WHAT IS THE COSMOGONIC MEANING OF THE ASTEROID DIAMETER 100-125 km?

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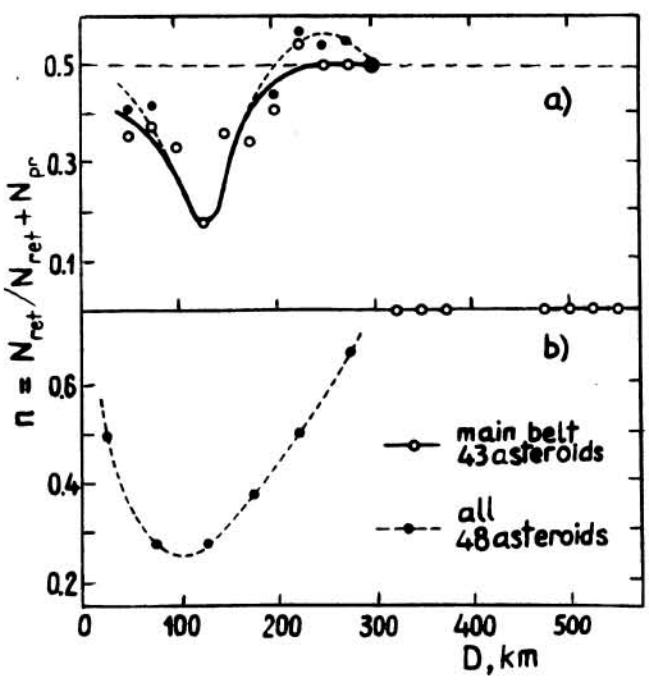
One can expect that sense of rotation is the most stable rotation characteristic of asteroids in process of their dynamic evolution. That is why studying relationship of this and other characteristics of asteroids is of considerable cosmogonic interest.

Analysing available data on asteroid sense of rotation we have already noted /1/ that: (i) the largest asteroids have prograde rotation, (ii) the predominance of prograde rotation over retrograde one takes place, and (iii) dispersion of mean rotation rate of asteroids with retrograde rotation is much more than for asteroids with prograde one.

At present the sense of rotation has been determined for about 50 asteroids. The increase of these data puts a question to what limiting diameter the predominance of prograde rotation takes place or, in other words, whether an equal probability of prograde and retrograde rotations exists and with what diameters.

Fig. a) presents the part of asteroids with retrograde rotation $n=N_{ret}/N_{ret}+N_{pr}$ versus asteroid diameters. The value n was calculated in the interval ΔD=100km, which was successivly shifted by a quarter of its value (25km) to smooth the function n(D). In this analysis the fourth asteroid in size 10 Hygiea was not used because its sense of rotation is not determined unambiguously.



As one can see from Fig. a) the character of n(D) dependence is complicated and intriguing. At D=300km the dependence has a rupture which separates the largest asteroids Ceres, Pallas and Vesta with primordial prograde rotation from asteroidswith D=200÷300km for which n≈0,5. The equal probability of both rotations, in our opinion, must be characteristic of an evolved state of collisional evolution. And the fact that this probability proved to be characteristic of large asteroids agrees with view of Binzel et al./2/ that these large asteroids, probably, reached the evolved state of collisional evolution having the survival lifetime (against catastrophic disruption) compared to the a ge of Solar System.

Quit unexpected is the minimum near D=125km. As it is known, the minimum in the size range 100-125km is also present in the dependences of mean rotation rate and lightcurve amplitude versus asteroid diameter /2/. And the fact that minimum is displayed so clearly in asteroid sense of rotation, indicates stability of this peculiarity and its cosmogonic nature. If this "cosmogonic diameter" really divides the primordial asteroids and their collisional fragments, then an increase of the part of retrograde rotation in the size region $D < 125$km becomes clear: with decrease of fragment size the probability that it will acquire prograde or retrograde rotation will be equal (that is 0,5).

The other, descending branch of minimum ($200 \gtrsim D > 125$km) apparently reflects a gradual fall of equilibrium (that is evolved) state of collisions because with decrease of asteroid size the probability of catastrophic disruption before their reaching evolved collisional interactions is increased.

This qualitative interpretation is undoubtedly not exhaustive. Here the character of dependence n(D) and the presence of minimum in the size region 100-125km are of more importance. Fig. b) confirms the existence of this minimum. The curve has been obtained by calculating n in the intervals ΔD=50km and without smoothing, that is all points in this figure are independent of each other. Though this curve is more rough, because of scarce data, it shows the minimum near D=100-125km with confidence.

There is no doubt that explanation of the nature of "cosmogonic diameter" phenomenon will provide important information on the processes of dynamic evolution in asteroid belt.

References:

1. Lupishko D.F. and Velichko F.P., 1987, Cinemat. Phys. Celest. Bodies, 3, 57-65.
2. Binzel R.P.,Farinella P.,Zappala V. and Cellino A.,1989, In: "Asteroids II", Eds.R.Binzel et al.,Arizona Univ. Press, Tucson.