Light Curves of Comets in 2005

March 18 and 19, 2006　36th Comet Conference

Seiichi Yoshida

comet@aerith.net

http://www.aerith.net/index.html

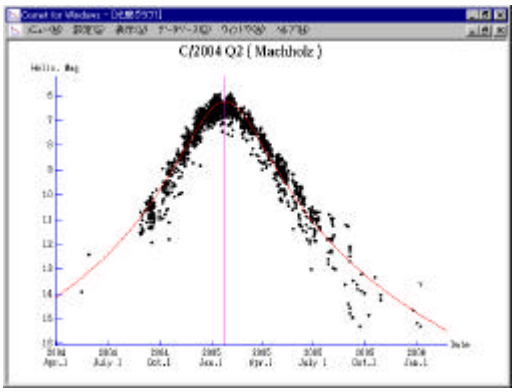
1. Overview

In this paper, I introduce the light curves of comets, bright comets or interesting comets with peculiar light curves, observed during a year between 2005 March and 2006 February.

My web page "Comet Catalog" also introduces the light curves of comets, including ones not described in this paper.

2. Bright Visual Comets

2-1. C/2004 Q2 (Machholz)



This graph represents the brightness change with a heliocentric brightness, corrected magnitude as observed on the Sun, in the vertical axis.

The light curve of this comet was completely theoretical. It is already farther than 5 A.U., however, the total light curve can be expressed by the following one formula.

m1 = 5.12 + 5 log delta + 9.84 log r (1881 obs., +/-0.38)

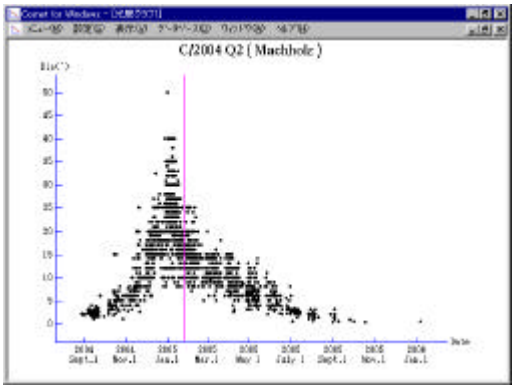
The light curve is stable probably because the comet is a big one and the perihelion distance is not too small. However, in the case of many other big comets with somewhat large perihelion distance, their light curves are not so stable. For example, the light curve formula had to be changed on the way even in the case of Comet C/1995 O1 (Hale-Bopp) or C/2001 Q4 (NEAT).

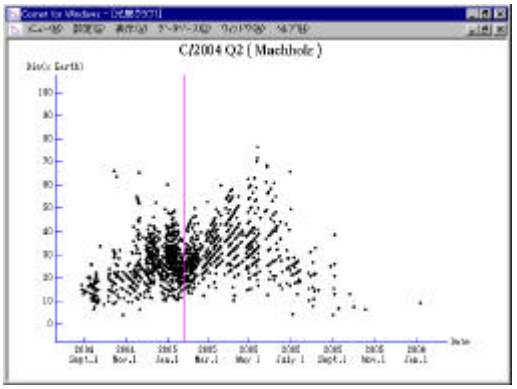
The following graph represents the coma size change, plotting the observed apparent diameter in arcmin, and the actual coma size as a multiple against the Earth diameter.

This comet is a good sample to see the coma size change. It passed very near by the Earth

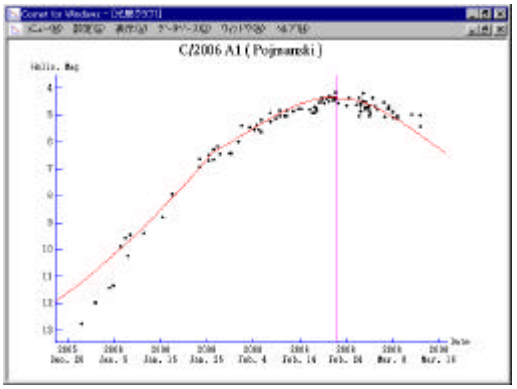
in early January in 2005, but no observational effect appears in the actual coma size.

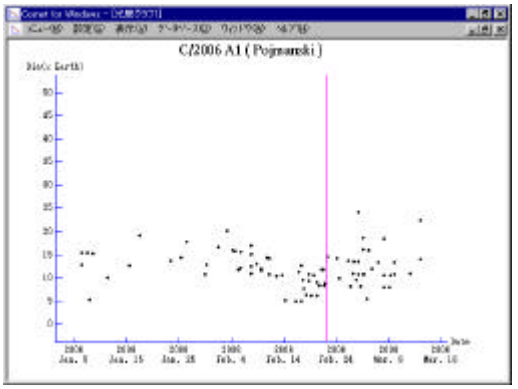
We can see that the coma size is enlarged after the perihelion passage.





2-2. C/2006 A1 (Pojmanski)



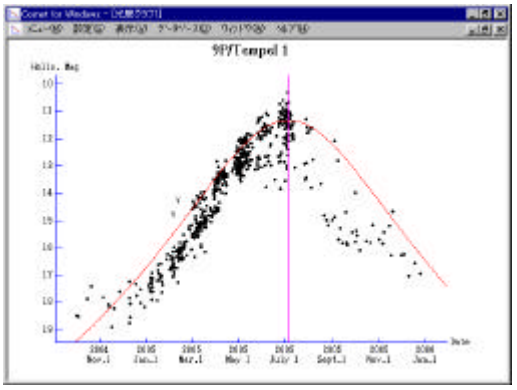


The left side graph represents the brightness change with a heliocentric brightness, corrected magnitude as observed on the Sun, in the vertical axis. The brightness evolution pace was drastically changed at around January 26, from 20 log r formula to 7.5 log r formula. The heliocentric distance was 0.82 A.U. at that time.

The right side graph represents the coma size change, plotting the actual coma size as a multiple against the Earth diameter. The heliocentric distance of this comet changed from 1.2 A.U. to 0.55 A.U., however, the actual coma size kept constant.

3. Remarkable Comets

3-1. 9P/Tempel 1



The graph represents the brightness change with a heliocentric brightness, corrected magnitude as observed on the Sun, in the vertical axis.

A bullet impacted the comet on 2005 July 4, but it only caused the temporary outburst of the nuclear brightness. The Deep Impact Mission did not influence to the total brightness.

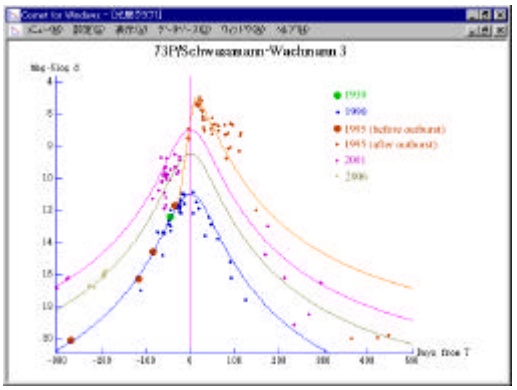
Comparing to the 1994 appearance, the trend of brightening and fading did not change, but the brightness was decreased by 0.5 mag. It may be a effect of a long term fading.

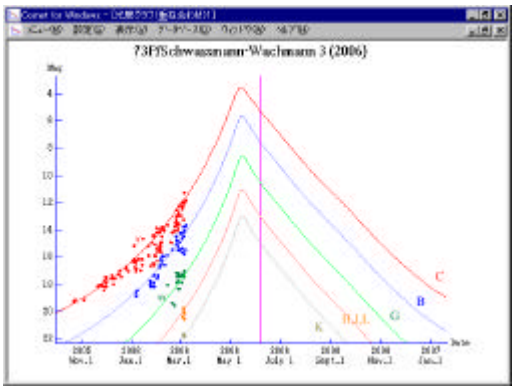
Some apparent features, typical features to bright periodic comets, are observed on this comet as follows.

- Strongly condensed when brightening.
- Cometary when brightest.
- Diffuse when fading.

Very large difference of the brightness change was found between visual observations and CCD total magnitude observations. From April to June, the comet brightened from 11.6 mag up to 9.8 mag visually. However, the CCD total magnitude had been almost constant as 11.1-11.9 mag at the same time. The difference was found based on the observations in good condition, so it will throw a discussion theme on CCD total magnitude measurements.

3-2. 73P/Schwassmann-Wachmann 3





The left side graph represents the long term change of the main component of the comet.

The absolute brightness changed as follows. The brightening effect of the outburst still remains.

Date	Absolute Mag.	Difference from Pre-Outburst Mag.
Pre-Outburst	11.5	
1995	5.5	-6
2001	7.5	-4
2006	9.0	-2.5

The right side graph represents the brightness of every component observed in this appearance.

The absolute brightness of every component is as follows. Even the component B is as bright as the comet itself before the outburst.

Component	Absolute Mag.	Difference from Pre-Outburst Mag.
C	9.0	-2.5
B	11.5	+/-0
G	14.5	+3

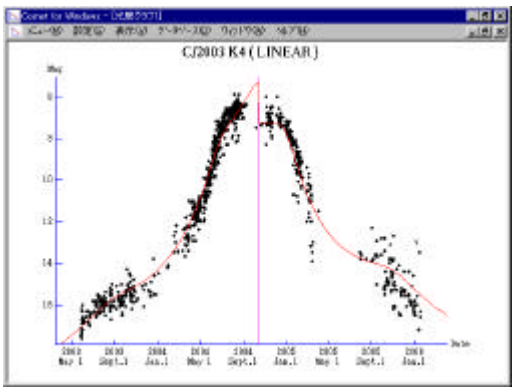
This comet brightens and fades rapidly along a 18 log r formula. This trend did not change after the outburst. And this trend seems common among all components.

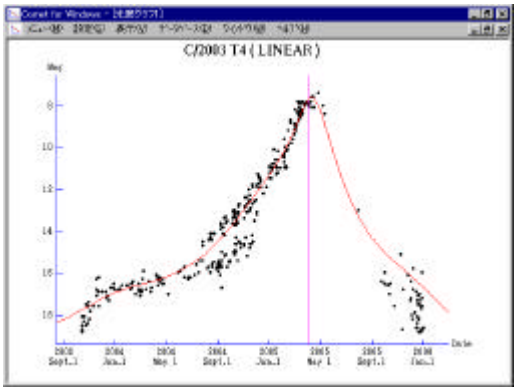
4. Visual New Comets

4-1. C/2003 K4 (LINEAR)

The fading was slow and it had been visible bright as 12-13 mag still in autumn. The comet had been visible visually for two years.

The brightening before the perihelion passage was rapid along a 12 log r formula. On the other hand, the fading after the perihelion passage was slow along a 8 log r formula.





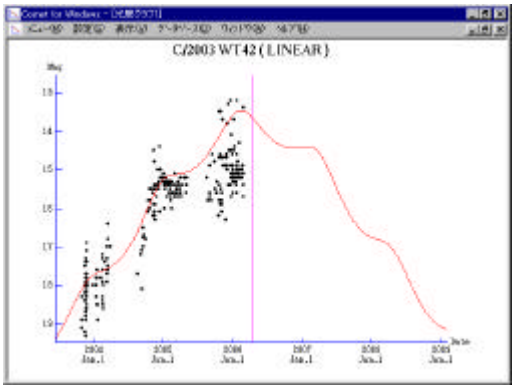
4-2. C/2003 T4 (LINEAR)

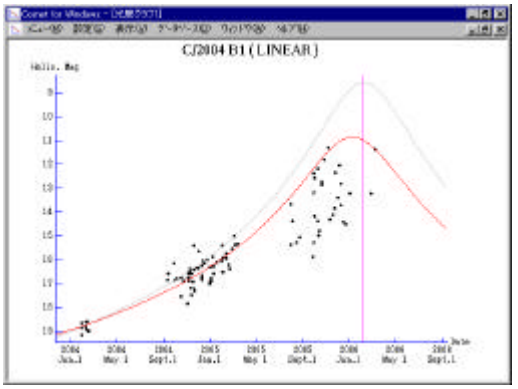
The brightening before the perihelion passage was slow along a 7 log r formula. On the other hand, the fading after the perihelion passage was usual along a 10 log r formula.

4-3. C/2003 WT42 (LINEAR)

It brightened rapidly along a 17.5 log r formula. The absolute brightness is so bright as -2.3 mag.

The perihelion distance of this comet is farther than 5 A.U. It is uncertain why the comet brightened so rapidly in spite of the distant location.





4-4. C/2004 B1 (LINEAR)

The graph represents the brightness change with a heliocentric brightness, corrected magnitude as observed on the Sun, in the vertical axis. The gray curve represents a light curve of a typical comet.

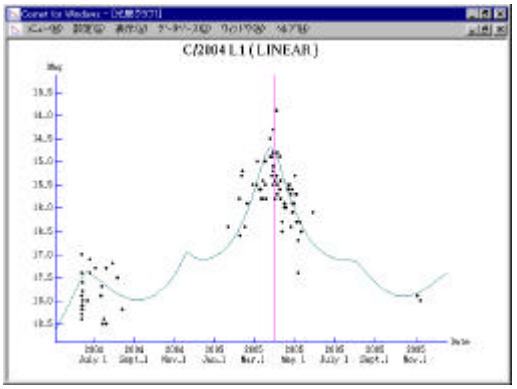
Actually, the brightness evolution was very slow. In addition, it started fading about 50 days before the perihelion passage. The magnitude formula is calculated as follows.

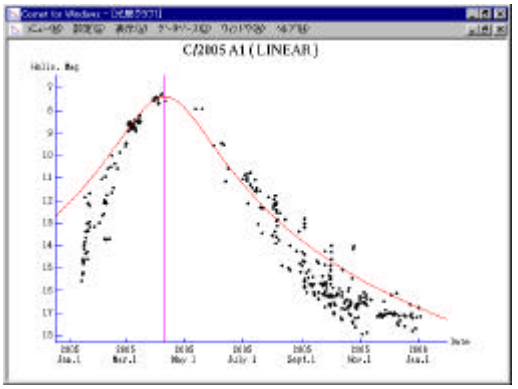
$$m1 = 8.3 + 5 \log \text{delta} + 7.0 \log r(t + 50)$$

4-5. C/2004 L1 (LINEAR)

The brightness evolution was very slow. The green curve in the graph represents the light curve of an asteroid with H = 12 mag.

It looks cometary with a tail, however, it can be classified as an asteroid if only based on the light curve.





4-6. C/2005 A1 (LINEAR)

The graph represents the brightness change with a heliocentric brightness, corrected magnitude as observed on the Sun, in the vertical axis. The brightening before the perihelion passage was somewhat rapid along a 12.5 log r formula. On the other hand, the fading after the perihelion passage was somewhat slow along a 8.5 log r formula.

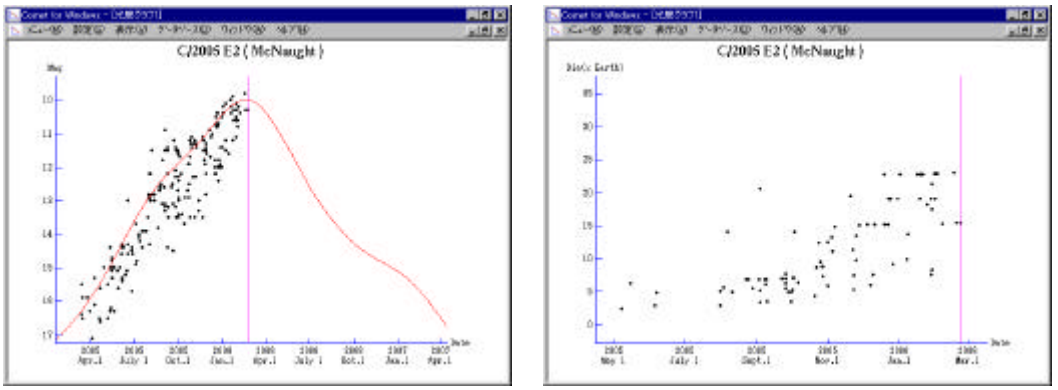
The total brightness change can be also expressed by an average formula as follows. But

the actual observed brightness shows a 1 mag slow variation around this average formula.

$$m1 = 8.0 + 5 \log \text{delta} + 10 \log r$$

A nuclear split was observed and the fragment had been observed stably for several months. The influence of the release of a big fragment is uncertain.

4-7. C/2005 E2 (McNaught)



The light curve is typical as follows.

$$m1 = 6.4 + 5 \log \text{delta} + 10 \log r$$

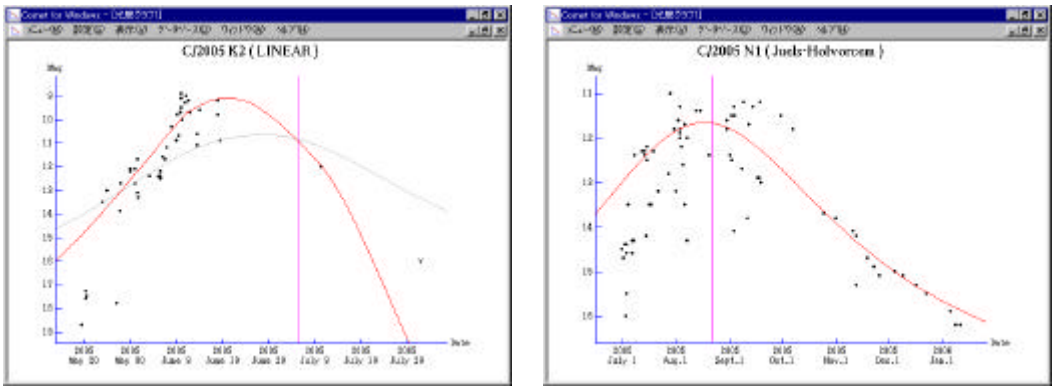
The right side graph represents the coma size change, plotting the actual coma size as a multiple against the Earth diameter. The coma size started being enlarged after late October, when the heliocentric distance was 2.3 A.U.

4-8. C/2005 K2 (LINEAR)

This is a typical small comet which cannot survive the perihelion passage, with a small perihelion distance (0.54 A.U.) and the faint absolute magnitude (13.5 mag). The abnormal very fast brightening when approaching to the Sun is also a common phenomenon found on such a comet.

A nuclear split was observed, but the fast brightening was not directly caused by the nuclear split. Irregular brightness variation was also observed.

It started declining about 24 days before the perihelion passage. It was still surviving 5 days after the perihelion passage, but it had been already disrupted 22 days after the perihelion passage.



4-9. C/2005 N1 (Juels-Holvorcem)

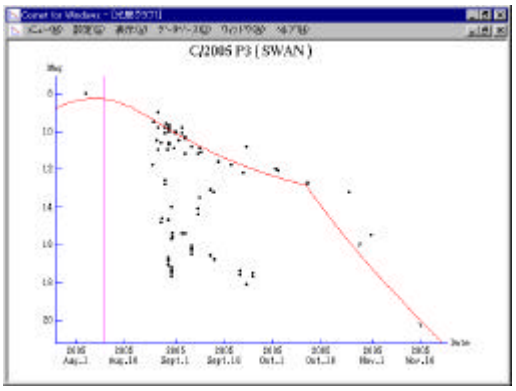
The magnitude formula is as follows. The fading was slightly faster than a typical comet.

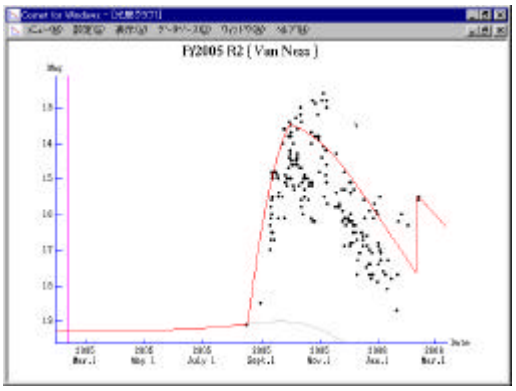
$$m1 = 10.0 + 5 \log \Delta + 11 \log r$$

4-10. C/2005 P3 (SWAN)

It had been extremely diffuse and fading rapidly, so it is a typical long periodic comet which brightens rapidly when approaching to the Sun.

The brightness difference between visual observations and CCD observations was extremely large. In September, the brightness difference was 6 mag or more. In October, it was still bright as 12-13 mag visually, however, it was almost too faint to measure by CCD observations. In November, it was reported as fainter than 20 mag. This comet is an extremely tiny comet with a nuclear absolute magnitude of 18 mag or fainter.



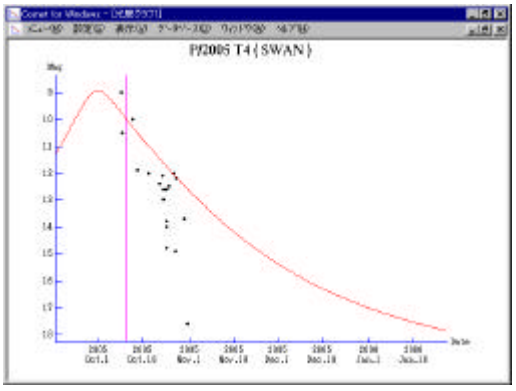


4-11. P/2005 R2 (Van Ness)

It moves along a cyclic orbit farther than 2 A.U. But it brightened 6 mag or more by an outburst.

Another small outburst was observed in 2006 February.

4-12. P/2005 T4 (SWAN)



Again, the brightness difference between visual observations and CCD observations was extremely large. It faded very rapidly and it was not observed in 2006.

This comet is also a typical long periodic comet which brightens rapidly when approaching to the Sun.

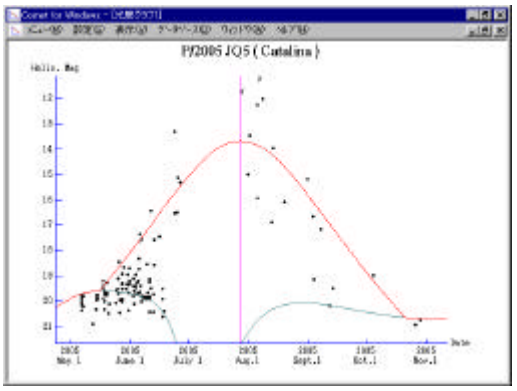
5. New Periodic Comets

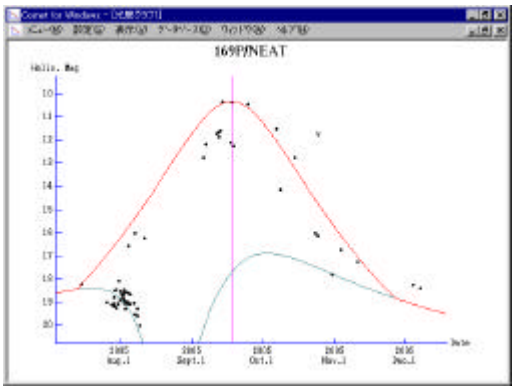
5-1. P/2005 JQ5 (Catalina)

The graph represents the brightness change with a heliocentric brightness, corrected magnitude as observed on the Sun, in the vertical axis.

This comet is a typical Near Earth Object with a very short period of 4.4 years. It approached only down to 0.10 A.U. to the Earth in June.

It brightened and faded very rapidly along a 23 log r formula around the perihelion passage. But it looked asteroidal in the distant location. The cometary activity was switched on at the heliocentric distance of 1.35 A.U. or farther. By the way, the turning point is farther than 1.8 A.U. in the case of Comet 2P/Encke or Comet 55P/Tempel-Tuttle.





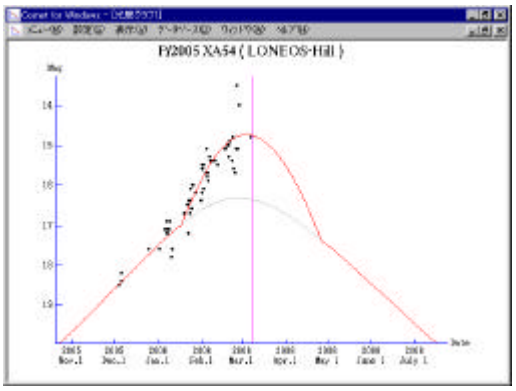
5-2. 169P/2002 EX12 (NEAT)

The graph represents the brightness change with a heliocentric brightness, corrected magnitude as observed on the Sun, in the vertical axis.

This comet is a typical Near Earth Object with a very short period of 4.2 years. It approached only down to 0.15 A.U. to the Earth in August.

It brightened and faded very rapidly along a 20 log r formula around the perihelion passage. But it looked asteroidal in the distant location. The cometary activity was switched on at the heliocentric distance of 1.25 A.U. or farther. By the way, the turning point is farther than 1.8 A.U. in the case of Comet 2P/Encke or Comet 55P/Tempel-Tuttle.

5-3. P/2005 XA54 (LONEOS-Hill)



This comet also brightened and faded rapidly around the perihelion passage. But this is not a Near Earth Object. The perihelion distance is far as 1.8 A.U.

This comet did not get diffuse after brightening. The brightness evolution was somewhat rapid along a 14 log r formula even in the distant location. So it seems to be a typical distant periodic comet which brightens rapidly around the perihelion, such as Comet 118P/Shoemaker-Levy 4 with a perihelion distance of 2.0 A.U.

5-4. Other New Periodic Comets with Rapid Brightness Evolution

Following new periodic comets were discovered.

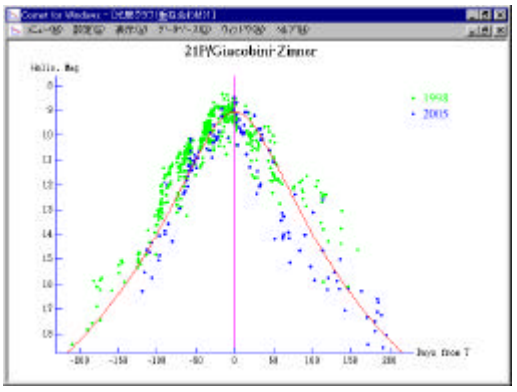
Comet	Magnitude Formula
P/2004 VR8 (LONEOS)	25 log r
P/2005 K3 (McNaught)	14 log r
P/2005 N3 (Larson)	45 log r

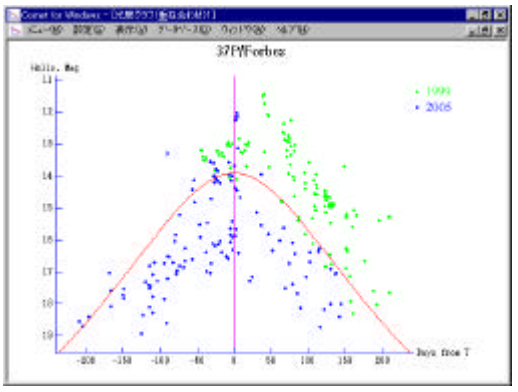
6. Returning Periodic Comets

6-1. 21P/Giacobini-Zinner

The graph represents the brightness change with a heliocentric brightness, corrected magnitude as observed on the Sun, in the vertical axis, and with the days from the perihelion passage in the horizontal axis.

The trend of the light curve differs from its previous appearance in 1998. In its previous appearance, it became brightest about two weeks before the perihelion passage. But in this appearance, it became brightest at the perihelion passage.





6-2. 37P/Forbes

The graph represents the brightness change with a heliocentric brightness, corrected magnitude as observed on the Sun, in the vertical axis, and with the days from the perihelion passage in the horizontal axis.

It became fainter than its previous appearance by 1-2 mag. One of the reason is the increase of the perihelion distance from 1.45 A.U. to 1.57 A.U.

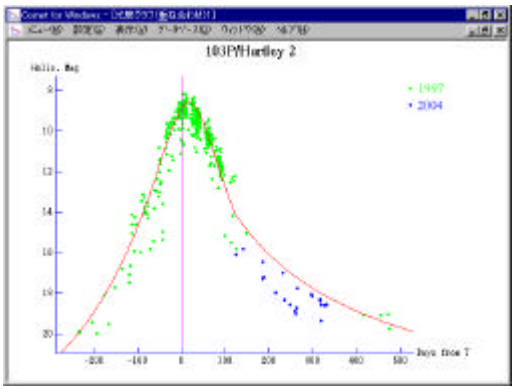
6-3. 103P/Hartley 2

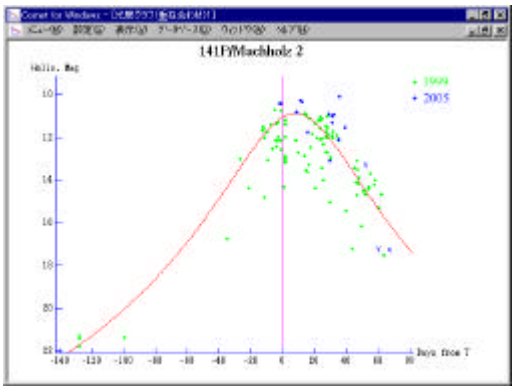
The graph represents the brightness change with a heliocentric brightness, corrected magnitude as observed on the Sun, in the vertical axis, and with the days from the perihelion passage in the horizontal axis.

The lack of the observations in its previous appearance in 1997 was covered by the recent observations, and the whole light curve was revealed. The light curve of this comet is summarized as follows.

- It starts brightening rapidly about half a year before the perihelion passage. It keeps very faint before that.
- It becomes brightest about three weeks after the perihelion passage.
- After the maximum brightness, it fades rapidly for about 100 days.
- Then the fading pace turns to be slow, and it keeps observable while fading gradually along a 10 log r formula.

In 2010, the condition will be excellent and it will reach to 4.5-5 mag.



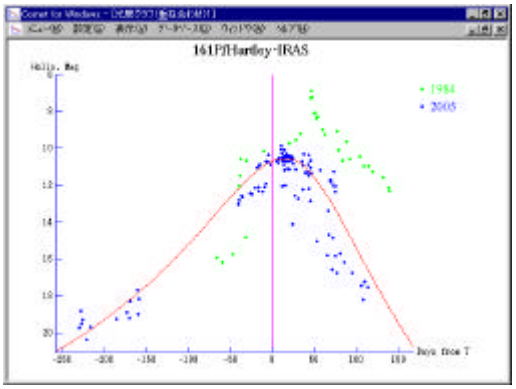


6-4. 141P/Machholz 2

The graph represents the brightness change with a heliocentric brightness, corrected magnitude as observed on the Sun, in the vertical axis, and with the days from the perihelion passage in the horizontal axis.

It was observed as bright as its previous appearance. The reason why it suddenly became hard to detect is probably because it located extremely low.

6-5. 161P/2004 V2 (Hartley-IRAS)



The graph represents the brightness change with a heliocentric brightness, corrected magnitude as observed on the Sun, in the vertical axis, and with the days from the perihelion passage in the horizontal axis.

Comparing to its previous appearance at the discovery, there are some features similar to that time, and some features very different from that time.

The features similar to its previous appearance at the discovery are as follows.

- Rapid brightening and fading, along a 18.5-19.5 log r formula.
- Trend to become brightest after the perihelion passage.
- Brightness at the perihelion passage.

The features very different from its previous appearance at the discovery are as follows.

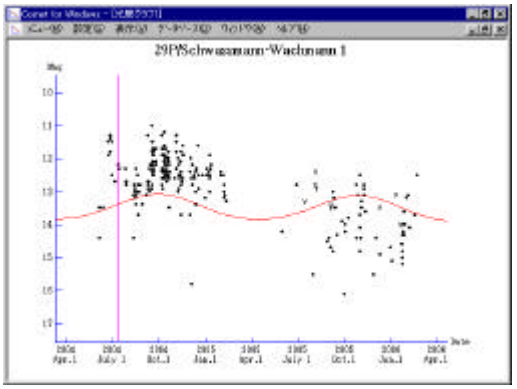
- Time to become brightest.
  - In 1984, it became brightest 45 days after the perihelion passage. In 2005, it became brightest 20 days after the perihelion passage.
- Brightening after the perihelion passage.
  - In 1984, it brightened after the perihelion passage by 3 mag. In 2005, it did not brighten furthermore after the perihelion passage.
- Fading after the maximum brightness.
  - In 1984, it faded along a 18.5 log r formula. In 2005, it faded very rapidly along a 35 log r formula.

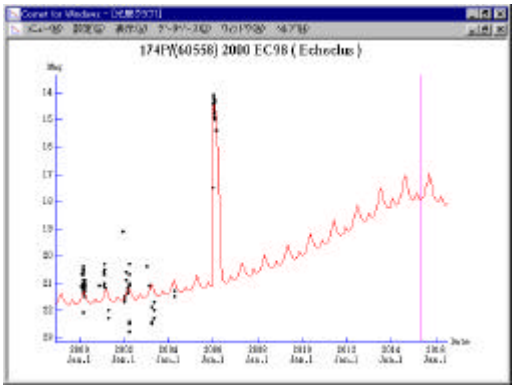
These results suggest that the brightening at the discovery was an unusual outburst.

7. Other Periodic Comets

7-1. 29P/Schwassmann-Wachmann 1

It had been bright in 2004, however, it had been faint in 2005.





7-2. 174P/(60558) 2000 EC98 (Echeclus)

It had been regarded as a very faint, fainter than 21 mag, asteroid until 2004. However, between the end of 2005 and early 2006, it turned to be a 14.5 mag comet.

It was farther than 13 A.U., but visible visually as a round diffuse object like a planetary nebula.

The astrometry of this comet was very hard even using CCD cameras, probably because the nucleus was still fainter than 21 mag even in the outburst.

The reason of the outburst is uncertain. It is uncertain whether any similarity exists between Comet 29P/Schwassmann-Wachmann 1 which repeats outbursts even locating farther than 5 A.U.

This comet was very diffuse, but the difference between the visual observations and CCD observations was very small.