The brighter comets of 2016

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A report of the Comet Section. Director: N. D. James

Figure 1. 43P/Wolf–Harrington imaged by Michael Jaeger on 2016 Oct 5.

In this report, observations of the brighter or more interesting comets at perihelion during 2016 are described and analysed, concentrating on those visually observed. Magnitude parameters are given for all comets with observations. Any evolution in the magnitude parameters of those periodic comets with multiple returns is discussed. Additional information on the comets discussed here, and on other comets seen or at perihelion during the year, may be found on the Section's visual observations web pages.

Introduction

52 comets were assigned year designations for 2016 and 45 previously numbered periodic comets returned to perihelion. 168 comets from the SOHO satellite and four from STEREO were credited during 2016, including two returning objects. 160 were members of the Kreutz group, five were members of the Meyer group, none were of the Marsden group, one was of the Kracht group (a return) and seven were not associated with any known group (one a return). Two of the objects were given designations (2016 J3 and 2016 N5).

There was one possible amateur discovery (2016 R3) for which Gennady Borisov may gain the Edgar Wilson Award, though there has been no formal announcement at the time of writing. 15 periodic comets from the year were numbered. One comet (252P/LINEAR) was reported as visible to the naked eye during the year. Overall 2016 was a disappointing year for visual comet observers.

In a change from previous practice, this and future reports will cover only the comets that were at perihelion during the year. Previously comets were described in the report for the year of their designation, however as sky surveys go ever deeper, comets are being discovered many years from perihelion. In order to not unduly delay publication of reports, it seems prudent to change this practice.

Where periodic comets are the subject of visual or electronic observations at five or more returns, the secular behaviour of the comet is considered, even though it may not qualify as a 'brighter' comet during the present return. Any evolution in behaviour is of interest, as is observation of a steady state.

Orbital elements for all the comets discovered and returning during the year can be found on the JPL Small-Body Database Browser,[1] which will also generate ephemerides. Discovery details and some information for the other comets found or returning during the year are available on the Section visual observations web pages,[2] which also contain links to additional background information. The raw visual observations for the year are on these pages in ICQ format, and in the Comet Observations database (COBS).[3] The full dataset from COBS is used for the multi-return analyses presented here, but otherwise only those observations submitted to the Section are included. Additional images of the comets are presented in the Section image archive.[4]

The comets given a discovery designation

2016 BA_{14} (P/PanSTARRS)

A 19th magnitude asteroid, discovered in Pan-STARRS 1 images taken with the 1.8m Ritchey–Chrétien on Jan 22.34, was subsequently shown to have a faint tail. Pre-discovery Pan-STARRS images were then found from 2015 December. Denis Denisenko suggested that the orbit was very similar to that of 252P/LINEAR [*CBET* 4257, *MPEC* 2016-C192, 2016 Feb 15].

The comet reached perihelion at 1.0au in 2016 March and passed 0.024au from the Earth on Mar 22. This is nearly optimum for a close approach to the Earth, as the minimum orbit intersection distance (MOID) is 0.018au; the Jupiter MOID is 0.094au. It will make another close approach to the Earth in 2048, but there

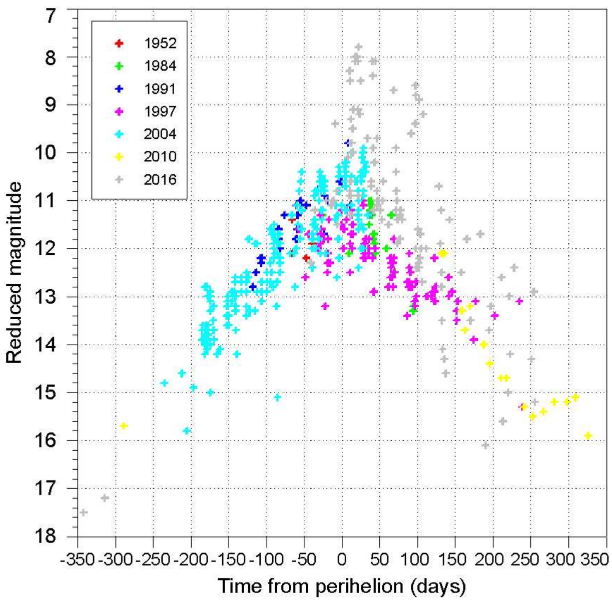

Figure 2. Composite plot showing all the observations of 43P/Wolf–Harrington.

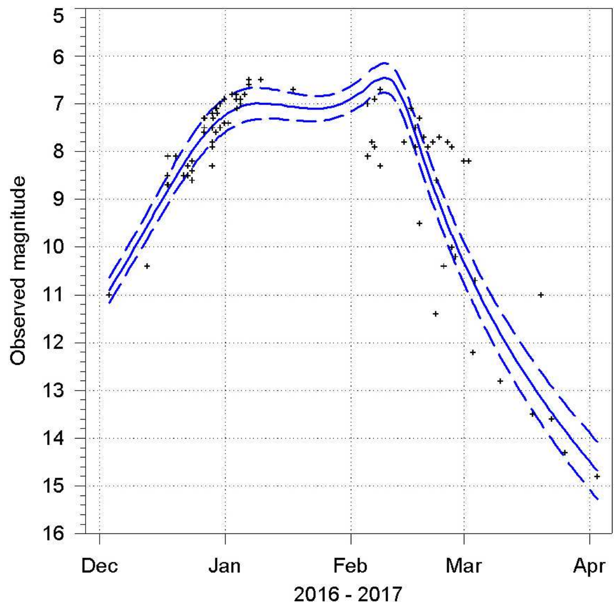

Figure 3. The observations of 45P/Honda–Mrkos–Pajdušáková at the 2016 return with a standard light curve fitted to them.

are no very close approaches to Jupiter over the century centred on the present.

It is intrinsically very faint and has one of the faintest absolute magnitudes of any comet observed by the Section. Despite this, the comet reached 13th magnitude at closest approach, when it was moving rapidly across northern skies. It was imaged by radar and the observations showed that the nucleus was about a kilometre in diameter, with a rotation period of around 37 hours.

2016 J3 (P/STEREO)

On May 26, Scott Ferguson reported to Karl Battams a comet in STEREO H1 images taken on May 14. Man-To Hui measured the images and Battams sent the astrometry to the Minor Planet Centre (MPC), who computed an orbit. Battams noted that strong forward scattering may have contributed to the comet's brightness, which reached around 8th magnitude [*CBET* 4281, *MPEC* 2016-K41, 2016 May 31].

The comet was at perihelion on May 21 at 0.47au and has a period of 7.7 years, according to the MPC elements. The orbital elements are extremely uncertain; JPL give error bars of 1.0au in the perihelion distance and 59 years in the period. Mike Olason submitted an image of the comet taken from Denver, USA on Jul 13, although there is no astrometry from the observation used in the orbit solution.

2016 R3 (Borisov)

Gennady Borisov discovered a 16th magnitude comet in images taken with the 0.3m *f*/1.5 astrograph at the MARGO observatory,

Table 1. Photometric observers

James Abbott, Witham, Essex
Alexandr R. Baransky, Okhnovka, Ukraine
Denis Buczynski, Ross-shire, Scotland
Peter Carson, Leigh-on-Sea, Essex
Mike Collins, Everton, Beds.
Roger Dymock, Waterlooville, Hampshire
James Fraser, Alness, Ross-shire
Stephen Getliffe, Haverhill, Suffolk
Marco Goiato, Brazil
J. J. Gonzalez, Asturias, Spain
Werner Hasubick, Germany
Kevin Hills, Cheshire
Nick James, Chelmsford, Essex
Carlos Labordena, Spain
Martin Lehky, Czech Republic
J. P. Navarro Pina, Spain
Mieczyslaw L. Paradowski, Poland
Nirmal Paul, India
Jan Qvam, Borrevannet, Norway
Jonathan D. Shanklin, Cambridge
William C. de Souza, Brazil
Johan Warell, Sweden
Graham W. Wolf, New Zealand
Chris Wyatt, New South Wales, Australia
Seiichi Yoshida, Japan

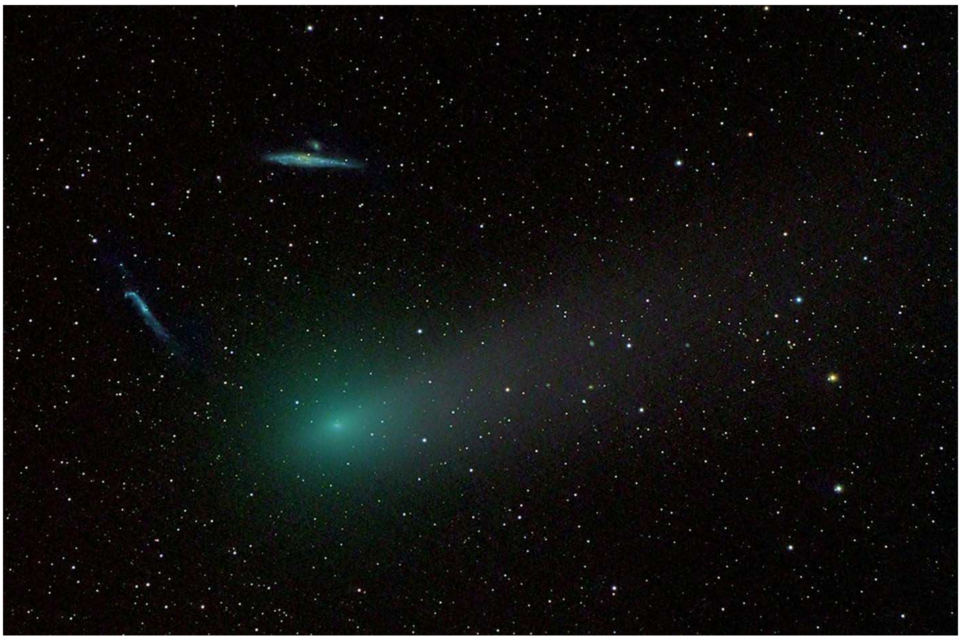

Figure 4. 45P/Honda–Mrkos–Pajdušáková, imaged by Alan Tough on 2017 Feb 19 with the iTelescope at Mayhill, New Mexico. The two galaxies are NGC 4631 and NGC 4656.

near Nauchnij, Crimea, on Sep 11.07. The object was confirmed by other astrometrists, including Peter Birtwhistle [*CBET* 4321, *MPEC* 2016-S03, 2016 Sep 16]. The comet was at perihelion at 0.4au in 2016 October.

Gareth Williams commented on the *MPEC*:

> 'The preliminary orbit for this object is being presented as a parabolic orbit, but the available observations are consistent with intermediate-period orbits with periods as short as 50 years, possibly even 30 years. As suggested by internal MPC checking routines (and subsequently by M. Meyer), the orbit of this object is very similar to that of 1915 R1 (Mellish), for which a parabolic orbit was published by Einaarson & Alter (1915, *Lick Obs. Bull.*, **8**, 151) based on only three observations ([it] was then compared to other available observations). A new orbit for C/1915 R1, based on all seven available observations, was computed.'

Attempts by Gareth Williams (and S. Nakano) to link the 1915 and 2016 apparitions were not successful. Trials were made for n= 0, 1, 2 & 3 intervening (missed) returns between the 1915 and 2016 perihelion passages. The two comets appear not to be the same object, but the possibility of a common origin will necessitate further investigation. The best-fit JPL orbit gives a period of around 1000 years, with an uncertainty of 250 years.

Unfortunately the circumstances of the apparition were about as poor as is possible, with the comet on the far side of the Sun at perihelion. It was intrinsically very faint and Michael Mattiazzo noted that it was not visible in STEREO imagery post-perihelion; it was not seen again.

The numbered periodic comets at perihelion in 2016

9P/Tempel

Last at perihelion in 2011, this comet was described in the report on the brighter comets of that year. [5] This additional return makes

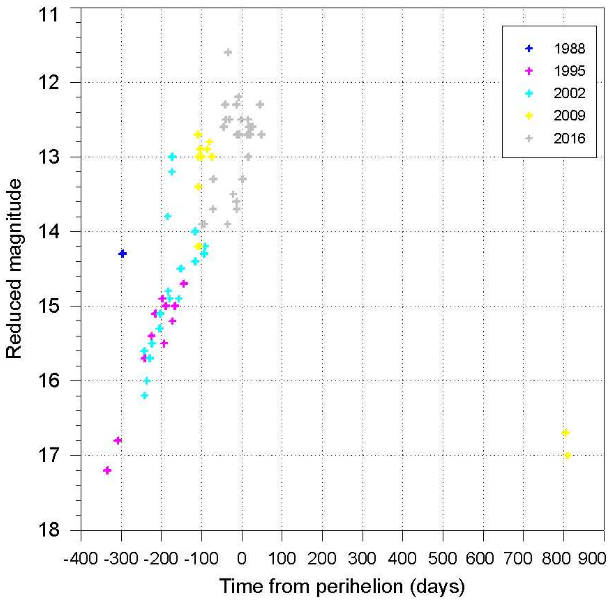

Figure 5. Composite plot showing all the observations of 77P/Longmore.

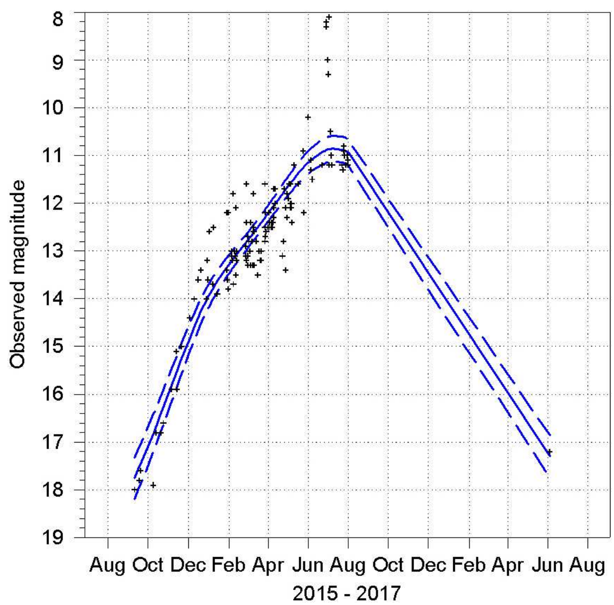

Figure 6. The observations of 81P/Wild at the 2016 return with a standard light curve fitted to them.

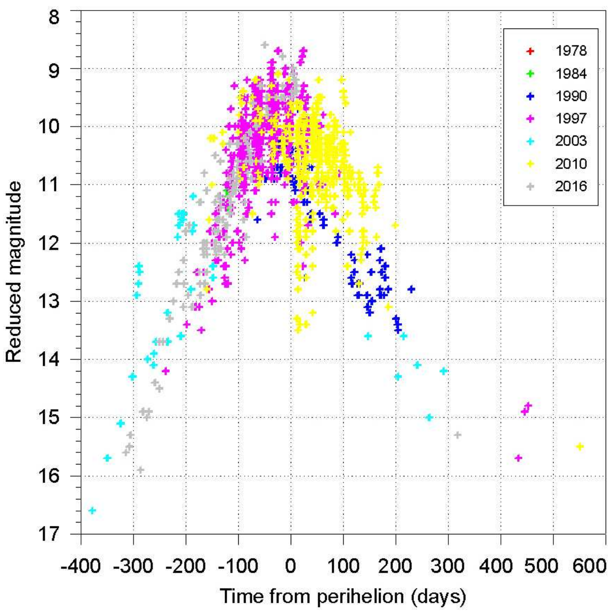

Figure 7. Composite plot showing all the observations of 81P/Wild.

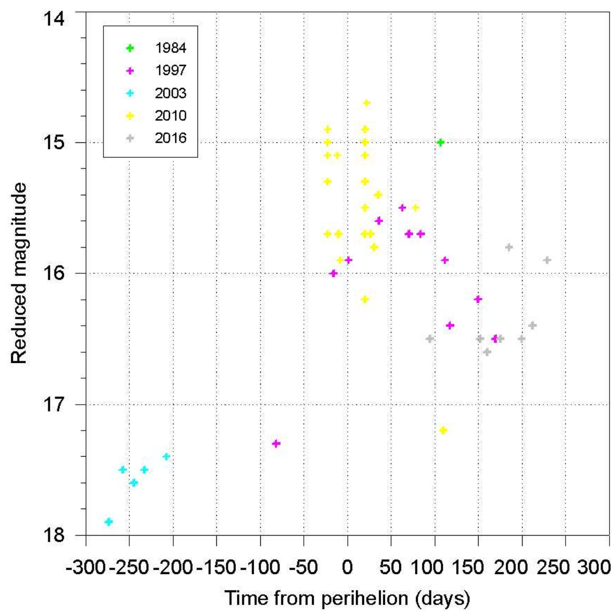

Figure 8. Composite plot showing all the observations of 94P/Russell.

no significant change to the overall light curve, and the comet's behaviour is clearly stable.

43P/Wolf–Harrington

The comet was described in the report on the brighter comets of 2004,[6] which included observations made at the 2010 return in the overall analysis. The comet was well observed at the 2016 return and, overall, the observations confirm the stable behaviour of the comet. There is however considerable scatter, particularly around the time of perihelion when the comet was about 10th magnitude; visual observers using low powers from good locations recorded the comet as up to three magnitudes brighter than other visual or electronic observers. The brighter observations also give a much larger coma diameter, and it seems likely that these observers were picking up a faint outer coma that was previously invisible.

The perihelion distance at the 2010 and 2016 returns was smaller than at those previous, but the 2010 return was a poor one with no visual observations. Other comets have shown a brighter intrinsic magnitude with reduced perihelion distance, but the evidence in this case is not good enough to confirm such behaviour.

No visual observers reported a tail, however a prominent tail is seen in many of the images taken from 2016 August to December. This may be the last return with visual observations, as the perihelion distance will increase from 1.36au to 2.44au following an approach to Jupiter of 0.065au in 2019 March.

45P/Honda–Mrkos–Pajdušáková

The comet was last at perihelion in 2011 and was described in the report on the brighter comets of that year.[5] This additional return makes no significant change to the overall light curve, and the comet's behaviour is clearly stable.

At this return the comet made an approach to the Earth of 0.08au in 2017 February – slightly further away than in 2011, but occurring after perihelion. When closest it was best seen from the northern hemisphere, whereas in 2011 the close approach was best seen from the southern hemisphere. The comet became slightly brighter at this approach, with a larger coma diameter being reported.

The comet was picked up by Seiichi Yoshida in early 2016 December, when it was 11th magnitude. It brightened rapidly and a month later Jonathan Shanklin made it +6.8, when viewed from the outskirts of Cambridge with his 20×80 binoculars. It passed through solar conjunction in late January, becoming a morning object as it emerged. Probably on account of this, observations were fewer in the first half of February.

The coma diameter reached a maximum of around 20 arcminutes at closest approach. By the time it returned to the evening sky in the second half of February it was fading, James Abbott making it +7.7 in 15×70 binoculars on Feb 18.99. Only a few visual observations were made after the end of February, with Yoshida making it 14th magnitude in late March. In general the coma was seen as small and well condensed prior to and during perihelion, but large and diffuse after solar conjunction. It showed little tail development to visual observers, though J. J. Gonzalez estimated a one-degree tail in late February.

Table 2. Astrometric, electronic, photographic & visual imagers during 2016

Observer	*Site*	*IAU Stn. No*
David Anderson	Girvan, Ayrshire	
Tony Angel	Spain	Z85
Alexander Baransky, *et al.*	Ukraine	585
Peter Birtwhistle	Great Shefford	J95
David Boyd	Wantage, Oxfordshire	
Erik Bryssinck	Belgium	B96
Denis Buczynski	Tarbatness	I81
Anvar Buriev	Tajikistan	190
Montse Campas	Spain	213
Peter Carson	Leigh-on-Sea, Essex	K02
José J. Chambó	Spain	
Alfons Diepvens	Belgium	C23
John Drummond	New Zealand	
Roger Dymock	Clanfield, Hampshire	G68, Q65
Ernesto Guido, *et al.*	Italy	H06, Q62
Roberto Haver	Italy	
Nick Hewitt	Northants.	
Kevin Hills	Cheshire	J22
Michael Jaeger	Austria	
Nick James	Chelmsford, Essex	970
Manos Kardasis	Greece	
Hisayoshi Kato	Japan	
Rob Kaufman	Australia	
Rolando Ligustri	Italy	235
Mikhail Maslov	Russia	
Andrew Mickleburgh	Cleethorpes	Z99
Richard Miles	Stourton Caundle, Dorset	K93, W85
Martin Mobberley	Cockfield, Suffolk	480
Ramon Naves	Spain	213
Mike Olason	USA	
Nirmal Paul	India	H06, Q62
Damian Peach	Selsey	
Danilo Privato	Italy	
Gerald Rhemann	Austria/Namibia	
Andrew Robertson	Broome, Norfolk	
Chris Schur	USA	
David Storey	Isle of Man	987
Justin Tilbrook	South Australia	D86
Alan Tough	Elgin, Scotland	
Adriano Valvasori	Italy	
Johan Warell	Sweden	K60
Americo Watkins	Stourton Caundle, Dorset	K93

77P/Longmore

A close approach to Jupiter in 1963 reduced the perihelion distance from 3.0 to 2.4au. The comet wasn't discovered until 1975, when Andrew Longmore found it on a Siding Spring Schmidt plate taken for the Southern Sky Survey. The orbit derived at the discovery apparition was based on only eight positions, but Stan Milbourn published a prediction for the 1981 return in the 1980 BAA *Handbook*, which proved very accurate.

The comet has never become much brighter than 13th magnitude, even at the better returns such as in 2016. Visual observations are few, but there are electronic and visual observations over five returns since 1988; most of these were made prior to perihelion due to the orbital geometry. The comet's behaviour has been consistent at the five returns and this should be maintained up to 2046, when the perihelion distance is significantly reduced.

81P/Wild

The discovery of the comet and its behaviour were described in the reports on the comets of 2003 and 2010.[7,8] Although the 2010

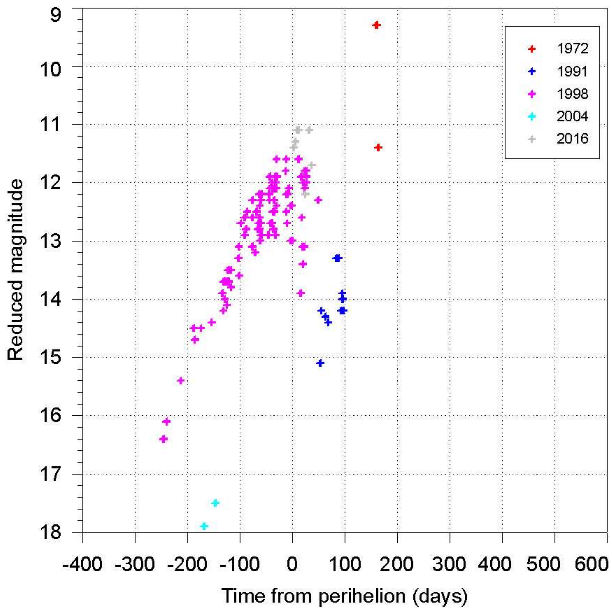

Figure 9. Composite plot showing all the observations of 104P/Kowal.

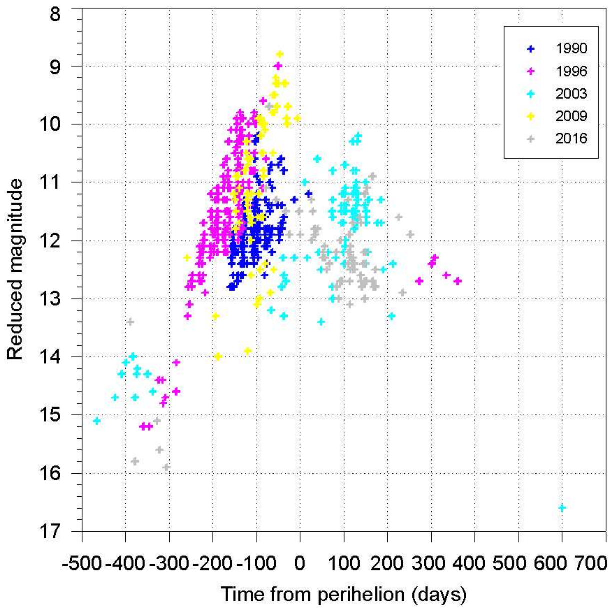

Figure 10. Composite plot showing all the observations of 116P/Wild.

report used some observations from 2015, the comet did not reach perihelion until 2016 when it was well observed. Additional observations from previous returns are also now available from the COBS database.

At the 2016 return the comet brightened rapidly, and much more quickly than at the rate which had been established in the 2010 report. In hindsight, this behaviour was present at previous returns, but it was not well captured by the mean light curve. Overall, the 2016 observations are well fitted by a single light curve with rapid brightening, and both the linear and standard fits are equally good. However, when all the returns are considered, no single curve provides a good fit. A better fit is obtained when the observations are divided into two sets: those obtained when the comet was further than 2.0au from the Sun, and the rest. The rate of brightening declines once the comet is closer to the Sun than 2.0au.

A couple of observers estimated the comet as being much brighter than given by the mean curve a few weeks prior to perihelion, when the comet was at 42° elongation from the Sun and heading towards conjunction. As with 43P, these observers may have been able to see a faint outer coma.

94P/Russell

A Jupiter encounter in 1975 reduced the perihelion distance a little and the comet was discovered in 1984 by Ken Russell, on a Siding Spring Schmidt plate.

The comet has never become bright enough for visual observation, but there are electronic observations over five returns, which show a consistent behaviour.

104P/Kowal

Leo Boethin discovered a comet in 1973 January from the Philippines, however due to a slow postal service it took some time

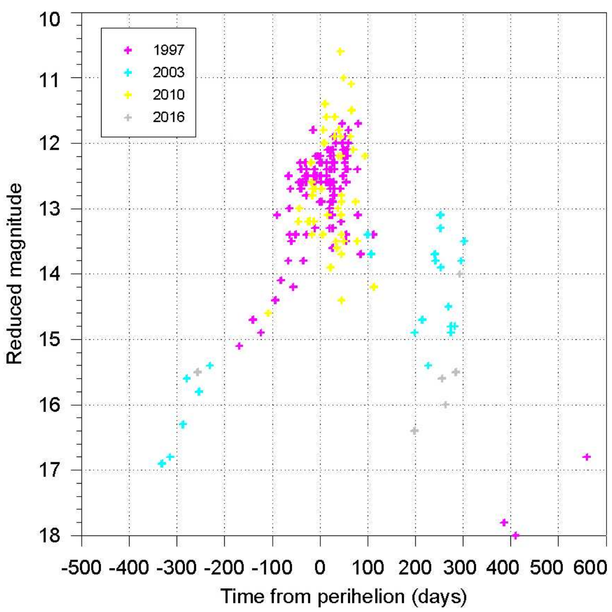

Figure 11. Composite plot showing all the observations of 118P/Shoemaker–Levy.

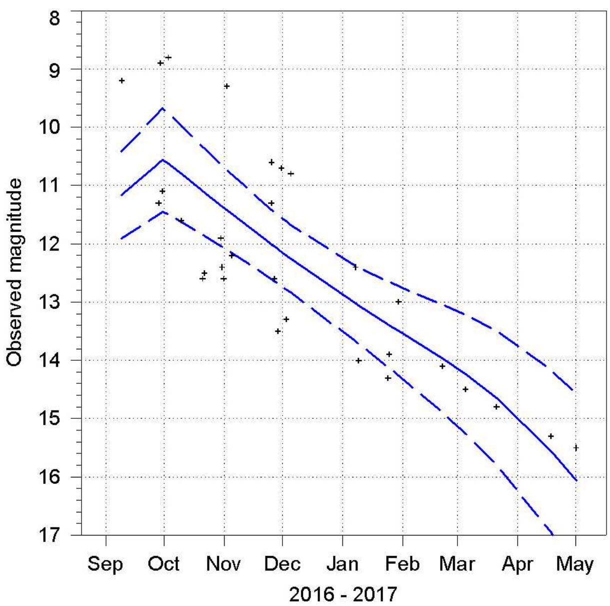

Figure 12. The observations of 144P/Kushida at the 2016 return with a linear light curve fitted to them.

to get the details to the *CBAT* and it was never confirmed.[9] The comet was recovered by Charles Kowal in 1979 at its next return. Only once the orbit was known was it possible to identify it as the comet seen by Boethin, since his approximate positions matched the ephemeris. The comet was presumed to be in outburst in 1973, and outbursts were also indicated by the large non-gravitational forces needed to link the apparitions.

Calculations by Kazuo Kinoshita show that the comet frequently passes close by Jupiter, and it has been gradually getting closer to the Sun. The perihelion distance was 1.5au at the discovery in 1979, reducing to 1.4au in 1998, 1.2au in 2015, 1.1au in 2022 and 0.98au in 2033. It will make a close approach to Earth in 2039 and a very close approach (0.09au) in 2049.

The 1973 estimates by Boethin are some six magnitudes brighter than the mean curve, so it was clearly a substantial outburst. The 2004 estimates are more indicative of the nuclear magnitude and unlikely to represent the true brightness of the comet. The observations at these returns were therefore omitted from the analysis of the mean curve. The remaining observations show a consistent behaviour at the three returns.

There were very few observations in 2016 and these suggest that the comet reached 12th magnitude.

116P/Wild

This comet was discovered on 1990 Jan 21.98 by Paul Wild, with the 0.40m Schmidt at the Zimmerwald station of the Bern Astronomical Institute, at a photographic magnitude of +13.5. The comet was perturbed into its present orbit after a close approach (0.15au) to Jupiter in 1987 July, which reduced the perihelion distance from 3.4 to 2.0au. A more distant approach in 1998 December increased it again to 2.2au.

Even at the best returns the comet only reaches 11th magnitude; 2016 was not one of these and the comet reached 13th magnitude. There are observations from five returns. The observations after the 1998 encounter are fairly well distributed about perihelion and are fitted by a standard light curve. Those before the encounter are concentrated prior to perihelion and are not well fitted by the usual regression; however, they are reasonably fitted by the post-1998 curve.

118P/Shoemaker–Levy

The team of Carolyn & Eugene Shoemaker and David Levy discovered this comet on film images taken with the 0.46m Palomar Schmidt in 1991. An encounter with Jupiter in 2020 July will reduce the perihelion distance from its present 2.0au to 1.8au.

The 2016 return was not a good one, with the comet in solar conjunction when it was at perihelion. Even at the best returns it only reaches 12th magnitude. There are however observations from five returns, which are slightly better fitted by the linear-style equation. The behaviour is similar at all five returns.

144P/Kushida

The discovery and orbit of the comet were described in the report on the comets of 2009.[10]

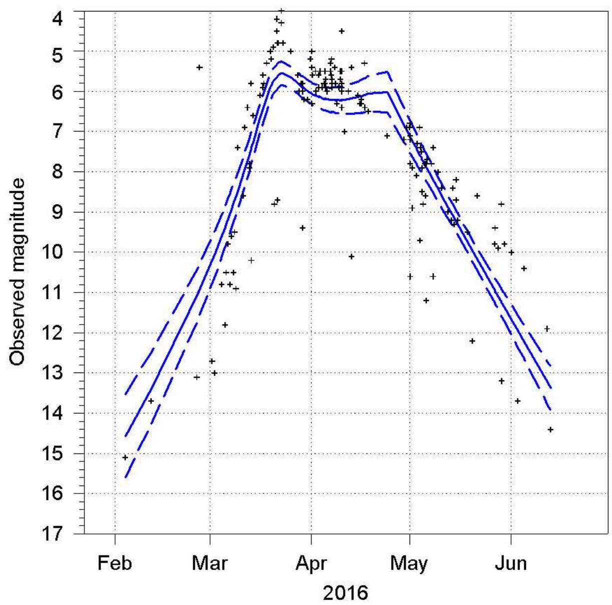

Figure 14. The observations of 252P/LINEAR at the 2016 return with a linear light curve fitted to them.

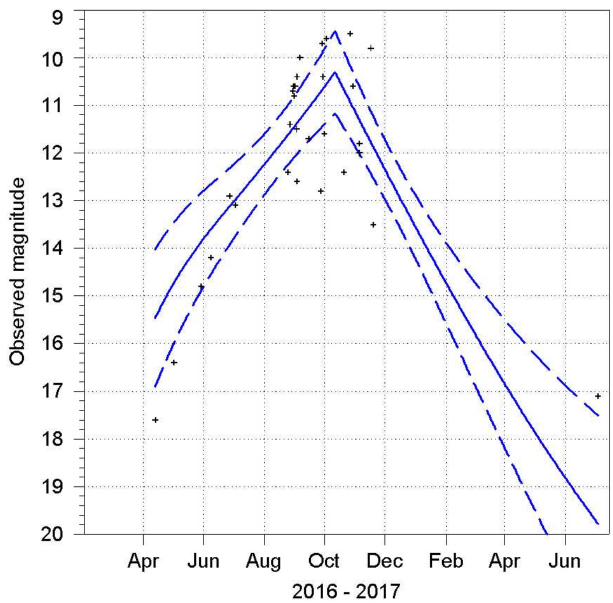

Figure 13. The observations of 237P/LINEAR at the 2016 return with a linear light curve fitted to them.

At the 2016 return the comet was only observed after perihelion, when it was fading from around 9th magnitude. When these observations are combined with those from the 2009 return they strengthen the case for a linear light curve, but are not sufficient by themselves. The only other return with observations was that of the discovery, when observations were only made after perihelion.

237P/LINEAR = 2002 LN_{13} = 2010 L2

A cometary object discovered by WISE on 2010 Jun 10.57 was quickly linked by the WISE team to an asteroidal object found by LINEAR on 2002 Jun 6.23. The comet has a period of 7.2 years and reached perihelion at 2.4au in 2009 December. It was around 20th magnitude at discovery. An encounter with Jupiter in 2013 March reduced the perihelion distance from 2.4au to 2.0au.

Table 3. Magnitude parameters of the comets of 2016

a) Standard magnitude parameters

Comet	No. obs.	r (au)	H_1	K_1	H_{10}
2016 A8 (LINEAR)	31	1.9–2.1			8.6±0.1
2016 B1 (NEOWISE)	9	3.5–3.8			5.8±0.3
2016 BA_{14} (P/PanSTARRS)	13	1.0–1.4			19.0±0.4
2016 R4 (P/Gibbs)	2	2.9			10.1±1.3
9P/Tempel (2016)	102	1.5–2.3	5.1±0.5	27.5±2.4	9.0±0.1
9P/Tempel (all)	2106	1.5–2.3	6.6±0.2	17.8±0.9	8.2±0.0
33P/Daniel	4	2.4–2.6			9.2±0.4
43P/Wolf–Harrington (2016)	109	1.4–3.3	7.3±0.3	13.3±1.3	8.1±0.1
43P/Wolf–Harrington (all)	508	1.6–3.3	6.7±0.3	16.5±1.0	8.3±0.8
45P/Honda–Mrkos–Pajdušáková (2016)	323	0.5–1.7	11.2±0.1	13.0±0.3	10.9±0.1
45P/Honda–Mrkos–Pajdušáková (all)	906	0.5–2.0	11.3±0.0	13.6±0.3	10.9±0.0
50P/Arend	10	2.0–2.5	6.3±2.2	21.5±6.3	10.3±0.2
53P/Van Biesbroeck	37	2.4–4.1	4.1±1.0	15.6±2.1	6.8±0.2
56P/Slaughter–Burnham	11	2.5–3.0			7.3±0.2
77P/Longmore (2016)	30	2.3–2.5			7.9±0.1
77P/Longmore (all)	74	2.3–4.5	5.7±0.9	17.1±2.3	8.6±0.1
81P/Wild (2016)	129	1.6–3.1	4.6±0.3	19.1±0.9	7.3±0.1
81P/Wild (all)	1624	1.6–4.2	6.6±0.1	12.3±0.5	7.2±0.0
81P/Wild (<2.0au)	1415	1.6–2.0	7.3±0.3	9.2±1.2	7.2±0.0
81P/Wild (>2.0au)	204	2.0–4.2	6.1±0.4	14.3±1.1	7.6±0.1
94P/Russell (2016)	8	2.3–2.7			10.8±0.1
94P/Russell (all)	53	2.2–2.9	9.6±0.9	13.1±2.3	10.7±0.1
100P/Hartley	4	2.0–2.1			11.6±0.2
104P/Kowal (2016)	7	1.2–1.3			9.4±0.2
104P/Kowal (all)	123	1.2–2.7	9.6±0.2	9.9±0.8	9.6±0.1
116P/Wild (2016)	79	2.2–3.3	4.2±1.0	18.2±2.6	7.3±0.1
116P/Wild (all)	658	2.0–4.0	5.6±0.5	13.4±1.3	6.9±0.1
118P/Shoemaker–Levy (2016)	6	2.5–2.9			9.5±0.4
118P/Shoemaker–Levy (all)	213	2.0–3.9	7.1±0.4	14.1±1.2	6.5±0.1
136P/Mueller	7	3.0–3.2			8.5±0.2
144P/Kushida	30	1.4–2.8	5.6±0.6	16.3±2.2	7.2±0.2
146P/Shoemaker–LINEAR	2	2.0–2.3			12.2±1.6
157P/Tritton	6	2.3–3.2			10.4±0.8
211P/Hill	4	2.4			9.4±0.2
226P/Piggott–LINEAR–Kowalski	10	1.8–2.3	8.9±1.6	13.3±5.5	9.9±0.2
237P/LINEAR	31	2.0–2.8	−7.6±2.2	53.5±6.8	6.2±0.3
238P/Read	3	2.4			12.5±0.6
252P/LINEAR	155	1.0–1.5			11.0±0.1
279P/La Sagra	3	2.2–2.4			13.0±0.4
288P/Spacewatch (300163)	6	2.4–2.5			12.3±0.1
333P/LINEAR	12	1.1–2.4	9.6±0.3	16.2±1.5	10.6±0.3
338P/McNaught	9	2.3–2.4			10.1±0.2
340P/Boattini	3	3.1			9.6±0.3
341P/Gibbs	4	2.6–2.8			9.7±0.5
343P/NEAT–LONEOS	6	2.3–2.6			9.9±0.3
344P/Read	5	2.8–2.9			9.8±0.2
346P/Catalina	4	2.2–2.3			11.4±0.2
362P/Spacewatch	5	3.5			7.4±0.2

b) Linear magnitude parameters

Comet	No. obs.	Days	H_1	K_1	ΔT
81P/Wild (2016)	129	−314–318	8.9±0.1	0.0116±0.0007	20.2±2.5
81P/Wild (<2.0 au)	1415	−127–122	9.0±0.1	0.0093±0.0010	21.3±3.4
81P/Wild (>2.0au)	204	−378–318	8.5±0.2	0.0155±0.0011	14.5±3.9
118P/Shoemaker–Levy (all)	213	−331–560	11.2±0.1	0.0082±0.0007	−16.0±7.8
144P/Kushida (2009+2016)	75	−71–243	8.6±0.1	0.0210±0.0014	−30.6±2.4
237P/LINEAR	31	−181–265	7.5±0.3	0.0303±0.0035	−3.2±7.9
252P/LINEAR	155	−40–89	9.2±0.2	0.0895±0.0057	−39.4±1.0

At the 2016 return, the comet brightened quite rapidly during the first half of the year and had reached 13th magnitude in late June: much brighter than expected. The observations by Kevin Hills show a consistent brightening from April to June, suggesting that this was not a sudden outburst. The brightening continued, with the comet reaching a peak of around 10th magnitude at perihelion.

The standard magnitude parameters are rather implausible (although giving a reasonable fit) and the observations are slightly better fitted by a linear light curve. At the previous return, with a greater perihelion distance, the comet might have reached about 16th magnitude; by the time it was discovered it would have faded to around 18th magnitude (visual). This is in line with the confirmation magnitude made with the 1.8m Spacewatch reflector. Without the observations by Hills there would, given the lack of observations from previous returns, have been a suspicion that the comet had outburst. The comet could reach 10th magnitude (telescopic) at the 2023 return.

252P/LINEAR = 2000 G1 = 2011 L5

The comet was moved into its present orbit in 1987 February, when an encounter to within 0.15au of Jupiter made significant changes to the elements. It was then discovered in 2000 April.[11] The comet had passed only 0.10au from the Earth in 2000 during late February and early March, when it could have reached 14th magnitude but was at high southern declination. It made another close approach to the Earth in 2016, passing 0.036au from us on Mar 21, when it was best seen from the southern hemisphere. 2016 BA_{14} has a very similar orbit and made an even closer approach a day later. Significant non-gravitational forces and approaches to Jupiter have prevented the determination of any likely split of the two objects. At around 300m diameter, 252P is much smaller and rotates faster in a complex rotational mode; it is however the more active of the two bodies.

The magnitude of the comets can be calculated from the equation:

$$m = H_1 + 5.0 \log(\Delta) + K_1 \log(r)$$

For many comets there are insufficient observations to calculate K_1 accurately and so a value of 10 is assumed, which gives the constant H_{10}. CCD observations approximating to visual, which include a measure of the coma diameter, are used to augment the light curves of those comets with insufficient visual observations. A correction for aperture of 0.0033 mm^{-1}, and the observer corrections derived in previous papers,[13,14] have been applied and the H values are reduced to zero aperture.

Some comets do not follow the standard equation and are better fitted with a linear equation:

$$m = H_1 + 5.0 \log(\Delta) + K_1 \,\mathrm{abs}(t - T + \Delta t)$$

where t is the Julian Date, T the Julian Date of perihelion and Δt an offset. If Δt is positive the comet is intrinsically brighter prior to perihelion.

The first observations of 2016 were made in February, but it brightened very quickly in March and had reached 6th magnitude by mid-month, peaking at 4th magnitude around the time of closest approach. The comet was a large and very diffuse object. The observations are best fitted by a linear light curve, with the comet at peak output some 39 days after perihelion and brightening unusually rapidly. The rapid brightening instigated reports of an outburst, but the degree of condensation has remained low. A standard light curve does not fit the observations.

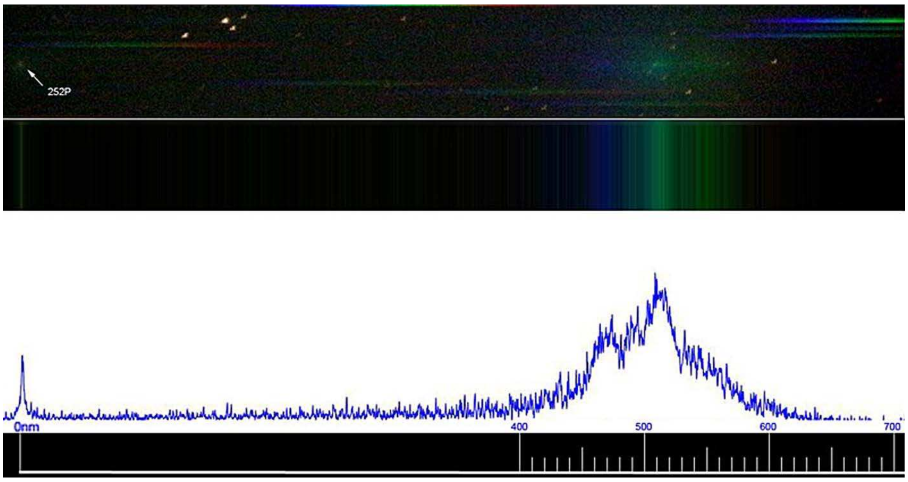

Figure 15. Low-resolution spectrum of 252P/LINEAR, taken by Rob Kaufman (Bright, Victoria, Australia) on 2016 Apr 4. Canon 650D on Vixen Polarie, with 200mm lens and Star Analyser grating. 6×180s, ISO 6400, *f*/5.6. Calibration approximate; spectrum uncorrected. Graph generated in *BASSProject.*

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Figure 16. 252P/LINEAR imaged by Justin Tilbrook on 2016 Mar 16, when it was close to the Large Magellanic Cloud.