SMALL VELOCITIES OF METEOROIDS: INTERRELATION OF SOLAR SYSTEM SMALL BODIES

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ABSTRACT. Reality and dynamical connection of meteoroids with small velocities are discussed.

Key words: asteroids, comets, meteoroids

Introduction

Meteoroids with velocities less than 20 km/s are practical absent in most statistical reliable radar meteor orbit catalogs. Owing to it meteoroids with radiants in antapex, geocentric elongations more than 130^0, also absent. Thus the question of reality and origin meteoroids with small masses is arises.

Reality of meteoroids with small velocities are confirmed by radiants of radar meteors in antapex derived from azimuthal observations. In these observations meteor velocity do not determined and because it selectivity of method is minimal. We have meteors with small velocities in catalogs of photographic observations also.

In the paper Andreev et al. (1993) had been demonstrated that absence of radar meteors with small velocities is connected with selectivity of radar observation method with determination of velocity.

Discussion

Thus the problem is the determination of the dynamical evolution path and parent bodies of meteoroids with small velocities.

Let us define domain in space of orbital elements a, e and i of parent bodies from which will be have meteoroids with velocities less than 23 km/s during collisions with the Earth.

From the integral of squares of the two body problem and vector adding of the Earth orbital and particle heliocentric velocities we can obtain relation for relative (geocentric) velocity of particle (Opik 1951):

$$V_g^2 = 3 - T, \quad (1)$$

where

$$T = 1/a + 2\sqrt{a(1-e^2)}\cos i. \quad (2)$$

The Earth orbital velocity is unit for all velocities.

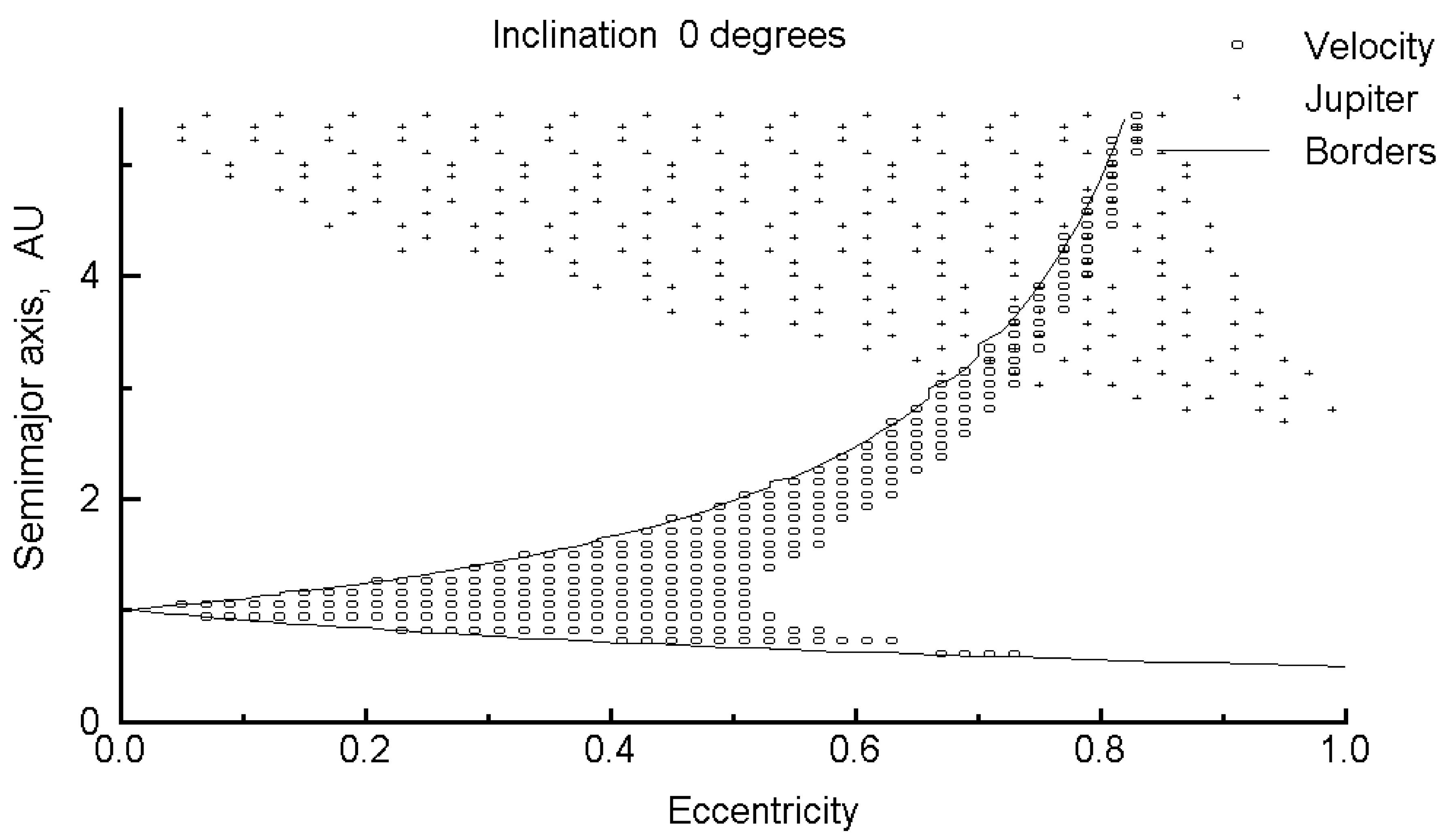

Fig. 1. Velocity domain for inclination 0°.

The appearance of T coincides with the Tisserand invariant which is approximation of Jacobi integral of three body problem.

If we define the upper limit of observational velocity of meteoroids equal to 23 km/s then value of T will be varies from 2.72 to 3.0.

L. Kresak in paper of 1967 (Kresak 1967) had suggested to use for analysis of small bodies dynamical evolution, in particular meteoroids, system of coordinates with axes eccentricity - semimajor axis. In this coordinate system we can define for different of inclination angles domain of orbital elements a and e in which we will be get meteoroids with observed velocity less than 23 km/s. This domain is show on Fig. 1 by open circles. This domain decreases with increasing of inclination of meteoroid orbit.

The distributions of a and e of asteroids and periodic comets were derived for all inclinations for velocities less than 23 km/s. For comparison the same distributions were derived for photographic meteoroids (McCrosky and Posen 1961). Very important is that what these distributions for meteoroids were derived with taking into account influence of motion and attraction of the Earth on flux of the sporadic meteoroids (Andreev and Belkovich 1975; Andreev et al. 1993) and selectivity of observation method (Andreev et al. 1983).

As follows from comparison of distributions $N(a)$ and $N(e)$ for asteroids and comets and ones for me-

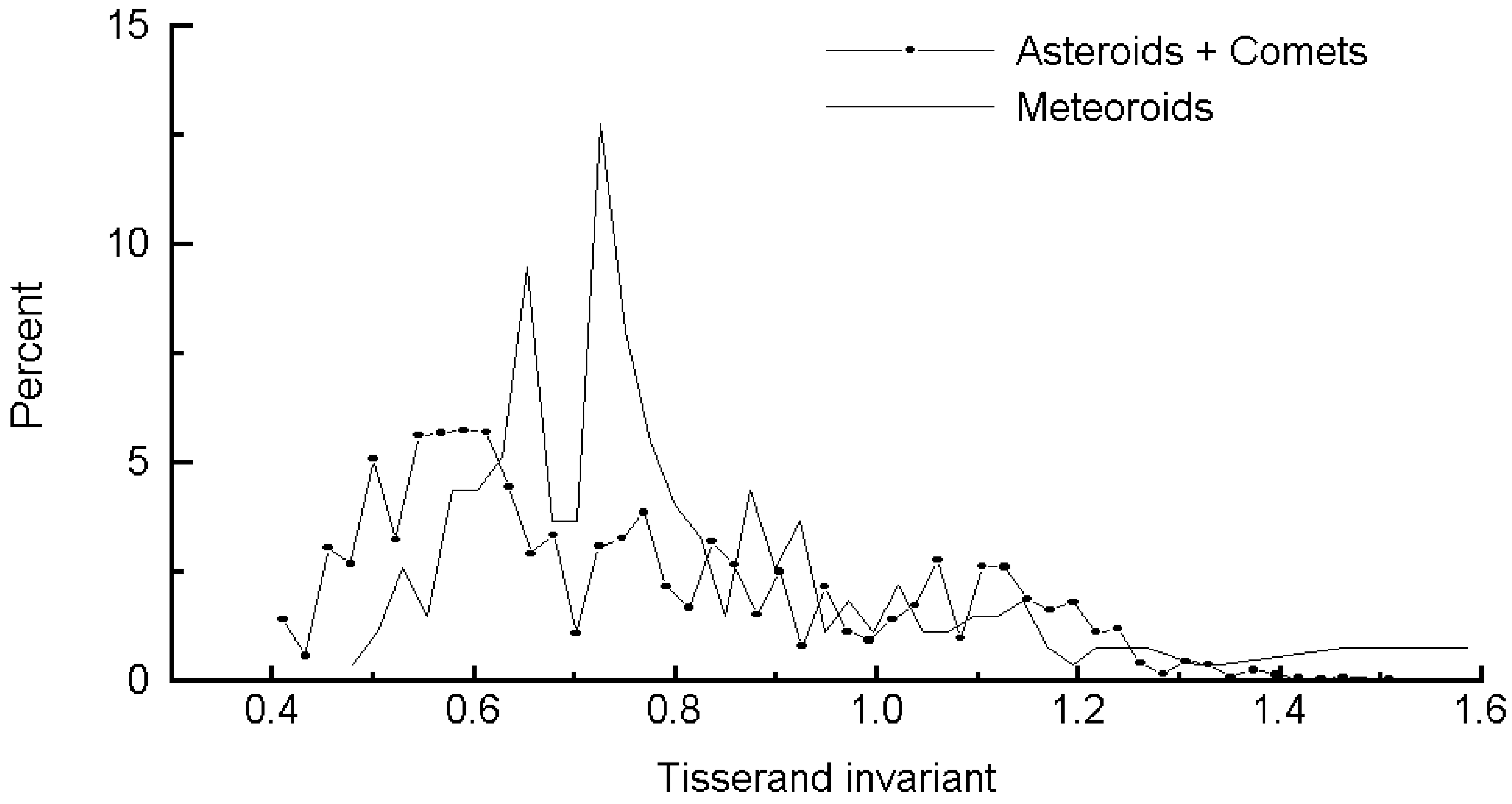

Figure 2. Distribution of Tisserand invariant.

teoroids they do not coincidence. This is a consequence of fact that from present population of asteroids and periodic short–periodic comets only small part has $q < 1AU$.

Thus question arises on dynamical way which could provide redistribution of orbital elements meteoroids.

The difference of distributions $N(a)$ and $N(e)$ is that what meteoroids with large a and e have large weight. From it follows that Poynting - Robertson effect, resulting in decreasing of a and e, do not play role and we must consider perturbations of Jupiter. As result of Jovian perturbations meteoroids from asteroids and comets do not crossing of the Earth orbit, will be collided with the Earth. Evolutionary path of these particles follows to curves having in coordinate system of Fig. 1 appearance of inner border of velocity domain drawing in Jovian domain of influence only. For this evolutionary motion Tisserand invariant relative of Jupiter

$$T_J = 1/a + 2A_J^{-1.5}\sqrt{a(1-e^2)}\cos i \qquad (3)$$

remains constant.

The distribution of T_J for meteoroids with velocities under consideration (548 meteors) and cumulative distribution for comets (14) and asteroids (288) are showed on Fig. 2. We can note nearly coincidence of main maximum of meteoroid distribution. Displacement of this maximum can be explain by large statistics of asteroids and that what productivity of comet and asteroids had been taken the same.

Conclusion

Thus it was show that we can point out evolutionary path large meteoroids. For more precise determination of distribution of large meteoroids on T_J we must have information on relative productivity of dust by comets and asteroids. As result we get information on distribution of meteoroids in the interval of velocities which do not observed owing to observational selectivity especially for radar observations.

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