Asteroids, Comets, Meteors 1991, pp. 121–124
Lunar and Planetary Institute, Houston, 1992

INFLUENCE OF SOLAR ACTIVITY UPON LIGHT CURVES OF COMETS P/HALLEY (1986 III) AND P/CHURYUMOV-GERASIMENKO (1982 VIII)

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ABSTRACT

It is shown that the comet P/Halley's (1986 III) total magnitudes correlate with changes in the solar activity indices and the solar wind velocity. A statistically reliable correlation between the outbursts of brightness and magnitude variations of the short-period comet Churyumov-Gerasimenko (1982 VIII) and the level of the solar activity has been found out.

INTRODUCTION

The dependence of cometary brightness from the level of solar activity was first obtained at the beginning of the 19th century. But despite a long, over a hundred-and-a-half-year history of such observations the mechanism of the Sun-comets relationship remains unknown.The situation is complicated by that that statistically cometary brightness is tied with a solar cycle phase, and for some comets variations of brightness do not well correlate with solar activity. Along with comets whose activity is closely connected with solar activity, there are comets that show such a link does not exist.

P/HALLEY (1986 III) AND SOLAR ACTIVITY

S.V.Orlov (1923) when analyzing observations of P/Halley (1910 II), obtained in 1909/1910, found out a distinctly observable connection between the comet's photometric nucleus magnitudes and the Wolf numbers. The comet's integral magnitudes appeared independent from the Wolf numbers. It was of interest to check this conclusion on new numerous observation data obtained in the framework of the IHW (more than 10000 estimates of P/Halley total magnitudes). In the present paper in order to compare variations of the comet's magnitudes with the solar activity the authors (1987) used a detailed light curve (over 5000 estimates of magnitudes) that covers the period July,1985 - June,1986. Taking into account that a correct comparison of the comet activity and solar activity may be obtained if the temporal shift, because of differences in the heliographical longitudes of the Earth and the comet does not exceed 4 days, there are two respective intervals on P/Halley's light curve: 1)October 15 -Dec.29,1985 (the comet's heliographical latitude was changing throughout this period from -3° to $+7^{\circ}$) and 2)(March 15 - 28,1986 (the comet's heliographical latitude - from -3° to -13°).

The spots square during the first period of observations does not exceed 900 millionth of visible hemisphere and during some periods it was approaching zero. The comet's strong outburst with the maximum October 29-30,1985 and its amplitude with more than 2^m coincides with the highest maximum of the solar spot-formation activity. Attention is drawn to the deep minimums on the light curve that correlate with the solar minimal activity (Filonenko, Churyumov, 1990). The comet's magnitudes minimums interval (25-27 days) is close to the Sun's rotation synodic period.

The character of the comet's flattened light curve corresponds the character of changes of the solar indices. In order to obtain quantitative estimates of the degree of the correlation between the comet activity and the solar activity Dobrovol'sky's method (1966) was applied. The 10-day average amplitude of the comet's brightness declination increases with the growing total spot area (S), with the linear correlation coefficient $R=0.62\pm0.22$ The coupling coefficient $K_{sm}=1$ by $D=5.7$ shows that the total spot area maximum is always followed by the comet's brightness maximum. But the correlation coefficient calculated by Dobrovol'sky's method is low - $R_{ms}=0.32\pm0.14$. This is probably connected with that that under low solar activity such indices as the spot area or those of calcium floccules cannot fully explain how the solar activity could influence the comet. The overlapping upon the flattened authors light curve quaziperiodic variations in the visual comet's brightness of a small amplitude (0.2^m-0.3^m) with a specific time scale between 7-8-day maximums and those blurring the correlation coefficient are, probably, the consequence of the comet's encounter with velocity waves in the solar wind (Ptitsyna et al.,1987).During the second interval the solar activity became even more low and that fact determined the character of the connection in question. For a month, March 15 - April 14, 1986, the solar activity was rather low and the rate of decrease in the comet's brightness became substantial. The increase in the solar spot-formation activity during the next four nights firstly slowed down the rate of decrease in the comet's brightness, though later it led to its growth. The comparison of the comet's light curve with the changing solar wind velocity in the former's periphery,measured by Vega-1 space probe,points to the existence of a reliable dependence with the correlation coefficient 0.71 ± 0.13 (see Fig.).

COMET P/CHURYUMOV-GERASIMENKO (1982 VIII) AND SOLAR ACTIVITY

The short-period comet Churyumov-Gerasimenko was discovered in 1969. But the conditions for observing it in 1969/1970 and in 1975/1976 apparitions were rather unfavourable. Because of this the comet's photometric behaviour remained practically unknown. Only during the comet's apparition in 1982/1981 great observation data (more 330 magnitude estimates) were obtained that made it possible to construct a detailed comet's light curve and to thoroughly study its peculiarities (Churyumov,Filonenko,1989a;1989b).

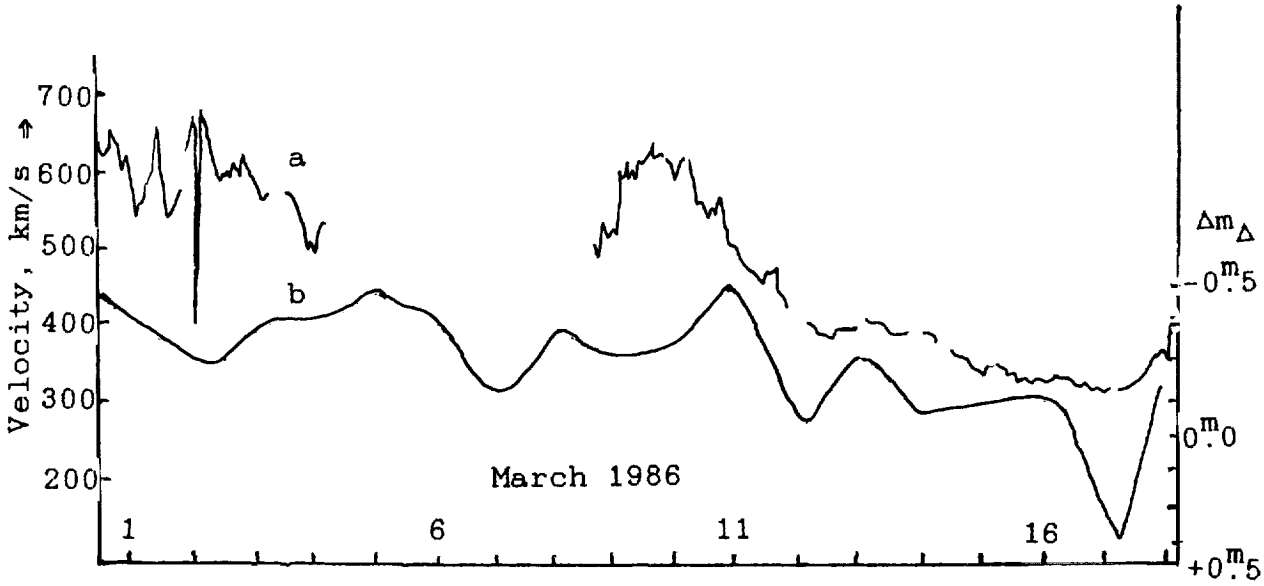

Fig. Changes of Δm_Δ (the declination of the total heliocentric magnitude from the minimal theoretical light curve (b)*) and the velocity of the solar wind (a). Note: * - the photometric parameters H_y and n from the Orlov's formula $m_\Delta = H_y + 2.5n\log r$ were calculated by the Filonenko's method (1987).

The comet was active, and during of six-months observations (late August,1982 - early March,1983) it had numerous outbursts (more 16) and variations of its integral magnitudes. At that time the mutual space dislocation of the Earth, the Sun and the comet during the whole period of observations was exceptionally favourable from the point of view of the study of the solar activity influence upon the comet's light curve (Filonenko, Churyumov,1990). A temporal shift preconditioned by the difference in the heliographical longitudes of the Earth and the comet did not exceed 2.3 of a day, and during October 25,1982 - February 5,1983 it was less than one day.The solar activity, visible from the Earth, when observed from the comet, changed insubstantially. The solar activity during the observation period was situated on the decrease branch of the 11-year solar activity cycle when most stable highspeed corpuscular streams were being formed. The comparison of P/Churyumov-Gerasimenko's light curve and the curve of the solar activity indices changes that are reduced to the comet's centre shows that the variations of the comet's brightness rather well correlate with the changes of the solar indices. Values of R, K and D are given in Table. It is evident that the correlation between the comet's brightness maximums and those of the solar activity indices is statistically meaningful and indicates that the growing spot total area increases the probability of the growth in the comet's brightness, but an increase in m_Δ may not be accompanied by an increase of S. The analogous connection with the Wolf numbers is less obvious and the maximum m_Δ. with more probability is accompanied by the maximum W than by the maximum W by the brightness maximum.

Table. Values of R, K and D.

The comparable values	R	K	D
m_Δ , W	0.51 ± 0.09	0.72	4.1
W, m_Δ		0.58	3.3
m_Δ, S	0.51 ± 0.09	0.46	2.5
S , m_Δ		0.79	4.6

Notes. m_Δ is the total heliocentric magnitude of the comet, W is Wolf number, S - total spot area, D - probability of an occasional apparition of the value K not equal 0.

CONCLUSIONS

1. It is shown that the total magnitude variations of comet P/Halley (1986 III) correlate with changes of the solar activity indices and the solar wind velocity.

2. A statistically reliable correlation between the P/Churyumov-Gerasimenko (1982 VIII) outbursts and variations in its total magnitudes with such solar activity indices as the total spot areas and the Wolf numbers has been found out.

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