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BEYER'S METHOD OF COMETARY BRIGHTNESS DISPERSION AS A CRITERION OF COMETARY ACTIVITY

BEYEROVA METODA DISPERSE JASNOSTÍ KOMET JAKO KRITÉRIUM KOMETÁRNÍ AKTIVITY

МЕТОД ДИСПЕРСИИ ЯРКОСТЕЙ КОМЕТ БЕЙЕРА — КРИТЕРИЙ КОМЕТНОЙ АКТИВНОСТИ

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Within the interval from 1932 till 1953 Beyer [1] was constructing the photometrical curves of 43 comets on the basis of his measurements of the total brightness of the comet head. The treatment of the material was carried out in the standard manner, i. e. by determining the photometrical parameters H_0 and n. The departures of the individual measurements from the smoothed-out straight line are considered by Beyer the product of the activity of a comet, and the average of their absolute values gives its certain characteristic.

An undisputed advantage of this method is the fact that all the observations were carried out by the same author and in the same way. On the other hand, this method has several disadvantages which may be summarized as follows:

(a) from the papers dealing with the dust-gas model of a comet [2, 3, 4, 5, 6] and with the statistics of the photometrical exponents [3, 4, 6, 7] it follows beyond any doubt that the photometrical exponent of any comet is a fuction of heliocentric distance. Since Beyer considers the exponent to be constant, the average dispersion Δm will change; this alternation will be different for various comets because the photometrical exponent depends also on the intensity ratio between the dust and gas constituents, and on the type of gas present in a cometary head;

(b) various comets react in a different way on the variation of solar activity (Schwassmann-Wachmann 1 as against a range of absolutely faint comets). There are even instances that the reaction of a certain comet on the change of solar activity differs at various periods. A typical example is the comet Whipple-Fedtke-Tevzadze 1942g [8]; prior to the perihelion passage (1942, December — 1943, February) the comet revealed considerable anomalies in the course of its brightness, while the sunspot number did not surpass 35 over the whole interval, no large sunspot group passed through the Sun's central meridian in the direction towards the comet, and the efficiency of chromospherical flares in the same direction exceeded the value of 100 only once on the other hand, after the perihelion passage (1943, February — 1943, May), the fluctuations of the comet brightness were much smaller, though the amplitude of the sunspot number variation amounted to about 70, 14 large sunspot groups went through the Sun-comet meridian, and the efficiency of flares once exceeded 200 and several times reached values over 100. The effects of this character seem to occur especially in the absolutely bright comets;

(c) the variation in the limpidness of the Earth's atmosphere may considerably affect the observed brightness dispersion, especially if it has a systematic course (see the co-called subjective factor [9]);

(d) an undetermined part of the resulting dispersion is produced by incidental departures; to give their influence on the value of the average dispersion is a quite insolvable problem.

Each of the given disadvantages of the method is the more prominent, the less abundant and homogeneous the material used.

When investigating the course of the average brightness dispersion Δm during the solar cycle, the differences between the reactions of various comets on the solar radiation variation represent the greatest obstacle. Therefore the investigation of the only, as far as possible absolutely faint comet must be relatively the most successful [10]. The same dependence may be statistically studied on the basis of the representative material, i. e. of that including a few hundred of comets at least. Such material, however, is not readily accessible.

So far, the material of the brightness dispersion, obtained by Beyer, has been treated in two ways:

(a) its dependence on the sunspot number dispersion, ε_R (Beyer [1]);

(b) its dependence on the phase of the solar cycle, Φ (Dobrovolsky [11]).

The results of Beyer's study show a certain course of the increase of the average dispersion Δm with increasing dispersion ε_R, some of the studied comets, however, are beyond this dependence so that the resulting correlation coefficient amounts to:

$$\psi[\Delta m, \varepsilon_R] = +0.32 \pm 0.09 \text{ (p. e.)}.$$

In his paper Dobrovolsky asserts that these "special" comets are not the exception, but the token of the double-wave in the Δm-course during the eleven-year cycle; according to Dobrovolsky, curve $\Delta m = \Delta m(\Phi)$ supports the form of the curve of comets discovered during the solar cycle (Tab. 1 of [11]). The dependence $\Delta m = \Delta m(\Phi)$, constructed by Dobrovolsky, gives indeed two maxima; however, the correlation coefficient between Δm and the number of discovered comets N, leads to the following rather unfavourable result:

$$\psi[\Delta m, N] = +0.04 \pm 0.10 \text{ (p. e.)}.$$

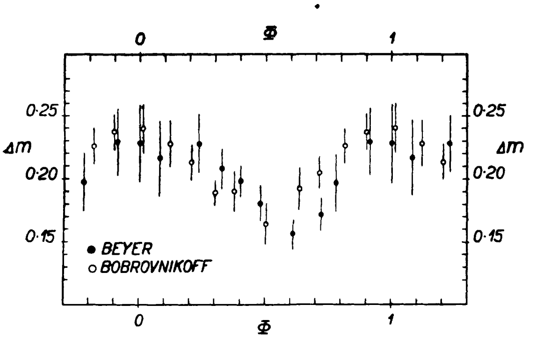

Fig. 1. Course of the cometary brightness estimations dispersion during the eleven-year solar cycle.

If we introduce into Beyer's above-mentioned statistics the results of his latest papers [12], we obtain the smoothed-out relation of $\Delta m = \Delta m(\Phi)$ in the form given in Fig. 1 by full circles. The maximum dispersion Δm coincides with the minimum solar activity,

Table 1

List of the brightness dispersions of 45 comets of Bobrovnikoff's observational series

comet	t	Δm m	R	Φ
1858 VI	1858.75	0.18	86	0.246
1861 II	1861.57	0.30	78	0.497
1862 III	1862.64	0.11	63	0.593
1874 III	1874.48	0.20	38	0.622
1881 III	1881.61	0.24	58	0.253
1884 I	1882.92	0.26	42	0.376
1886 II	1886.22	0.09	57	0.684
1886 IX	1886.91	0.31	6	0.749
1890 II	1890.81	0.49	11	0.100
1893 II	1893.57	0.20	89	0.328
1898 I	1898.33	0.36	20	0.721
1899 I	1899.34	0.21	11	0.805
1900 II	1900.65	0.15	4	0.913
1902 III	1902.81	0.12	16	0.093
1903 IV	1903.55	0.19	28	0.155
1904 I	1904.62	0.13	58	0.245
1906 VII	1906.92	0.03	52	0.439
1907 IV	1907.74	0.07	75	0.508
1908 III	1908.89	0.12	46	0.604
1910 II	1910.17	0.19	26	0.712
1911 II	1911.57	0.34	4	0.829
1911 V	1911.77	0.23	3	0.846
1911 VI	1911.80	0.20	3	0.849
1912 II	1912.91	0.30	4	0.942
1913 II	1913.40	0.34	0	0.983
1913 IV	1913.76	0.28	3	0.016
1913 VI	1913.78	0.23	3	0.018
1914 II	1914.42	0.15	8	0.082
1914 V	1914.67	0.24	10	0.107
1915 II	1915.56	0.22	72	0.196
1917 II	1917.41	0.15	115	0.381
1917 III	1917.50	0.27	117	0.390
1919 III	1919.70	0.22	55	0.610
1921 II	1921.34	0.15	27	0.774
1925 I	1925.40	0.21	43	0.176
1930 II	1930.03	0.13	65	0.630
1930 III	1930.32	0.21	38	0.659
1932 V	1932.69	0.24	4	0.891
1932 VI	1933.23	0.09	10	0.944
1932 X	1933.06	0.32	12	0.927
1935 I	1935.17	0.17	22	0.132
1936 II	1936.52	0.21	52	0.262
1937 II	1937.26	0.18	109	0.333
1937 IV	1937.41	0.26	124	0.347
1937 V	1937.60	0.11	138	0.365

while the minimum Δm occurs at about 0.2 of a cycle after the maximum of solar activity.

In 1941—1942 Bobrovnikoff [13] published a thorough study on the photometrical curves of 45 comets from 1858—1937. This study comprises a careful analysis of 4447 individual visual observations. Although the measurements were made by 160 observers the obtained results are considered reliable [14]. The average dispersions Δm determined for 45 comets investigated by Bobrovnikoff are listed in Tab. 1 of the present paper. The individual columns give the designation of the comet, the moment of the middle of the observations, the average dispersion Δm, the average sunspot number and the phase-shift of the middle of the observations referred to the preceding minimum of solar activity. The correlation coefficient

$$\psi[R, \Delta m] = -0.20 \pm 0.10 \text{ (p. e.)}$$

is again low, but it suggests the course of $\Delta m = \Delta m(\Phi)$ which is similar to that we found from Beyer's supplemented material. Fig. 1, in which the smoothed-out course of Δm from Bobrovnikoff's material is shown by open circles, proves it quite well. The agreement of both curves is excellent both in the phase-shift and in the amplitude and zero-point.

The cause of the ascertained course of the dispersion Δm cannot be determined at present; however, on the basis of a comparison of the forms of these curves with that of the Encke comet [10], and with respect to what has been said of Beyer's method in the present paper, it seems probable that the problem consists in the influence of a systematic effect inherent in the observational conditions.

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Souhrn

Dispersi pozorovaných jasností považuje Beyer za charakteristiku kometární aktivity. Výhody i nevýhody této metody jsou diskutovány v této práci a poukazuje se na to, že materiál v současné době dostupný nemůže být považován za representativní. To vysvětluje i vzájemně odlišné výsledky, k nimž dospěl Beyer, Dobrovolsky i autor tohoto článku. Tím více však je překvapující, že křivka dispersí jasností během slunečního cyklu stanovená z úplné Beyerovy řady pozorování se skvěle shoduje s analogickou křivkou řady Bobrovnikoffovy.

Резюме

Дисперсию наблюдаемого блеска кометы Бейер считает характеристикой кометной деятельности. Достоинства и недостатки этого метода дискутируются в настоящей работе и указывается на то, что материал доступный в настоящее время не может считаться репрезентативным. Это также объясняет взаимно отличающиеся результаты Бейера, Добровольского и автора. Тем более поразительное, что кривая дисперсий блеска комет в течение солнечного цикла определенная по материалу Бейера совпадает с той же кривой по материалу собранному Бобровниковым.