Origin of Short-Perihelion Comets

A. S. Guliyev

Abstract New regularities for short-perihelion comets are found. Distant nodes of cometary orbits of Kreutz family are concentrated in a plane with ascending node 76° and inclination 267° at the distance from 2 up to 3 a.u. and in a very narrow interval of longitudes. There is a correlation dependence between q and cos I concerning the found plane (coefficient of correlation 0.41). Similar results are received regarding to cometary families of Meyer, Kracht and Marsden. Distant nodes of these comets are concentrated close three planes (their parameters are discussed in the article) and at distances 1.4; 0.5; 6 a.u. accordingly. It is concluded that these comet groups were formed as a result of collision of parent bodies with meteoric streams. One more group, consisting of 7 comets is identified. 5 comet pairs are selected among sungrazers.

Keywords short-perihelion comets · meteor streams · split comets

1 Kreutz Cometary Family

The Kreutz cometary family is quite a mysterious phenomenon in the solar system. The strength of this family, by rate of comets discovered during last years, might be estimated as tens of thousands. Hence, Kreutz comets form a singular belt around the Sun. Meanwhile, research on Kreutz comets, essentially, covers observation of individual objects of this class. This system is studied in insufficient detail. The reason for this is that the system is quite young and quickly replenishes.

There are some explanations concerning an origin of short-perihelion comets of the Kreutz family. However it is impossible to consider any of them as comprehensive one. It might be possible to consider conventionally that these comets are fragments one or several large proto-comet nucleus. The version about disintegration proves to be true even when some Kreutz comets sometimes break up to separate parts during astronomical observations.

We present and comment some new regularities of considered system in the present book. They were not known earlier. These regularities, in our opinion, might give a sufficient basis for revision of the discussed origin's mechanism concerning to Kreutz comets or bring essential updates in this mechanism, at least.

According of the catalogue by Marsden and Williams (2008) and Minor Planet Electronic Circulars for 2008-2009, the number of long-period comets with parameters close to values

$$q = 0.006a.e.;\ e = 1;\ \omega = 80°;\ \Omega = 0°;\ i = 144°$$

is equal to 1502 (as of early 2010).

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Primary viewing of Kreutz comets shows that their perihelions are not concentrated chaotically around a certain center. There is absolutely other way for the better description of perihelion distribution. Perihelion of comets are located along some arch of the celestial sphere. Before making comments on this feature of Kreutz comets, we have to make a substantiation of this assumption. If each point of perihelion with parameters (L_i, B_i) is present as a material point on a surface of a certain sphere, then coordinates (L, B) of the of inertia center of this sphere will be determined from expressions:

$$Nk \cos L \cos B = \Sigma \cos L_i \cos B_i$$
$$Nk \sin L \cos B = \Sigma \sin L_i \cos B_i$$
$$Nk \sin b = \Sigma \sin B_i \,,$$

where N and k are number of perihelion and level of inferred concentration, accordingly. Calculations for 1502 points give following values:

$$L = 282°.82;\ B = 35°.06;\ R = 0.992$$

As a residual dispersion it is possible to consider value $\Sigma \sin^2\theta_i$, where θ_i are angular distances of perihelion from point (L, B).

$$S_p = \Sigma sin^2\theta_i = 12.33 \quad (1)$$

Now let us consider a working hypothesis about perihelion location along the big circle of celestial sphere with parameters Ω' (ascending node) and I' (inclination). Calculations made by us give following values

$$I' = 37°.48 \qquad \Omega' = 171°.32 \quad (2)$$

A residual dispersion in this case will be $S_{res} = 5.24$. This is almost twice less, than *(1)*.

It was found other plane with parameters

$$I' = 76°.34; \quad \Omega' = 267°.15 \quad (3)$$

concerning which distant nodes of Kreutz comets orbits have maximum in the interval 2 – 3 a.u. (Figure 1). It is close to the normal distribution with the maximum near 2.5 a.u in the interval of 0-5 a.u. (Hereinafter in the analysis are used overlapping on an axis abscissa each other intervals).

In addition angular sizes of distant nodes (DN) concerning a plane (3) have a sharp maximum in a narrow interval of longitude (Figure 2). These features of the distant nodes theoretically can be explained by two reasons: 1. Comets are generated by a planet body moving in the plane (3) and on distance nearby 2.5 a.u.; 2. There is an unknown meteoric stream in this plane and in the distance near 2.5 a.u., which is the reason of smashing Kreutz comets.

The first explanation seems to be extremely improbable as there is no similar body among known asteroids. If even it existed in the solar system, the mechanism of generation cometary nucleys by them would be not clear. Therefore it is evident to decide in favor of the second mechanism. It seems quite logical and explains almost all features of considered Kreutz comets.

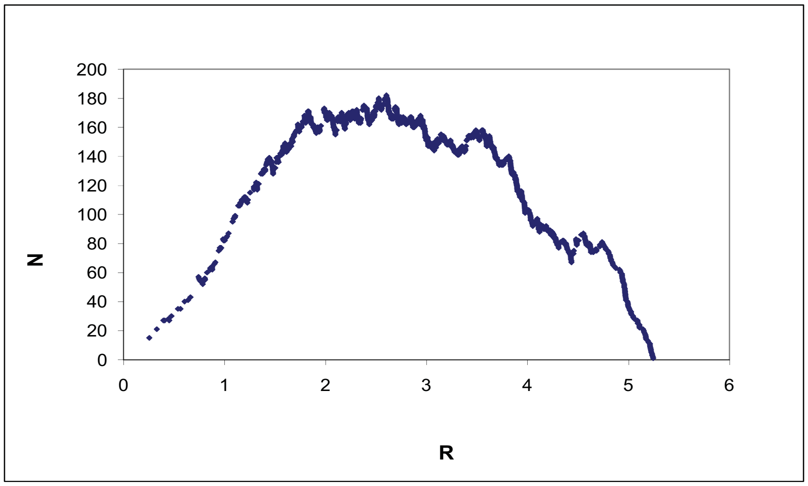

Figure 1. Distribution of distant nodes of Kreutz comets regarding to the plane (3) in the interval up to 5.3 a.u.

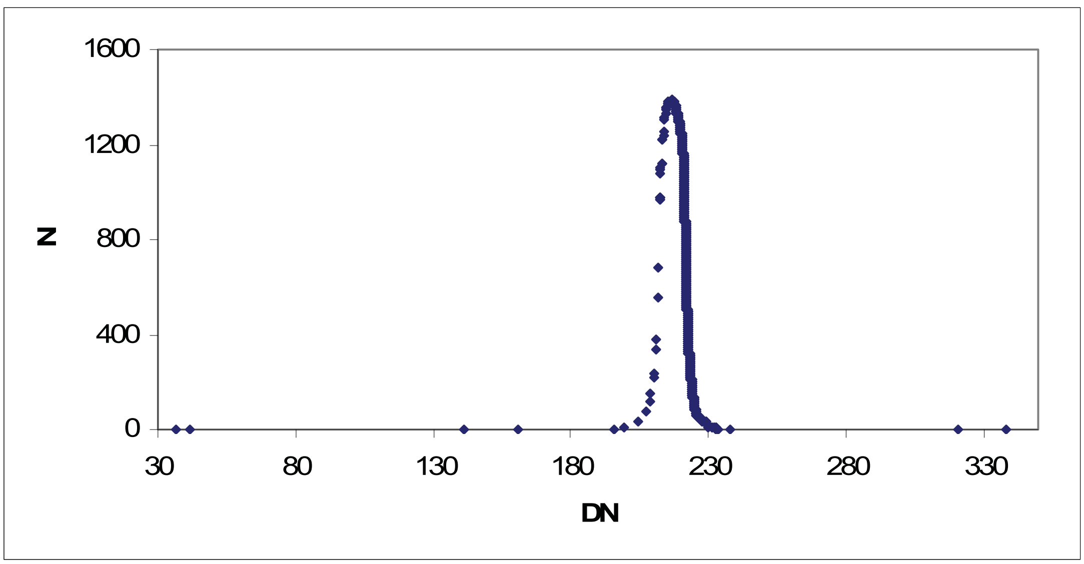

Figure 2. Distribution of distant nodes (DN) longitudes of Kreutz comets relative (3).

It is reasonable to make the following hypothesis on the origin of studied comets**.** Huge proto-comet nuclei, appearing in the inner part of the solar system at first, have fallen into unknown meteoric stream. It has got a lot of cracks. These cracks in a combination with tidal influence of the Sun have led to disintegration of proto-comet nuclei on to finer fragments. Fragments have fallen in the same meteoric stream at their next returning to perihelion and have got sets of impacts and cracks which lead to their secondary splitting, etc.

2 Meyer Group of Short – perihelion Comets

Under Meyer group of comets we will mean comets with parameters, varying around values:

$$q = 0.036a.e.;\ e = 1;\ \omega = 57°;\ \Omega = 73°;\ i = 73°$$

The number of such long-period comets, as of early 2010, was 100.

Results of our calculations and analyses show that the assumption of concentration along the plane

$$I' = 53°.69;\quad \Omega'_c = 11°.07 \tag{4}$$

describes real distribution of perihelion better, than the similar assumption regarding to some point ($S_p = \Sigma \sin^2 B_i{}' = 0.265$). Ninety percent of points are concentrated in the field of ±4° regarding the plane (4)

Calculations show, that there is one more plane with parameters

$$I' = 84°.68;\quad \Omega' = 270°.87 \tag{5}$$

near which distant nodes of cometary orbits have significant concentration in the interval 1.1 – 1.4 a.u. (Figure 3).

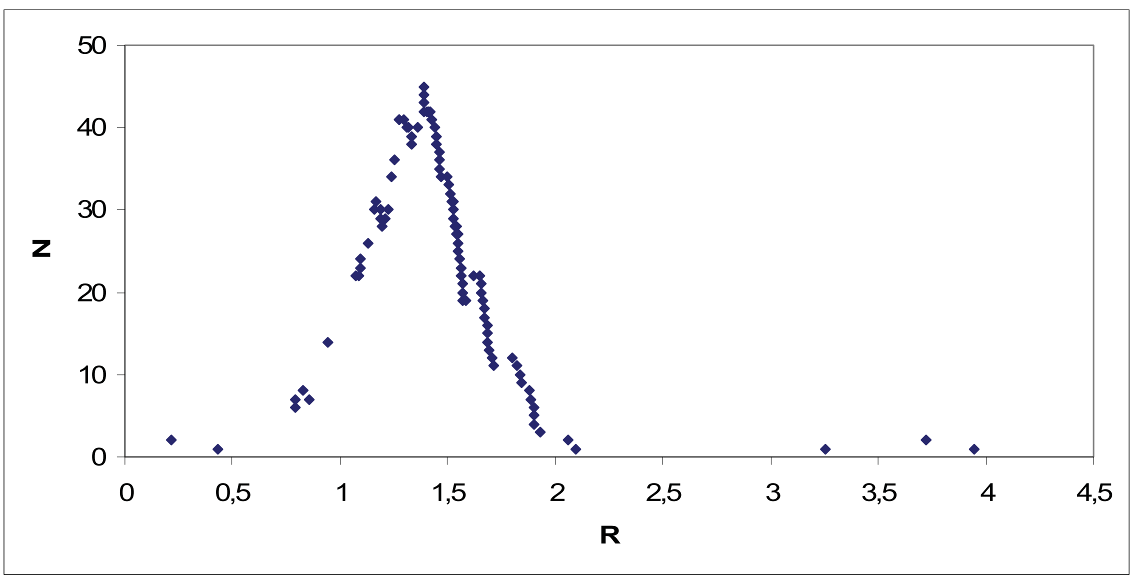

Figure 3. Distribution of distant nodes of Meyer comets regarding to the plane (5)

These features in combination with correlation between q and $\cos I$ (coefficient of correlation is equally to -0.3) give a basis to put forward the following hypothesis. One of the long-period comets having parameters

$$I = 72°.8;\ \Omega = 72°.6;\ q = 0.036$$

and appearing in the inner part of solar system for the first time at passage of the zone with parameters R ~1.4 a.e.; $I' = 84°.68$; $\Omega' = 270°.87$ has got powerful jets of a meteoric stream. The orbit of comet had an inclination to this plane about 150°. Therefore a head-on collision occurred, i.e. impacts of meteoric particles on comet nuclei were powerful. As a result, comet nucleus has collapsed on to many fragments.

3 Kracht and Marsden Cometary Groups

Analogical results have been obtained concerning the cometary groups of Kracht and Marsden. First of them has following characteristics

$$q = 0.045 a.e.;\ e = 0.98;\ \omega = 59°;\ \Omega = 44°;\ i = 13°$$

and contains 35 comets (2010). It is established at first that distant nodes of these comets are concentrated near the plane

$$I' = 24°.08; \quad \Omega' = 104°.51$$

and in the interval of the distance 0.4 – 0.6 a.u. There is a sharp concentration of distant nodes on longitude in this case too.

Group of Marsden has following characteristics

$$q = 0.050 a.e.;\ e = 0.98;\ \omega = 24°;\ \Omega = 79°;\ i = 27°,$$

and contains 32 comets (2010). Calculations show that perihelion of these comets are concentrated near the plane

$$I' = 10°.21; \quad \Omega' = 359°.60$$

At the same time we have found that distant nodes of these comets are concentrated near the plane

$$I' = 89°.50; \quad \Omega' = 101°.22$$

and in the distances from 3 up to 8.7 a.u.

In the opinion of the author, these two groups have been formed as a result of comet-meteor stream collisions, too.

4 New Group of Sungrazers and Other Splitted Comets

The author has analyzed features of 63 sporadic short-perihelion comets by own methods described in the book. A new group was identified among them. It contains 7 comets (C/2007 K19, C/2006 L7, C/2007 L12, C/2005 L10, C/2006 M6, C/2007 M6, C/1997 M5). Perihelion of these comets are concentrated near the plane with parameters:

$$I' = 53°.9; \quad \Omega' = 222°.1.$$

Five pairs among short-perihelion comets are selected except this group: C/2002 V5 and C/1996 V2; C/2004 U2 and C/2005 M3; C/2005 D1 and C/2007 C12; C/2000 V4 and C/2001 T5; C/2008 S2 and C/2004 X7. Probably they are fragments of splitted comets.

References

B.G.Marsden and G.V.Williams, 2008. Catalogue of Cometary Orbits, 17th ed. 195p.