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Nonstationary activity of the nuclei of comets

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We studied the statistical regularities of splitting comets and formation their abnormal tails. The dependence of comet's nucleus splitting and abnormal tail formation on heliocentric and geocentric distances and orbital elements of comets were investigated. General regularities of these phenomena were revealed.

Keywords: Comets; Nucleus splitting; Abnormal tail

1 Introduction

Comets are extremely non-stationary objects; the forms of display of non-stationary activity of comets include brightness flashes, gas-dust jets, halos, heterogeneity in a plasma tail, the synchrone in a dust tail, the abnormal tail and comet nuclei splitting. The most catastrophic form of display of non-stationary activity of a comet is nuclei splitting. As a result of nuclei splitting of comets, meteoroid streams are formed or the comet disappears completely. Other kinds of similar activity of nucleus of comets are abnormal tails directed to the Sun. Such tails result from synchronous emission of meteoroid particles from a nucleus. The reasons and mechanisms of splitting of nuclei of comets, formation of an abnormal tail of comets are not always known. Often it is not possible to define exact times of an origin of these phenomena.

The purpose of the present work is to reveal from observations the general laws of splitting of nuclei of comets and formation of an abnormal tail of comets. To achieve the purpose we make two catalogues. The first catalogue includes comets at which nuclear splitting is registered or there are obvious signs of nuclear splitting, and is the continuation of similar catalogues of V.P. Konopleva (1967), V.A. Golubev (1975), O.V. Dobrovolsky and S.I. Gerasimenko (1987) and Kh.I. Ibadinov (1998). Our catalogue includes 98 comets like these. The second catalogue includes observations of 60 comets with abnormal tails. This catalogue significantly supplements A.A. Demenko's (1965) catalogue which included 16 comets. These catalogues will be separately published and on the basis of these catalogues we investigate the conditions of splitting of nucleus of comets and the formation of an abnormal tail. Dependence of these phenomena on heliocentric (r) and geocentric (Δ) distances of a comet at the moment of their registration, on an inclination of a plane of cometary orbit relative

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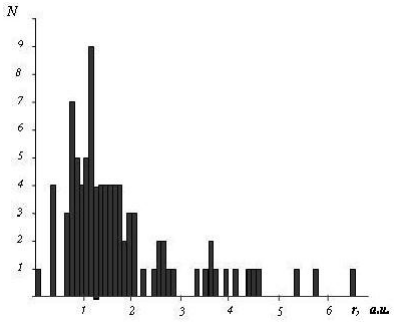

Figure 1 Dependence of number of comets N on heliocentric distance r.

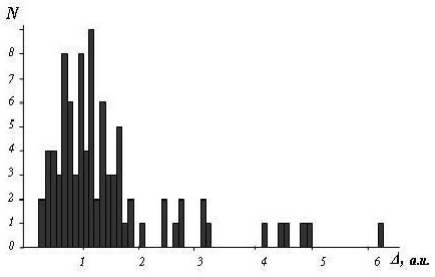

Figure 2 Dependence of number of comets N on geocentric distances Δ.

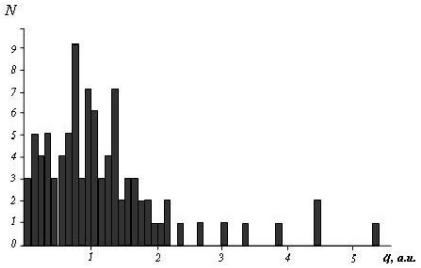

Figure 3 Dependence of number of comets N on perihelion orbit distances q.

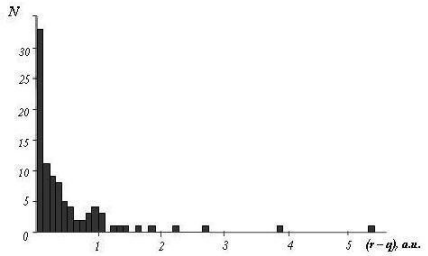

Figure 4 Dependence of number of comets N on $(r - q)$.

to the ecliptic plane (i), on perihelion distance (q)of comet orbits is studied. The dependences of density (the relation of number of splitting comets N and number of comets with abnormal tails to total number of comets N_t) these phenomena on r, Δ, i and q are studied. In this paper we will discuss only the basic results of statistical research of these phenomena.

Figures 1–3 are in the form of the histograms showing the dependences of number of splitting comets N on heliocentric r and geocentric distances Δ of comet at the moment of registration of splitting and dependence N on perihelion distances. Similar dependences for comets with abnormal tail are presented in Figs 5–7. It can be seen that the maximum number of nuclei splitting and abnormal tails of comets is located at the interval of heliocentric and geocentric distances 0.6–1.6 AU. It is most likely due to the visibility conditions of comets, i.e. near to the orbit of the Earth nuclei splitting and abnormal tail are observed in the best conditions rather than far from it. In Figs 1 and 7 the dependences of quantity of comets N with the splitting of nuclei and quantities of comets with an abnormal tail on distance of perihelion of orbits q are presented. Here we observe again maxima at 0.6–1.6 AU. In our opinion, this effect also is caused by conditions of observation of comets (affinity of perihelion to the Earth orbit).

The results presented in Figs 4 and 8 can throw light on the general laws and the most probable mechanisms of splitting nuclei of comets and formation of abnormal tail of comets. In Fig. 4 dependence of quantity of comets N on a difference between

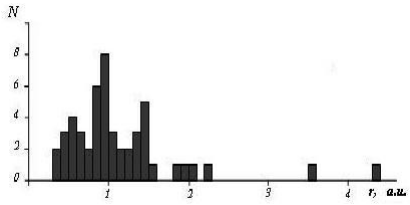

Figure 5 Dependence of number of comets N with an anti-tail on heliocentric distance r.

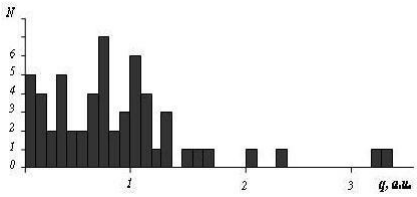

Figure 6 Dependence of number of comets N with an anti-tail on distance perihelion orbits q.

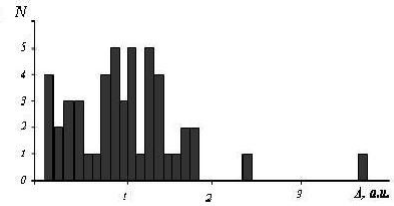

Figure 7 Dependence of number of comets N with an anti-tail on geocentric distances Δ.

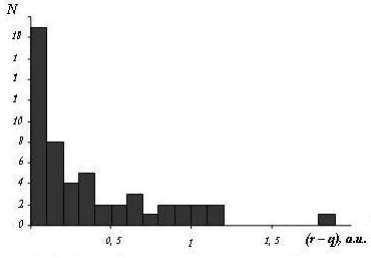

Figure 8 Dependence of number of comets N with an anti-tail on $(r - q)$.

heliocentric distance r of comet where nuclei split and perihelion distance of comet orbits q, i.e. $(r - q)$, is presented. It can be seen that the maximum is in the area of the perihelion $(r - q \approx 0)$. The result confirms Dobrovolsky's and Gerasimenko (1987) and Ibadinov (1998) conclusions that the maximum number of splitting of comets occurs on area of the perihelion. We have found almost similar result and for abnormal tail of comets. On Fig. 8 dependence of number of comets with abnormal tails on $(r - q)$ is presented. The maximum in distribution $N\,(r - q)$ is reached on $r - q \approx 0$, that is on area of the perihelion. Such law for nuclei splitting and for abnormal tails is clear and indicates strong influence from the Sun and the maximum inflow of a solar energy on a comet nucleus in perihelion area. In distribution N $(r,\ \Delta,\ q,\ (r - q))$ separate peaks on large distances are observed. Peaks are very accurately traced on an interval 3–5 AU. Here the influence of Jupiter is considerable. This group of comets includes also Hale–Bopp comet which has fragmented under the influence of perturbations of Jupiter. It is not excluded that collision of comets with asteroids and meteoroids takes place also.

From the statistical analysis of the facts of splitting nuclei of comets it is enough confidently established that the probability area of splitting is perihelion of orbits. For comets close approaching to the Sun and for comets approaching to Jupiter the probability of revealing of nuclei splitting is high, when the comet is on heliocentric and geocentric distances 0.6–1.6 AU. It is connected with conditions of visibility.

Conclusions

The catalogues of splitting nuclei and abnormal tails of comets are created. It is established that the probability of revealing the fact of nuclei splitting and formation of abnormal tail of comets is high on heliocentric and geocentric distances 0.6–1.6 AU. Probably, it is connected with conditions of observations and visibility of comets. The greatest number of occurrences of nuclei splitting and abnormal tail of comets are registered near to the Sun, in the area of perihelion of comet orbit. The most plausible reason for a nuclei splitting is tidal influence of the Sun and Jupiter and considerable inflow on a nucleus of solar beam energy. It is revealed that the abnormal comet tails are formed on the great distances from the Sun, between orbits of Mars and Jupiter.

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