

SOME PECULIARITIES OF SOLAR ACTIVITY INFLUENCE ON PHOTOMETRICAL BEHAVIOR OF COMETS.

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Introduction: The first indications of a relationship between comet brightness and the level of solar activity were found near the beginning of the 19th century. But despite more than one and a half centuries of investigation, the mechanism of solar-comet interactions remains as yet unknown. The situation is complicated by the fact that although comet brightness is in general correlated with the phase of the solar 11-year cycle, the brightness variations of individual comets are not sufficiently well correlated with solar activity. Also, while the activity of some comets is closely coupled to solar activity, other comets are known that show no such connection (e.g., comets C/Timmers (1946 C1), C/Eclipse comet (1948 V1), C/Honda (1955 O1), etc.). Therefore, a study of the correlation of comet's brightness (especially for new comets) with solar activity is timely.

Influence of Solar Activity on the Light Curves of Some Comets: The effects of solar activity on the light curve of short-period comet Churyumov-Gerasimenko (now this comet is a target for ROSETTA space mission) we investigated for the first time. A statistically significant correlation between outbursts and integrated magnitude variations of this comet with solar activity indices has been discovered [1, 2].

The extensive observational data, including measurements by the VEGA 1 spacecraft we used to show that solar activity substantial affects the integrated magnitude of comet Halley [1, 2]. This our result does not agree with the early conclusions of S. Orlov [3].

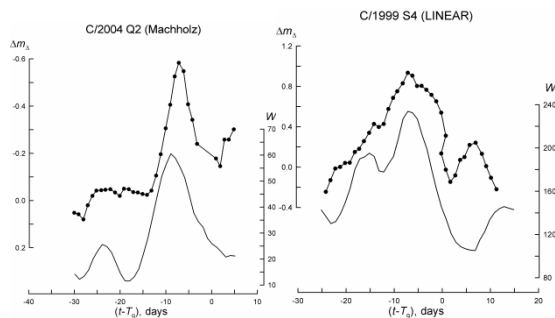


Fig. 1. Comparison of brightness variations for comets C/2004 Q2 and C/1999 S4 with variations of Wolf numbers.

On the basis of more than 10.5 thousand estimations of integrated brightness we constructed the light curves of six new comets: C/1999 S4

(LINEAR), C/2001 Q4 (NEAT), C/2002 T7 (LINEAR), C/2002 V1 (NEAT), C/2004 Q2 (Machholz) and 153P/2002 C1 (Ikeya-Zhang) [4]. For all comets the brightness variations good correspond to the level of solar activity (Fig.1, for example). But the comets are divided into two groups: 1) for comets C/2001 Q4 (NEAT), C/2002 V1 (NEAT) and C/2004 Q2 (Machholz) the maxima of Wolf numbers correspond to the *maxima* (outbursts) of brightness, and 2) for comets C/1999 S4 (LINEAR), C/2002 T7 (LINEAR) and 153P/2002 C1 (Ikeya-Zhang) the maxima of Wolf numbers correspond to the *minima* of brightness. The correlation coefficients, calculated by Dobrovol'sky's method [5], are presented at the last column of Tab. 1. As can see, the correlations are significant for all comets.

Table 1. Dobrovol'sky's correlation coefficients

Comet	Observational period	Correlation coefficient
C/1999 S4	2.11.1999 - 16.12.1999	0.84 ± 0.10 (for maxima brightness)
	11.07.2000 - 1.08.2000	0.80 ± 0.13 (for maxima brightness)
C/2001 Q4	13.09.2003 - 17.11.2003	1 (for minima brightness)
	21.03.2004 - 10.06.2004	0.62 ± 0.15 (for maxima brightness)
	20.10.2004 - 1.12.2004	1 (for maxima brightness)
C/2002 T7	1.11.2003 - 19.12.2003	0.8 ± 0.1 (for maxima brightness)
	6.05.2004 - 1.06.2004	1 (for minima brightness)
C/2002 V1	29.11.2002 - 25.12.2002	0.67 ± 0.25 (for maxima brightness)
C/2004 Q2	25.08.2004 - 6.06.2005	0.75 ± 0.07 (for maxima brightness)
153P/2002 C1	18.03.2002 - 5.08.2002	0.84 ± 0.06 (for minima brightness)

In Fig. 2 the dependence of averaged values of cometary brightness with Wolf numbers are presented for comets C/2002 V1 (NEAT) and C/2004 Q2 (Machholz). For other comets these dependences are the same. So for all explored comets the cometary brightness is increased with solar activity when the Wolf numbers are increased from ~ 40 to ~ 120; when Wolf numbers are less or more than these values the cometary brightness is decreased with increment of solar activity.

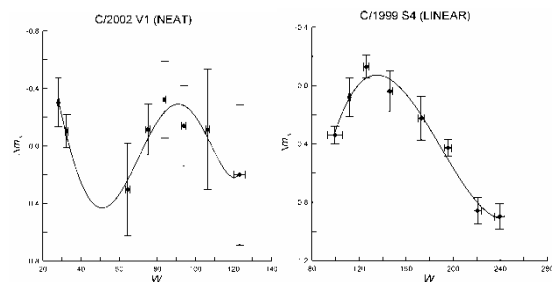


Fig. 2. Dependence of averaged values of brightness for comets C/2002 V1 and C/2004 Q2 with Wolf numbers.

Influence of Secular 90-year Solar Cycle on the Brightness Secular Variations of Short-period Comets: We explored the secular variations of 17 short-period comets [6]. For all these comets the normalized deviations of absolute magnitude had been calculated:

$$\Delta H_{10} = (H_{10}^i - \overline{H_{10}}) / A,$$

where H_{10}^i is the comet's absolute magnitude in i appearance, $\overline{H_{10}}$ is mean magnitude calculated from all comet's appearances, A is amplitude of comet's secular variations. A dependence of values ΔH_{10} , averaged from 10 points for all 17 comets, with a phase of Gleissberg solar cycle is presented in Fig. 3. This phase had been calculated as:

$$\Phi = \frac{t - T_0}{T},$$

where t is the moment of comet's appearance, T_0 is the moment of previous maximum of Gleissberg cycle, T is the length of the respective Gleissberg solar cycle (the yearly average Wolf numbers were smoothed by Gleissberg's method [7]). This dependence had been approximated by sinusoid:

$$\Delta H_{10} = [\sin(1.95\pi\Phi + 2.3)] / 3.5$$

with correlation coefficient $R = 0.81 \pm 0.07$ ($R_{\text{crit}}(0.05) = 0.41$).

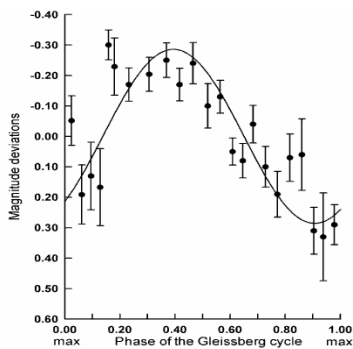


Fig.3. Dependence of ΔH_{10} with phase of the Gleissberg cycle.

This phenomenon can explain the observational fact that the secular fading of short-period comets is not a monotone.

References: [1] Churyumov K., and Filonenko V. (1991) *Pis'ma Astron. Zh.* 17, 1135-1142. [2] Churyumov K., and Filonenko V. (1992) *ACM*, 121-124. [3] Orlov S. (1923) *Trans. Astron. Observ. of Yur'evskii Inst.* 21, 3. [4] Churyumov K. et al. (2008) *Kinematics and Physics of Celestial Bodies* 24, 146-154. [5] Dobrovol'sky O. (1966) *Comets*, Moscow: Nauka. [6] Filonenko V. (2006) *LPS XXXVII*, Abstract #1597. [7] Gleissberg W. (1967) *Solar Physics*, 2, 231.