Comet Levy 1990 c

A report of the Comet Section

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Comet Levy 1990 c, later designated comet 1990 XX, was
discovered visually by David Levy, of Tucson, Arizona, on
1990 May 20.44 and was his 6th discovery. The comet was
found with his 0.41-m reflector near Alpha Andromedae at
magnitude 9.6, having a short tail[1]. The first section
observations were made on May 23rd. Closest approach to the
Earth occurred at the end of August at a distance of 0.43
AU. The comet was followed from the UK until early
September, by which time it had reached 4^m. It then moved
too far south for observation from the England, though
observers living further south continued to observe it
through perihelion. Further UK observations were secured in
February and March 1991. The final observations were made
in mid April, when the comet was around 12^m.

Table 1.

Orbital elements for Comet Levy 1990 XX from 314
observations 1990 May 21 - 1992 Apr 01[2].

Epoch 1990 Nov 05

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T  1990 Oct. 24.6837    w  242.6656 }            242.6605 }
q  0.938705             W  139.3647 } 2000.0     138.6629 } 1950.0
e  1.000417             i  131.5829 }            131.5882 }
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Figure 1.
Orbital diagram

Table 2

Ephemeris for Comet Levy 1990 c

Magnitudes calculated from m = 4.0 + 5.0*Log(d) + 7.0*Log(r)

Latitude: 53.0øN Longitude: 0.0øW

Day	R.A. hh mm.m 1950.0	Dec dd.mm	Mag	D A.U.	R A.U.	Observable hh.mm to hh.mm	Elong dd
1990 May							
8/ 9	23 47.3	26.58	9.7	3.34	2.73	1.49 to 2.23	46

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18/19    23 53.6    27.27    9.4    3.10    2.61      1.06 to  1.54    52
28/29    23 59.0    27.58    9.0    2.85    2.49      0.22 to  1.26    59


June
 7/ 8     0  3.4    28.30    8.7    2.58    2.36     23.36 to  1.01    66
17/18     0  6.2    29.00    8.3    2.30    2.24     23.17 to  0.45    74
27/28     0  6.7    29.26    7.8    2.00    2.12     23.15 to  0.51    82


July
 7/ 8     0  3.8    29.41    7.2    1.69    1.99     22.56 to  1.14    91
17/18    23 55.3    29.33    6.6    1.38    1.87     22.30 to  1.43   101
27/28    23 37.2    28.34    5.8    1.06    1.74     22.01 to  2.12   114


August
 6/ 7    23  0.5    25.20    4.9    0.77    1.61     21.33 to  2.39   129
16/17    21 47.2    15.32    3.8    0.52    1.49     21.03 to  3.05   151
26/27    19 43.7    -7.11    3.1    0.43    1.37     20.35 to  2.27   141


September
 5/ 6    17 43.1   -26.52    3.4    0.55    1.26     20.07 to 21.21   104
15/16    16 30.9   -34.30    3.9    0.79    1.16     Not Observable    79
25/26    15 50.8   -37.31    4.3    1.04    1.07     Not Observable    63


October
 5/ 6    15 25.5   -39.01    4.5    1.27    1.00     Not Observable    50
15/16    15  7.3   -39.50    4.7    1.48    0.95     Not Observable    39
25/26    14 52.6   -40.17    4.9    1.65    0.94     Not Observable    31


November
 4/ 5    14 39.9   -40.30    5.1    1.76    0.96     Not Observable    25
14/15    14 28.4   -40.34    5.3    1.82    1.01     Not Observable    25
24/25    14 17.1   -40.35    5.6    1.83    1.09     Not Observable    30


December
 4/ 5    14  5.2   -40.36    5.8    1.80    1.18     Not Observable    38
14/15    13 51.2   -40.36    5.9    1.72    1.29     Not Observable    48
24/25    13 33.2   -40.29    6.1    1.62    1.40     Not Observable    60


1991 January
 3/ 4    13  9.2   -40.01    6.1    1.49    1.52     Not Observable    73
13/14    12 37.0   -38.45    6.2    1.36    1.65     Not Observable    88
23/24    11 55.4   -35.57    6.2    1.24    1.77     Not Observable   105


February
 2/ 3    11  6.8   -30.46    6.3    1.16    1.90     Not Observable   124
12/13    10 17.8   -23.06    6.4    1.15    2.02     22.15 to  3.24   142
22/23     9 35.5   -14.14    6.8    1.22    2.15     19.42 to  3.13   153


March
 4/ 5     9  3.6    -5.58    7.2    1.37    2.27     19.05 to  2.50   149
14/15     8 41.6     0.42    7.6    1.57    2.40     19.23 to  2.20   137
24/25     8 27.5     5.43    8.1    1.83    2.52     19.43 to  1.47   124


April
 3/ 4     8 19.4     9.24    8.6    2.10    2.64     20.04 to  1.12   111
13/14     8 15.7    12.05    9.0    2.40    2.76     20.26 to  0.36   100
23/24     8 15.0    14.05    9.4    2.69    2.88     20.50 to 23.59    90


May
 3/ 4     8 16.7    15.33    9.7    2.99    2.99     21.16 to 23.21    80
13/14     8 20.0    16.38   10.0    3.28    3.11     21.44 to 22.44    71
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23/24    8 24.5  17.27 10.3  3.56  3.22   Not Observable   62
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Figure 2.
Observing circumstances

<u>Observations</u>

Over 700 observations were received from 49 observers who
are listed in Table 2. Observations were received on
virtually every night from July 11 to September 2nd.

Figure 3
Observed light curve

Table 3.

List of Visual Observers

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James Abbott,  ..............Witham, Essex
Karl-Gustav Andersson,  ......Sweden
Rod Arnold,  ................Signy Is, Antarctica
Hans Bengtsson,  ............Sweden
Peter Birtwhistle,  .........Birmingham
Andrea Boattini,  ...........Italy
John E. Bortle, .............NY, U.S.A.
Paul Brazier,  ..............Signy Is, Antarctica
Steve Brincat,  .............Malta
Robert Bullen,  .............Bognor Regis, West Sussex
Mike J Collins,  ............England
Haakon Dahle,  ..............Oslo, Norway
Vidican Dan,  ...............Bucuresti, Romania
Jorgen Danielsson,  .........Sweden
Russell Eberst,  ............Willowbrae, Scotland
Anders Ekloef,  .............Sweden
Jens Ergon,  ................Sweden
Daniel Fischer,  ............Germany
James Fraser,  ..............Alness, Rossshire
A. Gambin,  .................Malta
Bjoern Haakon Granslo,  ......Oslo, Norway
Werner Hasubick,  ...........Germany
Roberto Haver,  .............Italy
Alan Heath,  ................Nottingham
Guy M. Hurst,  ..............Basingstoke, Hampshire
Jost Jahn,  .................Bodenteich, Germany
Albert F. Jones,  ...........New Zealand
Graham Keitch,  .............Manaton, Devon
Mark Kidger,  ...............Canary Islands
Norman S. Kiernan,  .........Pulborough, West Sussex
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Stefan Korth,  ...............Germany
Andy Lacey,  .................Rothera Point, Antarctica
Jose Carvajal Martinez,  .....Spain
Richard McKim,  ..............Oundle, Northamptonshire
Oernulf Midtskogen,  .........Norway
Herman Mikuz,  ...............Ljubljana, Slovenia
Roy Mitchell,  ...............Bridport, Dorset
David Moore,  ................Dublin, Eire
Roy W. Panther,  .............Walgrave, Northampton
Andrew R. Pearce,  ...........Australia
Alfredo Jose Serra Pereira,  .Portugal
Jose Ripero Osorio,  .........Spain
Patrick Schmeer,  ............Germany
Jonathan D. Shanklin,  .......Cambridge
Tony Tanti,  .................Malta
Melvyn D. Taylor,  ...........Wakefield, Yorkshire
Frank Ventura,  ..............Malta
Fiona Vincent,  ..............St Andrews, Fife
Johan Warell,  ...............Sweden
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Magnitude observations

The variation in the brightness of the comet was analysed
using the procedures described by Shanklin[3]. The initial
analysis using the raw data gave:

$$m_1 = 4.4\tilde{n}0.1 + 5.0*\log(d) + 9.1\tilde{n}0.2*\log(r)$$

When the analysis is repeated with the corrections to remove
systematic observer variations applied (shown in Table 4)
the variation in the brightness of the comet becomes:

$$m_1 = 4.3\tilde{n}0.1 + 5.0*\log(d) + 9.2\tilde{n}0.2*\log(r)$$

Most observations were made with refractors (including the
naked eye and binoculars) and there was a greater use of
reflectors after perihelion and when the comet was fainter.
Because of this uneven distribution, all types have been
treated together in this analysis. When a correction for
the aperture is included the equation becomes:

$$m_1 = 4.5\tilde{n}0.1 + 5.0*\log(d) + 7.1\tilde{n}0.2*\log(r) + 0.0039\tilde{n}0.0002*Ap$$

where Ap is the aperture in mm. The large change in the
log(r) coefficient from the previous equation is because
larger apertures are used when the comet is further from the
sun and thus fainter; the larger aperture makes it appear
even fainter, so the correction has a large effect on the
computed log(r) coefficient. If the magnification is used

to make the correction instead of the aperture a similar
equation is found:

$$m_1 = 4.5ñ0.1 + 5.0*\log(d) + 7.2ñ0.2*\log(r) + 0.0122ñ0.0007*pwr$$

where pwr is the magnification used by the observer. If the
correction for the observed coma diameter is also included
the final equations are:

$$m_1 = 4.7ñ0.1 + 5.0*\log(d) + 6.9ñ0.2*\log(r) + 0.0033ñ0.0003*Ap - 0.013ñ0.002*C$$

or

$$m_1 = 4.7ñ0.1 + 5.0*\log(d) + 7.0ñ0.2*\log(r) + 0.0109ñ0.0008*pwr - 0.013ñ0.002*C$$

Where C is the coma diameter in minutes of arc. When this
relation is combined with the maximum reported coma diameter
of 50' the absolute magnitude becomes 4.1ñ0.2.

Once the corrections for aperture and coma were determined
the data was reanalysed to investigate pre and post
perihelion brightness. Only 10% of the observations were
made post perihelion, which reduces the reliability of the
analysis, but it showed that the comet faded more rapidly
after perihelion; this is confirmed by the paucity of UK
observations in March and April 1991, when the comet should
still have been a binocular object.

Pre perihelion: m_1 = 4.91ñ0.04 + 5.0*log(d) +
5.9ñ0.2*log(r)

Post perihelion: m_1 = 4.82ñ0.13 + 5.0*log(d) +
8.2ñ0.4*log(r)

Figure 4
Analysed light curve

Table 4. Applied magnitude corrections

Observer	Correction	Observations	Standard Deviation
Abbott	0.2	8	0.3
Andersson	0.2	4	0.1
Bengtsson	0.2	3	0.1
Birtwhistle	-0.2	12	0.2
Boattini	-0.9	4	0.6
Bortle	-0.3	21	0.3
Brincat	-0.2	17	0.4
Collins	-0.0	13	0.3
Dahle	0.1	32	0.7

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Danielsson    -0.4          3                  0.2
Ekloef         0.5          1                  0.0
Ergon          0.2          1                  0.0
Fischer       -0.1          4                  0.1
Fraser         0.2         14                  0.2
Gambin        -0.1          2                  0.0
Granslo        0.1         13                  0.4
Hasubick      -0.1          3                  0.2
Haver         -0.5         16                  0.2
Hurst         -0.0         12                  0.3
Jahn           0.2         30                  0.4
Jones          0.6         30                  0.5
Keitch        -0.3         47                  0.2
Kiernan        0.3          2                  0.2
McKim          0.1          3                  0.2
Midtskogen    -0.0          9                  0.3
Mikuz          0.2         31                  0.5
Moore          0.5          2                  0.0
Panther       -0.0         23                  0.4
Pearce         0.1         43                  0.4
Pereira       -0.1         44                  0.4
Ripero        -0.9          3                  0.9
Schmeer        0.4         12                  0.3
Shanklin      -0.3         23                  0.4
Tanti         -0.3         40                  0.3
Taylor         0.5         10                  0.4
Ventura       -0.1         14                  0.4
Warell        -0.0          2                  0.1
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Coma observations

If a comet has an unchanging coma diameter the observed
angular size will only depend on the comet's distance from
the Earth, though in poor conditions it will appear smaller.
When the observed size for comet Levy is reduced to a
standard distance no significant variation with distance
from the sun is seen. The observed coma was largest at
closest approach and reached around 50'. In general the
coma appeared larger when the comet was closest to the earth
and therefore brighter. It appeared smaller when larger
apertures were used. A central condensation, some 4
magnitudes fainter than the total magnitude of the comet was
reported by a number of observers. No features were seen in
the coma, however Bortle noted semi-periodic variation in
the central condensation.

Figure 5
Observed coma diameter v time

In general the degree of condensation of the coma (DC) was
observed to increase as the comet's distance from the sun
decreased. Values range from around 2 when the comet was
2.5 AU from the sun to around 7 at perihelion, however there
was considerable scatter between observers.

Tail and Photographic observations

The first visual observations of a tail were made in late
June, when the comet was around 8^m. By late July a tail of
over 1ø was being reported, and the maximum length of around
5ø was reached in August, with the dust tail in a broad
diffuse fan and a longer, narrow gas tail.

Because the comet was relatively bright and well placed,
many BAA members took photographs of it. Although the tails
were never spectacular the photographs show the broad,
diffuse dust tail and the narrow and highly variable gas
tail. A number were published in The Astronomer (TA)[4] and
also in the Journal[5,6,7].

Table 4. Photographic Observers

K G Anderson,	Sweden.
E Aristidi,	Ariane Observatory.
Denis Buczynski,	Conder Brow, Lancashire.
Jean Dragesco,	Ariane Observatory.
John R Fletcher,	Lenton, Nottinghamshire.
Gerhard Gramm,	
Richard T Glynn,	Okehampton, Devon
Alan Heath,	Nottingham
Brian Manning,	Kidderminster, Worcs.
Jean-Claude Merlin,	Le Creusot, France
Herman Mikuz,	Ljubljana, Slovenia.
Martin Mobberley,	Cockfield, Suffolk.
Stewart Moore,	Fleet, Hampshire.
Bob Neville,	Towcester, Northants.
Martin Radcliffe,	Armagh, NI.
Harold Ridley,	Eastfield, Yeovil, Somerset.
John W Smith,	Sandown, Isle of Wight.

Astrometric observations

As usual the section continued its tradition of astrometric
work and the measured positions of comet Levy were
communicated to Central Bureau as promptly as possible and
on occasion this was within 24 hours of a plate being taken.
Due to its generally well condensed nature very short
exposures could be taken, some being less than 20 seconds.

Astrometric observations from the following observers have been published in the Minor Planet Circulars:

Table 5 Astrometric observers

Observer	Location	IAU No.
H B Ridley	Eastfield	984
J D Shanklin	Cambridge	503

Comet Section observations

May 1990
Martin Mobberley saw the comet visually prior to photographing it on May 23.06. The first section observation of the comet was made by Jonathan Shanklin on May 23.08, when he made it 11.6, with a 0.6' coma diameter in the 0.30-m Northumberland refractor. He also attempted an astrometric observation on the same night, but was foiled by trees. A further attempt on the 25th was successful and was amongst the first astrometric positions obtained of the comet.

June 1990
In early June, Tony Tanti, observing from Malta and Graham Keitch from Devon made the comet around 10^m in their large reflectors, though Keitch made it nearly a magnitude brighter in 20x80B. By the end of the month the comet had reached 8.5, with a coma diameter of around 4'. On the 27th Keitch observed a short tail in pa 290.

July 1990
The bulk of the section observations were made during July and August when the comet was an easy binocular or naked eye object. At the beginning of the month, Peter Birtwhistle observing with 20x80B made the comet around 8th magnitude, with the coma diameter around 5'. Moonlight was a problem until just after mid-month, but once the skies became dark again most observers noted that a tail one to two degrees long in pa 245 had formed. James Abbott observing on the 21st with 10x50B estimated the total magnitude at 7.0, with a 9' coma diameter and by the end of the month Roy Panther made it 5.6 and a 12' coma diameter in 12x50B.

Fig 5
Sketch

August 1990
Some observers managed to see the comet with the naked eye early in the month, but moonlight was again a problem until mid month. On the 18th the comet passed close to M15 providing an excellent opportunity for photographers[5]; the

comet was much larger and more condensed than the globular
cluster. The comet was now closest to the Earth and large
coma sizes were reported: James Fraser made it 20' in
diameter in 8x30B on the 21st with a total magnitude of 4.2.
The geometry for viewing the tail improved towards the end
of the month and many observers noted the broad fan of
material in pa 080, Richard McKim making it 0.5ø long in his
0.22-m reflector.

Figs 6 & 7

September 1990
The comet moved rapidly south during the month and the last
observation from the UK was made by Melvyn Taylor on the 6th
when he made it 4.7 in 10x40B. Tony Tanti and Frank Ventura
observing from Malta and Mark Kidger observing from the
Canaries were able to follow it until the middle of the
month. Tail lengths of between 1 and 2 degrees in pa 085
were reported.

October - December 1990
An observation from an unusual location was made by Andy
Lacey at Rothera station, Antarctica on October 13, when he
made the comet about 3rd magnitude in 10x50B. Andrew
Pearce, observing from Australia and Albert Jones from New
Zealand were the main contributors of observations from the
end of September till the end of December 1990. Their
observations show the comet fading from 5th magnitude to 7th
magnitude, with the tail shrinking from around 1ø in pa 100
to 0.5ø in pa 280.

January 1991
The comet was too far south for observation from the UK, but
Albert Jones in New Zealand was able to observe it
throughout the month, reporting it at around 8th magnitude.

February 1991
Robert Bullen recovered the comet on February 19.0 with his
0.22-m reflector in poor conditions, estimating it around
9th magnitude and the coma diameter 8-10'. Peter
Birtwhistle found the comet three days later, making it 8.0
in 20x80B, with a coma diameter of 4'.

March 1991
The comet faded steadily during the month, though the coma
remained weakly condensed and around 4' diameter. On the
8th, Roy Panther made it 9.1 in his 0.20-m reflector, and he
made the last visual UK observation on the 21st, when it was
9.8.

April 1991

Harold Ridley at Eastfield, and Shanklin at Cambridge took astrometric plates on the 3rd, but Shanklin failed to find it visually, estimating that it must have been fainter than 10th magnitude. No other visual observations seem to have been made in the UK. The last reported observations of the comet were made from the Southern hemisphere in the middle of the month, by which time it had faded to 12^m and the coma had shrunk to 1' diameter.

May 1991
Shanklin took his last astrometric plate on the 9th; this was amongst the last astrometric positions reported, only Oak Ridge observatory following it after this with the 1.5-m reflector[8].

Acknowledgements

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References

1.   IAUC 5017, 1990 May 21
2.   Marsden, B. G., *Catalogue of Cometary Orbits*, 9th edition, IAU CBAT, (1994).
3.   Shanklin, J. D., Comet Analyses. *JBAA*. [This volume].
4.   Hurst, G. M., Comet Notes. *TA, Vol 27, No 315 to Vol 28, No 326*, (1990, 1991).
5.   Mobberley, M. P., Cover picture, *JBAA, 100, 6,* (1990).
6.   Shanklin, J. D. Comet News. *JBAA, 100, 5, p208*, (1990).
7.   Observer's Forum. *JBAA, 100, 6, pp310-311,* (1990).
8.   MPCs 16483, 1990 July 8 to 18493, 1991 August 25.

Figure captions:

Figure 1. The orbits of comet Levy 1990 c and the earth, with symbols representing the various orbital elements.
Figure 2. The observing circumstances of comet Levy 1990 c. The comet was discovered at T-157 days, with section observations made between T-154 and T+197 days.
Figure 3. The observed magnitude of the comet. The curve is a best fit over the entire apparition; the comet faded by around 1^m after perihelion. Tick marks indicate the first of each month.
Figure 4. The magnitude of the comet corrected for systematic differences between observers, magnification and

coma diameter and reduced to a distance of 1 AU from the earth, plotted against distance from the sun.

Figure 5. The comet photographed by *B G Manning* on 1990 August 12^d 23^h 07^m with 0.27-m f5 reflector; exposure 10 minutes on hypered Kodak TP 4415.

Figure 6. The comet photographed by *J W Smith* on 1990 August 16^d 22^h 32^m with 0.20-m f1.5 Schmidt; exposure 20 minutes on Kodak TP 2415.

Figure 7. Sketches of the comet made by *R Bullen* using a 0.16-m f8 reflector x68. a) July 13.95, b) Aug 02.00, c) Aug 13.97, d) Aug 27.97.