1, 1991 IV)

Discovered by Antonin Mrkos at the Klet Observatory, Czech Republic, on March 16.96 at a photographic magnitude of 15, when it was at opposition in Virgo. [IAUC 5212, March 19]. This was his thirteenth comet discovery, 43 years after his first. The comet moved south, through Corvus and into Hydra. Pearce made two observations of the comet in mid April, making it near 14^m.

l Helin-Lawrence (1991 F2, 1992 I)

Discovered by Eleanor F Helin and Kenneth J Lawrence with the PS on March 17.40 at magnitude 15 when at opposition on the border of Bootes and Virgo. [IAUC 5213, March 19]. Although only four observations were made, they extend from mid April 1991 to October 1992. Pearce estimated it around 14^m in mid April 1991. Shanklin obtained an astrometric plate on May 9. The comet slowly moved south and became too low to observe from the UK. It passed solar conjunction in late September, but was then only visible from the southern hemisphere. Jones made it 12^m in early December when it was in Centaurus. In early January it was at high southern declination and predicted to be 10^m but no observations were received. The solar elongation remained poor and it passed conjunction again in mid April 1992 moving north again. It became visible from the UK in late July, with opposition occurring in early October when the comet was on the borders of Pegasus and Pisces. However no observations were made until Hasubick photographed it at 15^m on 1992 Oct 29.80. The magnitude behaviour is rather anomalous, but seems to fit a 5*log(r) behaviour better than 10*log(r).

m 21P/Giacobini-Zinner (1992 IX)

Recovered by Karen J Meech, Institute for Astronomy, University of Hawaii and Bill Weller of the Cerro Tololo Interamerican Observatory (CTIO) using the 2.2-m Hawaii reflector on February 16, when the comet was at morning quadrature on the Libra-Serpens border. The comet was magnitude 22 on March 14 and 15 with a prototype wide field CCD being developed by Weller for the CTIO Schmidt. [IAUC 5225, March 28]. The apparition was a poor one and the comet was not observed visually. The comet is associated with the October Draconid meteors, which can produce major displays when the earth passes the descending node close to the comet. The next strong display may take place in 1998.

n 4P/Faye (1991 XXI)

Recovered by Tsutomo Seki at photographic magnitude 18.5 on April 16.80 when the comet was in Aquarius in the early morning sky. [IAUC 5246, April 22]. On October 10 David Rabinowitz detected a band of light 1-2' wide, 2ø long extending beyond the end of the scan of the SWT scan. On the next night Jim Scotti confirmed the band and noted that it could be traced back to the head of P/Faye, ie for more than 10ø; the band had a uniform width of around 2'. The Earth crossed the plane of the comet's orbit on October 13.3 and it was at opposition a few days later. [IAUC 5366, October 15].

The comet was discovered in 1843 and reached 5^m, though this has never been reached at subsequent returns. It is possible that this was a one off caused by a slight reduction in perihelion distance from 1.8

to 1.7 AU following a close encounter with Jupiter in 1841. Several authors have suggested that the absolute magnitude of the comet is declining rapidly, but it reaches a similar magnitude at all favourable apparitions.

In August the comet was in Pisces in the morning sky (Fig 4). Oernulf Midtskogen observed the comet visually with his 0.32-m reflector on August 16 when it was 12.6. It slowly brightened as it headed towards opposition and closest approach to the Earth. Shanklin made it 11.3 with the Northumberland 0.3-m refractor of the University of Cambridge on September 17. Photographs taken by Manning on October 3.99[14] and Ridley on October 6.06 and a CCD image by Terry Platt on October 5[15] show a short tail about 4' long in pa 260ø. The comet was brightest in early November, Panther estimating it at 10.0 with his 0.25-m reflector on November 3. A photograph taken by Martin Mobberley on November 9.87 was published in the Journal[16]. It then slowly faded, remaining in the evening sky moving through Cetus and into Taurus. Jones made it 11.0 with his 0.32-m reflector on December 10 and 12.1 on 1992 January 1, whilst an astrometric plate by Michael Hendrie on December 24.76 puts it at about 11^m. A CCD image taken by Gavin on Dec 26.96 shows the comet to have a 40" tail with a central spine in pa 40ø. The final observation received by The Astronomer was made on February 24, when Mikuz made it 13.2.

The absolute coma size was largest at perihelion, and it was also larger after perihelion compared to the same time before perihelion. The DC increased from about two when the comet was 100 days away from perihelion to a peak of about five when still 40 days from perihelion. It then declined again, reaching about two 100 days after perihelion.

Table 6. Ephemeris for comet 4P/Faye 1991n

Magnitudes calculated from m = 6.0 + 5.0 * Log(Δ) + 20.0 * Log(r)
Latitude: 53.0øN Longitude: 0.0øW

Day	R.A. (1950.0) hh mm.m	Dec ø.mm	Mag	Δ A.U.	R A.U.	Observable hh.mm to hh.mm	Elong ø
1991 August							
1/ 2	0 42.6	12.48	12.2	1.27	1.92	23.41 to 2.25	114
11/12	0 55.9	13.48	11.7	1.14	1.87	22.52 to 2.52	120
21/22	1 8.2	14.28	11.2	1.03	1.82	22.07 to 3.16	126
31/32	1 19.2	14.42	10.8	0.92	1.77	21.24 to 3.39	133
1991 September							
10/11	1 28.5	14.24	10.4	0.83	1.73	20.44 to 4.00	141
20/21	1 35.7	13.30	10.0	0.75	1.69	20.07 to 4.20	150
30/31	1 40.7	11.57	9.6	0.69	1.66	19.33 to 4.38	159
1991 October							
10/11	1 43.8	9.52	9.3	0.65	1.64	19.02 to 4.56	169
20/21	1 45.6	7.25	9.1	0.62	1.62	18.33 to 5.11	177
30/31	1 47.2	4.58	9.0	0.62	1.60	18.07 to 4.21	169

1991 November									
9/10	1	49.8	2.52	9.1	0.63	1.59	17.42	to 3.33	159
19/20	1	54.4	1.23	9.2	0.66	1.59	17.28	to 2.48	149
29/30	2	1.4	0.39	9.3	0.71	1.60	17.20	to 2.08	140
1991 December									
9/10	2	11.2	0.38	9.6	0.77	1.61	17.17	to 1.33	133
19/20	2	23.3	1.14	9.9	0.85	1.63	17.19	to 1.02	126
29/30	2	37.6	2.16	10.2	0.93	1.66	17.25	to 0.35	120
1992 January									
8/ 9	2	53.6	3.38	10.6	1.03	1.69	17.35	to 0.09	114
18/19	3	11.1	5.10	11.0	1.13	1.72	17.48	to 23.44	109
28/29	3	29.5	6.47	11.4	1.25	1.76	18.03	to 23.20	104

1992 February							
7/ 8	3 48.9	8.22	11.8	1.37	1.81	18.20 to 22.54	99
17/18	4 8.8	9.53	12.2	1.50	1.85	18.37 to 22.26	94
27/28	4 29.2	11.15	12.7	1.64	1.91	18.55 to 21.57	89

Fig 4
Obs plot

Fig 5
Light curve

Fig 6
Coma diameter

Fig 7
Photo Ridley

Fig 8
CCD image Maurice Gavin

o 101P/Chernykh (1991 L1, 1992 II)

Recovered by Jim Scotti with the SWT on June 8.41 at a magnitude of 20.3 when the comet was in Aquarius at morning quadrature. The comet was some 3ø from the predicted position. [IAUC 5285, June 11]. On September 15 and 16 Jane Luu and David Jewitt observed the comet with the 2.4-m at the Michigan-Dartmouth-MIT Observatory, Arizona and found that the comet had split, with components of 16^m and 19^m separated by 1'. [IAUC 5347, September 16]. Further observations were reported on IAUC 5391 [November 21], together with calculations by Z Sekanina of the Jet Propulsion Laboratory, California Institute of Technology. These indicated that the companion separated on 1991 April 14.7ñ4.1 at 3.3 AU from the sun, with a separation velocity of 15.0ñ0.9 ms^{-1} along the radius vector, higher than that observed in any other split comet. The secondary was not expected to survive past perihelion.

Midtskogen made three observations between August 17 and September 1, making it around 12^m, with a small coma around 1' in diameter. The comet was at opposition in mid September and Shanklin obtained an astrometric plate on October 4, when it was at its brightest. However despite being well placed in Aquarius until December no further visual observations were reported; indeed some ICQ observers estimated it fainter than 14^m.

p 102P/Shoemaker 1 (1991 L2, 1991 XXIII)

Recovered by Alan C Gilmore and Pamela M Kilmartin at the Mount John Observatory, New Zealand on June 8.71 at photographic magnitude 18

when the comet was approaching opposition in Grus. [IAUC 5286, June 11]. This was the first return of the comet and no visual observations were made. The comet was discovered at the very favourable return in 1984, following a close approach to Jupiter in 1980 which reduced the perihelion distance from 3.8 to 2.0 AU. In 1984 it reached 11^m and it was expected to reach 12^m at this return.

q P/Levy (1991 L3, 1991 X1)

Visually discovered by David Levy of Tucson, Arizona with his 0.41-m reflector at magnitude 8 on June 14.45, as the comet brightened on its way to perihelion. [IAUC 5291, June 14]. Tucson's location of 32øN helped in the discovery as further north in the UK, the comet did not become observable until almost a month later. The comet has a period of just over 50 years and if perihelion is in September a close approach to the earth is possible; there may be an identity with the comet of 1499.

The comet was a morning object and this discouraged many observers from attempting to view it (Fig 9). On discovery the comet was in the borders of Aries and Pisces. Jones estimated it at 9.0 with the 0.32-m reflector on July 3 and it remained at a similar magnitude all month and became quite well condensed. A short tail was reported in mid month by Roberto Haver, 0.5ø long in pa 260 - 270, consistent with the direction of the radius vector. The comet moved north west with little change in solar elongation, reaching Auriga in early August. Graham Keitch estimated it at 8.8 on August 4 with 20x100B. It faded and became less condensed with Shanklin estimating it at 11.0 with the Northumberland refractor on September 8 when it was on the borders of Lynx and Gemini. The coma diameter decreased from around 4' in early July to around 1.5' in September.

Table 7. Ephemeris for comet P/Levy 1991q

Magnitudes calculated from m = 7.6 + 5.0 * Log(Δ) + 8.1 * Log(r)
Latitude: 53.0øN Longitude: 0.0øW

Day	R.A. hh mm.m (1950.0)	Dec ø.mm	Mag	Δ A.U.	R A.U.	Observable hh.mm to hh.mm	Elong ø
1991 May							
3/ 4	23 1.1	-15.01	9.9	1.59	1.43	Not Observable	62
13/14	23 36.2	-9.17	9.4	1.47	1.33	Not Observable	61
23/24	0 13.5	-2.37	9.0	1.37	1.23	Not Observable	60
1991 June							
2/ 3	0 53.4	4.44	8.6	1.31	1.14	Not Observable	57
12/13	1 36.2	12.23	8.4	1.27	1.07	Not Observable	54
22/23	2 22.0	19.42	8.2	1.28	1.01	Not Observable	51
1991 July							

2/ 3	3 10.4	26.04	8.1	1.31	0.99	Not Observable	48
12/13	4 0.7	31.01	8.2	1.36	0.99	0.51 to 1.27	46
22/23	4 50.8	34.22	8.4	1.44	1.01	0.41 to 1.56	45
31/32	5 34.1	36.06	8.7	1.51	1.06	0.41 to 2.22	45
1991 August							
1/ 2	5 38.8	36.13	8.7	1.52	1.07	0.42 to 2.25	45
11/12	6 22.8	36.51	9.1	1.60	1.14	0.50 to 2.52	45
21/22	7 1.8	36.38	9.4	1.67	1.23	1.02 to 3.16	47
31/32	7 35.8	35.52	9.8	1.74	1.32	1.13 to 3.39	49
1991 September							
10/11	8 4.8	34.47	10.1	1.80	1.43	1.20 to 4.00	53
20/21	8 29.4	33.37	10.4	1.84	1.54	1.23 to 4.20	57
30/31	8 50.0	32.26	10.7	1.88	1.65	1.21 to 4.38	62

Fig 9
Obs plot

Fig 10
Light curve

Fig 11
Sketch Robert Bullen ?

r Helin-Alu (1991 L4, 1992 V)

Discovered by Eleanor Helin and Jeff Alu with the PS on June 13.32 at magnitude 16 when it was just past opposition in Libra. [IAUC 5292, June 15]. A distant comet, no visual estimates were made of it.

s 46P/Wirtanen (1991 XVI)

Recovered by Tsutomo Seki at photographic magnitude 17 on July 8.77 in the early morning sky in Cetus. [IAUC 5303, July 11]. The comet seems to have been rejuvenated by close approaches to Jupiter in 1972 and 1984 which reduced its perihelion distance from 1.6 to 1.1 AU. 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. Although reported to have undergone an outburst to 11^m at its last return, the behaviour at this apparition suggests that this was in fact normal. The comet was visible in the morning sky, remaining at an almost constant solar elongation around 55ø, only increasing as the comet faded. It followed a standard power law, reaching 10^m in late September when it was at perihelion in Cancer and closest to the earth. Shanklin obtained an astrometric plate on September 20. Thereafter it faded and was last seen in Virgo in December at 13^m.

t 103P/Hartley 2 (1991 N1, 1991 XV)

T V Kryachko of Majdanak, USSR, discovered a comet on July 9.85 of visual magnitude 11 in the morning sky in Pisces, moving west. This turned out to be comet P/Hartley 2, returning 5.6 days earlier than predicted. [IAUC 5304, July 12]. In 1982 the comet had made a close approach to Jupiter, and it was discovered by Hartley four years later, around nine months after 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 give a radiant of 19^h56^m +14ø, some 5ø Nf Altair, with a likely maximum around November 17. The next return of the comet in December 1997 will also be quite favourable, though perturbations have increased the perihelion distance to 1.03 AU. The best return would be if perihelion occurred in early November.

The first section observation was made on August 7.02 when Hasubick estimated it at 9.7 with his 0.20-m reflector, with some condensation in a 2.3' coma and DC3. It brightened throughout August and became a little more condensed, Roy Panther observing with his 0.25-m reflector on August 29.10 made it 8.8, with a coma 4.5' diameter and DC4. Peak brightness occurred in early September, when the comet was at perihelion in Gemini, Robert Bullen making it 7.8 in his 0.22-m reflector x89 on September 8.14, with a DC5 coma 5.5' in diameter. It remained in the morning sky at a moderate solar elongation (Fig 13). It was now moving south and slowly faded, Jonathan Shanklin making it 8.1 on September 20.15 in 20x80B. By mid October it had faded further, reaching 8.9 in 8x50B according to Sally Beaumont observing on October 21.20. The last section observation was made by Panther on November 20.25 when it was 10.5 in his 0.25-m reflector x50, with a larger more diffuse coma at 7' DC1. Now in Sextans, Herman Mikuz continued to observe it till the end of December when it was 13.5^m.

The observed light curve, which uses a standard power law fit, shows that the comet's brightness peaked after perihelion. This behaviour is found in many short period comets which slowly approach the sun and are observed over a relatively small range in solar distance. When the comet's brightness is analysed with respect to the time from perihelion the following equation derived:

$$m = 7.6ñ0.1 + 5 * \log(\Delta) + 0.035ñ0.002 * (T - 13.4ñ1.3) + 0.025ñ0.005 * ap$$

where T is the number of days after perihelion. The aperture coefficient is similar to that derived for the standard power law.

Table 8. Ephemeris for comet 103P/Hartley 2 1991t

Magnitudes calculated from $m = 8.4 + 5.0 * \log(\Delta) + 9.6 * \log(r)$
Latitude: 53.0øN Longitude: 0.0øW

Day	R.A. hh mm.m (1950.0)	Dec ø.mm	Mag	Δ A.U.	R A.U.	Observable hh.mm to hh.mm	Elong ø
1991 June							
2/ 3	22 56.5	4.52	11.3	1.43	1.67	Not Observable	84
12/13	23 23.9	8.33	10.8	1.27	1.57	Not Observable	86
22/23	23 55.3	12.39	10.3	1.13	1.48	0.34 to 0.45	87
1991 July							
2/ 3	0 32.1	17.05	9.8	1.01	1.38	23.55 to 1.00	86
12/13	1 16.1	21.40	9.3	0.91	1.29	23.24 to 1.27	84
22/23	2 8.7	25.53	8.8	0.83	1.20	23.04 to 1.56	80
1991 August							
1/ 2	3 9.7	29.01	8.4	0.79	1.12	22.58 to 2.25	76
11/12	4 16.1	30.20	8.1	0.77	1.06	23.10 to 2.52	71
21/22	5 21.8	29.32	7.9	0.79	1.00	23.39 to 3.16	66
31/32	6 21.7	27.00	7.8	0.82	0.97	0.16 to 3.39	63
1991 September 1991							
10/11	7 13.5	23.25	7.9	0.88	0.95	0.53 to 4.00	60
20/21	7 57.5	19.23	8.1	0.94	0.96	1.24 to 4.20	59
30/31	8 34.7	15.18	8.4	1.00	1.00	1.49 to 4.38	60
1991 October							
10/11	9 6.5	11.23	8.7	1.06	1.05	2.07 to 4.56	61
20/21	9 33.5	7.43	9.1	1.11	1.11	2.21 to 5.14	64
30/31	9 56.5	4.22	9.4	1.15	1.19	2.29 to 5.31	67
1991 November							
9/10	10 15.8	1.21	9.8	1.18	1.28	2.34 to 5.47	71
19/20	10 31.5	-1.20	10.1	1.20	1.37	2.34 to 6.02	77
29/30	10 43.7	-3.40	10.4	1.21	1.46	2.29 to 6.16	83
December 1991							
9/10	10 52.1	-5.38	10.7	1.20	1.56	2.20 to 6.28	90
19/20	10 56.6	-7.11	10.9	1.19	1.66	2.05 to 6.36	99
29/30	10 57.1	-8.17	11.1	1.18	1.75	1.43 to 6.39	108

Fig 12
Obs plot

Fig 13
Observed light curve

Fig 14
Reduced light curve

Fig 15
Sketch Robert Bullen

Fig 16
Photo Harold Ridley

u 50P/Arend (1991 VIII)

Recovered by Tsutomo Seki at photographic magnitude 17.5 on August 1.78 when the comet was in the morning sky in Auriga, emerging from conjunction after perihelion. [IAUC 5322, August 9]. At its best ever return the comet only reached 14^m and this apparition was not a good one.

v McNaught-Russell (1991 Q1, 1992 XI)

Discovered by Rob McNaught and Kenneth Russell with the UKS on August 30.44 at photographic magnitude 16.5, but confirmed on an earlier plate taken on August 3.55. [IAUC 5333, September 2]. The comet was just past opposition in Telescopium and remained a faint object, never becoming much brighter than at discovery.

w McNaught-Russell (1991 R1, 1990 XXII)

Discovered by Rob McNaught and Kenneth Russell with the UKS on September 3.53 at photographic magnitude 18 just past opposition in Aquarius, ten months after perihelion. [IAUC 5335, September 5]. This comet has a record large perihelion distance of 6.99 AU.

x P/Spacewatch (1991 R2, 1990 XXIX)

Discovered by Tom Gehrels with the SWT on September 8.26 at a magnitude of 21 when at opposition in Aquarius and nine months past perihelion. [IAUC 5341, September 10]. Although one of the faintest discoveries on record, the comet can reach 15^m at a good opposition.

y P/McNaught-Hughes (1991 S1, 1991 IX)

Discovered by Rob McNaught and Shaun M Hughes with the UKS on September 30.51 at photographic magnitude 16.5 when the comet was just past opposition in Aquarius and three months past perihelion. [IAUC 5354, October 1]. An intrinsically faint and distant comet it gets little brighter than at discovery.

z P/Shoemaker-Levy 5 (1991 T1, 1991 XXII)

Discovered by the SLT with the PS on October 2.30 at photographic magnitude 16 when at opposition on the Cetus-Pisces border. [IAUC 5359, October 4]. Although still 70 days from perihelion it is another intrinsically faint and distant comet which also gets little brighter than at discovery.

a_1 Shoemaker-Levy (1991 T2, 1992 XIX)

Discovered by the SLT with the PS on October 6.50 at photographic magnitude 16.5. [IAUC 5363, October 10]. A photograph[17] taken by Martin Mobberley on July 22.94 and a full report[8] have been published in the Journal.

b_1 P/Shoemaker-Levy 6 (1991 V1, 1991 XVIII)

Discovered by the SLT with the PS on November 7.19 at photographic magnitude 13 when the comet was in the evening sky on the Pisces-Cetus border. [IAUC 5382, November 11]. Prior to discovery it was at high southern declinations but rapidly moved north, passing perihelion in Grus on Oct 13.9. Circumstances for observation from the southern hemisphere were favourable and it could potentially have been discovered by amateur comet seekers. On October 26 it made its closest approach to the earth at 0.22 AU when it was on the Aquarius-Sculptor border. Greatest elongation occurred in mid November when the comet was in Pisces and visual observations reported on the IAUC suggest that it reached 11^m. Shanklin obtained an astrometric plate on November 12. Section observations cover the period November 12 to December 28, with Hasubick estimating the comet at photographic magnitude 14 on the later date, when the comet was in the evening sky on the Andromeda-Triangulum border.

c_1 62P/Tsuchinshan 1 (1991 XIV)

Recovered by Tsutomo Seki at photographic magnitude 17 on November 8.84 in Virgo as the comet emerged from conjunction in the morning sky. [IAUC 5383, November 12]. This was a poor apparition of the comet, with perihelion occurring at a small solar elongation and it faded after recovery. At a good apparition such as in 1985 it can reach 11^m. It was discovered at Purple Mountain Observatory, Nanking, China in 1965, following a close approach to Jupiter in 1960 which reduced q from 2 to 1.5 AU.

d_1 P/Shoemaker-Levy 7 (1991 V2, 1991 XIX)

Discovered by the SLT with the PS on November 13.35 at photographic magnitude 16.5 when it was in opposition in Perseus and close to perihelion. [IAUC 5389, November 18]. This was a good apparition and the comet is unlikely to be observed visually. The discovery ties Carolyn Shoemaker with the record set by Pons, who had 26 comets bearing his name. It also brings David Levy's total to 16, though he only discovered 7 of these visually.

e_1 60P/Tsuchinshan 2 (1992 XII)

Recovered by Jim Scotti and David Rabinowitz with the SWT on December 3.21 at a magnitude of 21.2 when the comet was a month past opposition in Aries. [IAUC 5403, December 13]. After recovery the solar elongation slowly decreased and the comet never approached closer to the earth than 1.3 AU. The second of the pair of comets discovered at the Purple Mountain Observatory in 1965, the comet has never been brighter than 15^m and at this return was not predicted to be brighter than 16^m.

f_1 104P/Kowal 2 (1991 X1, 1991 XX)

Masao Ishikawa (Fukaya, Saitama, Japan) photographically discovered a 14th magnitude comet on December 12.70 with a 0.16-m astrograph moving slowly south in Hydra. This was subsequently identified as comet P/Kowal 2, returning to perihelion 54 days early. [IAUC 5406, December 17]. The comet had been missed at its 1985 return which was a poor one. The comet was fading after perihelion but was at a good solar elongation with opposition in late January. No visual observations of the comet were made but Hasubick and Mikuz obtained photographic and CCD observations on five occasions between December 27 and 1992 February 8 when it was around 14^m.

g_1 Zanotta-Brewington (1991 Y1, 1992 III)

Discovered by a regular contributor to the work of the section, Vittorio Zanotta of Milan, Italy observing from an alpine dark sky site with a 0.15-m reflector at visual magnitude 9 on December 23.76 and independently by Howard Brewington who made it 10th magnitude on December 24.13. [IAUC 5412, December 24]. The comet was in the evening sky in Delphinus, moving slowly south west (Fig 18). The discovery was confirmed through TA with photographs taken by Martin Mobberley and Herman Mikuz.

At discovery the comet was moderately condensed, DC4 with a 4' diameter coma. A photograph taken by Martin Mobberley[16] on December 27.75 was published in the Journal. It initially brightened as it approached the sun and earth and on January 10.77 H A Davies estimated that it was 8.0^m in a 0.22-m reflector. Maurice Gavin took a photograph and CCD images on the same evening[18] and these show a short tail 3' long in pa 40ø. By the end of the month the comet was rapidly moving southwards and became a difficult object to observe from northern latitudes, with magnitude estimates ranging from 7 to 9. Albert Jones picked it up near perihelion, when it was in Aquarius at a solar elongation of 41ø, but conditions improved as it moved further south. On February 9.39 he made it 8.2^m in his 0.32-m reflector and

still well condensed at DC6. By February 26.37 it had faded to 9.1^m and become smaller and more diffuse, with a coma diameter of 2.5' and DC3. It continued to fade and became more diffuse, reaching 11^m in mid March and 11.7 on March 26.37 when Jones made his last observation of the comet. By now it was at high southern declination near the large Magellanic cloud and was only 0.7' diameter and DC2.

Figure 20 shows the comet's mean light curve and it is clear that it faded rather more rapidly after perihelion. Separate values for the magnitude coefficients before and after perihelion are given in the table.

Table 9. Ephemeris for comet Zanotta-Brewington 1991g$_1$

Magnitudes calculated from m = 8.9 + 5.0 * Log(Δ) + 6.2 * Log(r)
Latitude: 53.0øN Longitude: 0.0øW

Day	R.A. (1950.0) hh mm.m	Dec ø.mm	Mag	Δ A.U.	R A.U.	Observable hh.mm to hh.mm	Elong ø
1991 December							
9/10	20 1.3	23.12	10.0	1.31	1.23	17.17 to 21.13	63
19/20	20 30.0	20.14	9.5	1.18	1.08	17.19 to 20.59	59
29/30	21 5.1	16.23	8.8	1.05	0.94	17.25 to 20.47	55

1992 January							
8/ 9	21 47.3	10.45	8.1	0.92	0.80	17.35 to 20.31	50
18/19	22 36.1	2.01	7.5	0.81	0.70	17.48 to 20.04	45
28/29	23 27.8	-10.45	7.0	0.73	0.65	18.03 to 19.08	41
1992 February							
7/ 8	0 16.4	-25.54	7.0	0.71	0.66	Not Observable	42
17/18	0 59.4	-39.44	7.4	0.73	0.74	Not Observable	48
27/28	1 40.6	-50.26	8.0	0.79	0.86	Not Observable	56
1992 March							
8/ 9	2 26.9	-58.21	8.5	0.84	0.99	Not Observable	65
18/19	3 26.0	-64.02	9.0	0.90	1.14	Not Observable	74
28/29	4 43.3	-67.29	9.5	0.95	1.29	Not Observable	83
1992 April							
7/ 8	6 13.7	-68.16	9.9	1.01	1.44	Not Observable	92
17/18	7 39.4	-66.22	10.3	1.09	1.59	Not Observable	99
27/28	8 47.4	-62.38	10.7	1.18	1.74	Not Observable	106

Fig 17
Obs plot

Fig 18
Light curve

h_1 Mueller (1991 X2, 1992 VIII)

Discovered by Jean Mueller with the 1.2-m Oschin Schmidt on Mt Palomar during the course of the 2nd Palomar Sky Survey (POS) on December 13.48 at photographic magnitude 17.5, and confirmed by the SLT with the PS on December 31.35. [IAUC 5420, 1992 January 1]. The comet was on the border of Ursa Major, Leo Minor and Lynx, moving slowly north east a month prior to opposition, which occurred in mid January when the comet was in Lynx.

The first observation reported to TA was made by Herman Mikuz on January 16.20 when the comet was 14.4 in his 0.35-m reflector x80, 1' diameter and DC1. The comet was now moving south east on its way to perihelion on the Cetus-Aquarius border and in early February John Bortle made it 10.6 and by mid month 8.6, becoming more condensed. Hasubick made it 7.6 using 25x100B on February 28.19 and it was still the same magnitude on March 4.78. This was the last section observation made as the comet's solar elongation rapidly decreased (Fig 21). No positive observations were made after perihelion, despite relatively favourable observing circumstances with the comet in Pegasus, and it seems that the comet did not survive its relatively close encounter with the sun (q=0.2 AU).

Table 10. Ephemeris for comet Mueller 1991h$_1$

Magnitudes calculated from m = 10.1 + 5.0 * Log(Δ) + 12.6 * Log(r)
Latitude: 53.0øN Longitude: 0.0øW

Day	R.A. hh mm.m (1950.0)	Dec ø.mm	Mag	Δ A.U.	R A.U.	Observable hh.mm to hh.mm	Elong ø
1992 January							
8/ 9	8 5.1	50.37	12.6	0.81	1.73	17.35 to 6.39	150
18/19	6 25.7	50.52	11.5	0.64	1.55	17.48 to 6.33	145
28/29	4 26.6	42.03	10.6	0.56	1.37	18.03 to 4.11	122
1992 February							
7/ 8	3 3.0	26.11	9.8	0.58	1.17	18.20 to 0.43	93
17/18	2 14.3	11.30	9.0	0.67	0.95	18.37 to 22.11	67
27/28	1 41.0	0.23	7.8	0.79	0.72	18.55 to 20.18	46
1992 March							
8/ 9	1 7.5	-8.04	5.7	0.91	0.47	Not Observable	28
18/19	0 10.4	-11.49	1.8	1.04	0.22	Not Observable	12
28/29	23 16.0	4.37	4.5	1.09	0.35	Not Observable	18
1992 April							
7/ 8	23 9.8	24.10	7.7	1.13	0.61	2.51 to 3.50	33
17/18	23 16.5	40.32	9.7	1.22	0.85	1.01 to 3.22	44
27/28	23 28.8	53.54	11.1	1.34	1.08	22.56 to 2.53	52

Fig 19
Obs plot

Fig 20
Light curve

Other comets

1P/Halley (1982 U1, 1986 III)

In early February comet Halley was discovered in outburst and there was much speculation on the cause[19].

6P/d'Arrest (1989 II)

A Carusi and G B Valsecchi of the Istituto Astrofisica Spaziale, Rome and L Kresak and M Kresakova of the Slovak Astronomical Institute, Bratislava announced the identification of comet La Hire 1678 with P/d'Arrest [IAUC 5283, June 6]. The non gravitational parameters seem stable, despite 8 approaches within 0.5 AU of Jupiter during the 26 revolutions between 1678 and 1851.

29P/Schwassmann-Wachmann 1 (1989 XV)

The comet outburst in early August [IAUC 5321, August 9], reaching 12^m and then fading to 14^m by mid September. Mikuz made a series of visual observations showing that it was initially well condensed, about 1.5' in diameter but became larger and more diffuse as it faded. Harold Ridley obtained an astrometric plate on August 9.09 which showed the comet at 12.5 with a coma 15"-20" diameter. It was in opposition in mid November on the borders of Taurus and Aries. Another outburst occurred in December [IAUC 5396, December 4] when it reached 13^m.

49P/Arend-Rigaux (1991 XVII)

Although comet Arend-Rigaux was at perihelion in 1991, no visual observations were made. Professional observations suggest that it only reached 16^m, some 2^m fainter than predicted. It was discovered during its best ever apparition in 1950, when it reached 11^m; at another good return in 1984 it reached 12^m. At these returns it showed a faint coma and short tail, but at more distant returns it appears virtually stellar and this has lead to some reports of it being on the verge of extinction. The comet is one of a handful that has a measured nuclear rotation period, which is thought to be around 6.73 hours[20].

96P/Machholz 1 (1991 XII)

Comet P/Machholz 1 (1986 VIII) was photographed in Orion by Alan Gilmore and Pamela Kilmartin with the 0.6-m reflector at the Mount John Observatory, New Zealand on July 3.76 at magnitude 16 in the morning sky as it approached conjunction. [IAUC 5301, July 9]. After perihelion it was estimated at around 9^m on July 31 and had faded to 10^m a week later, when the comet was in Leo. This comet was not given a year letter as it can be observed all round the orbit. The orbit is very unusual, with the smallest perihelion distance of any short period comet (0.13 AU), which is decreasing further with time, a high eccentricity (0.96) and a high inclination (60ø). Studies by Sekanina[21] suggest it has only one active area, which is situated close to the rotation pole and becomes active close to perihelion. The comet may be the parent of the Quadrantid meteor shower[22].

109P/Swift-Tuttle (1992 S2, 1992 XXVIII)

Reports of high (and not so high) Perseid rates were made on a number of IAUC, with Brian Marsden predicting a return on 1992 November 25.85. Comet Swift-Tuttle did return in 1992 and papers describing

the apparition and the associated meteor activity have been published in the Journal[23,24].

Comets not recovered

Several comets predicted to return in 1991 were not recovered. Comet 83P/Russell 1 was predicted to reach perihelion at the start of the year, however its perihelion distance increased from 1.6 to 2.2 AU following an encounter with Jupiter in 1988 and it is possible that it is now lost.

D/Haneda-Campos 1978 R1 had a very unfavourable return and was also missed at its previous return. It is possible that it was discovered when in outburst as it faded very quickly after discovery. The comet experiences fairly frequent encounters with Jupiter and it is quite likely that it will be lost.

D/Kowal-Mrkos 1984 H1 had a poorly determined orbit on its discovery orbit and then suffered a close approach to Jupiter between 1987 and 1990 which increased the perihelion distance from 1.9 to 2.7 AU. It is probably lost.

D/Skiff-Kosai 1977 C1 was originally designated as asteroid 1977 DV_3 when discovered by Kosai, but in 1986 Brian Skiff found a cometary image on a 1977 Palomar plate. By this time its return in 1984 had been missed and the perihelion date is now becoming uncertain, though the prediction was expected to be accurate within a week. It is possible that it will be recovered at a future apparition.

Other objects

Rob McNaught found an unusual fast moving asteroid on a UKS plate taken on February 18.53 [IAUC 5193, 1991 February 21]. This minor planet, 1991 DA, has a 40 year period, with an aphelion of 22 AU, perihelion of 1.58 AU and an inclination of 62ø. Although this is very much a cometary type of orbit, no trace of coma was detected. For most of its orbit it remains at a high southern declination, only crossing the celestial equator for a short time prior to perihelion.

Acknowledgements

Thanks are due to Harold Ridley for preparing the excellent series of prospects for comets, which were distributed with the section newsletters for many years. I received the report of his death as I was preparing this paper at Faraday station in the Antarctic. Much of the background material to this present series of papers comes from his unpublished work. He will be sadly missed. Thanks are also due to Guy Hurst for the long hours spent in preparing cometary material for publication in TA magazine.

References

1. Merton, G., 'Comet section report for 1949', *J. Brit. Astron. Assoc.*, **60** (8), 240 (1950)
2. Hendrie, M. J. & Keitch, G. S., 'Comet Kohler 1977 XIV', *J. Brit. Astron. Assoc.*, **91** (3), 251 (1981)
3. Hendrie, M. J. & Morris, C. S., 'Photometric Parameters of Comets: 1948 - 1954', *J. Brit. Astron. Assoc.*, **93** (1), 1 (1982)
4. Shanklin, J. D., 'Comet Analyses', *J. Brit. Astron. Assoc.*, **105** (6), 291 (1995)
5. Nakano, S. (Ed). ICQ Handbook 1991.
6. Marsden, B. G. *Catalogue of Cometary Orbits*, 9th and 10th editions, IAU CBAT, (1994, 1995)
7. Shanklin, J. D., 'Comet Levy 1990c', *J. Brit. Astron. Assoc.*, **105** (6), 295 (1995)
8. Shanklin, J. D., 'Comet Shoemaker-Levy 1991a$_1$', *J. Brit. Astron. Assoc.*, **106** (1), 19 (1996)
9. Shanklin, J. D., 'The Comets of 1990', *J. Brit. Astron. Assoc.*, 106 (2), [In Press] (1996)
10. Buckley, R. J., 'The missing comets', *J. Brit. Astron. Assoc.*, **87** (3), 226 (1977)
11. Manning, B. Cover picture, 1991a, *The Astronomer*, **27** (322) (1991)
12. Ridley H. B. Cover picture, 1991a, *The Astronomer*, **27** (323) (1991)
13. Mobberley, M. P., 'A trio of comets', *(a, b and d), J. Brit. Astron. Assoc.*, **101** (2), 122 (1991)
14. Manning, B. Cover picture, 1991n, *The Astronomer*, **28** (331) (1991)
15. Platt, T. C. Cover picture, 1991n, *The Astronomer*, **28** (333) (1992)
16. Mobberley, M. P., 'Observers forum', *(n, g$_1$), J. Brit. Astron. Assoc.*, **102** (1), 45 (1992)
17. Mobberley, M. P., 'Observers forum', *(a$_1$), J. Brit. Astron. Assoc.*, **102** (5), 280 (1992)
18. Gavin, M. Cover picture, 1991g$_1$, *The Astronomer*, **28** (335) (1992)
19. Notes & News, 'Dramatic outburst on Comet Halley', *J. Brit. Astron. Assoc.*, **101** (3), 138 (1991)
20. Belton, M. J. S., 'Characterization of the rotation of cometary nuclei', *Comets in the Post-Halley Era*, 691 (1991)
21. Sekanina, Z., *Astron J,* **99**, 1268 (1990).
22. Green, D, Rickman H, Porter A. & Meech K., 'The strange periodic comet Machholz', *Science,* **247**, 1063, *2 Mar 1990.*
23. Mobberley, M. P., 'Comet Swift-Tuttle 1992t', *J. Brit. Astron. Assoc.*, **104** (1), 11 (1994)
24. Bone, N. M. & Evans, S. J., 'Visual and photographic observations of the Perseid meteor shower in 1993', *J. Brit. Astron. Assoc.*, **106** (1), 33 (1996)

Figure Captions:

Figure 1. The orbit of comet 97P/Metcalf-Brewington 1991a. 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 the ascending node of the comet's orbit looking towards the sun. From this viewpoint the orbit appears as a straight line, showing the inclination of the comet's orbit. c) 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+2; observations used in the analysis cover the range T+4 to T+43.

Figure 2. The observed magnitude of comet 97P/Metcalf-Brewington. The curve is a best fit over the apparition, with no corrections applied. Tick marks indicate the first of each month from January 1991. The scatter between observers is accentuated by the scale of the magnitude axis.

Figure 3. The orbit of comet Arai 1991b. a) Viewed from the north ecliptic pole. b) Viewed from the ascending node of the comet's orbit looking towards the sun. c) Viewed from the rotating reference frame. The comet was discovered at T+26; observations used in the analysis cover the range T+28 to T+56.

Figure 4. The orbit of comet 4P/Faye 1991n. a) Viewed from the north ecliptic pole. b) Viewed from the ascending node of the comet's orbit looking towards the sun. c) Viewed from the rotating reference frame. Observations used in the analysis cover the range T-100 to T+101.

Figure 5. The observed magnitude of comet 4P/Faye. The curve is a best fit over the apparition, with no corrections applied. Tick marks indicate the first of each month from August 1991.

Figure 6. The observed coma diameter of comet 4P/Faye. The tick marks indicate the first of each month from August 1991.

Figure 7. Comet 4P/Faye photographed by Harold Ridley on 1991 October $6^{d}\ 1^{h}\ 20^{m}$ with 0.17-m f7 astrograph; exposure 30 minutes on TMax 400. The scale bar indicates 5'. [Note to Editor - at the original scale, the scale bar should be 10 mm long]

Figure 8. Image of comet 4P/Faye by Maurice Gavin on 1991 December $26^{d}\ 23^{h}\ 04^{m}$ with 0.26-m f4 reflector and SBIG ST-4 CCD camera;

exposure 120 seconds. The scale bar indicates 2'; north is at the top. Note the tail and central spine at pa 40ø.

Figure 9. The orbit of comet P/Levy 1991q. a) Viewed from the north ecliptic pole. b) Viewed from the ascending node of the comet's orbit looking towards the sun. c) Viewed from the rotating reference frame. The comet was discovered at T-24; observations used in the analysis cover the range T-19 to T+67.

Figure 10. The observed magnitude of comet P/Levy. The curve is a best fit over the apparition, with no corrections applied. Tick marks indicate the first of each month from June 1991.

Figure 11. Sketch of comet P/Levy made by *Robert Bullen* using a 0.22m f7 reflector x64 on 1991 August 9.06.

Figure 12. The orbit of comet 103P/Hartley 2 1991t. a) Viewed from the north ecliptic pole. b) Viewed from the ascending node of the comet's orbit looking towards the sun. c) Viewed from the rotating reference frame. The comet was discovered at T-64; observations used in the analysis cover the range T-58 to T+110.

Figure 13. The observed magnitude of comet 103P/Hartley 2. The curve is a best fit over the apparition, with no corrections applied. Tick marks indicate the first of each month from July 1991.

Figure 14. The magnitude of comet 103P/Hartley 2, corrected for aperture and systematic differences between observers and reduced to a distance of 1 AU from the earth, plotted against time from perihelion.

Figure 15. Sketch of comet 103P/Hartley 2 made by *Robert Bullen* using a 0.22-m f7 reflector x64 on 1991 August 15.1.

Figure 16. Astrometric photograph of comet 103P/Hartley 2 by Harold Ridley on 1991 September $8^{d}\ 3^{h}\ 27^{m}$ with the 0.17-m f7 astrograph.

Figure 17. The orbit of comet Zanotta-Brewington $1991g_1$. a) Viewed from the north ecliptic pole. b) Viewed from the ascending node of the comet's orbit looking towards the sun. c) Viewed from the rotating reference frame. The comet was discovered at T-39; observations used in the analysis cover the range T-39 to T+54.

Figure 18. The observed magnitude of comet Zanotta-Brewington. The curve is a best fit over the apparition, with no corrections applied. Tick marks indicate the first of each month from December 1991.

Figure 19. The orbit of comet Mueller $1991h_1$. a) Viewed from the north ecliptic pole. b) Viewed from the ascending node of the comet's orbit looking towards the sun. c) Viewed from the rotating

reference frame. The comet was discovered at T-99; observations used in the analysis cover the range T-65 to T-16.

Figure 20. The observed magnitude of comet Mueller. The curve is a best fit over the apparition, with no corrections applied. Tick marks indicate the first of each month from December 1991.