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ABOUT DISTRIBUTION AND ORIGIN OF THE PECULIAR GROUP OF SPORADIC METEORS

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ABSTRACT

A particular group of sporadic meteors are picked out from analysis of meteor catalogues derived from results of radar observations in Mogadisho and Kharkov. The semi-major axes are equal or more than 1.73 AU and inclinations of orbits are equal or more than $90°$ for these meteors. The distributions of radiants, velocities and elements of orbits were derived. The probable source of meteor bodies of this peculiar group is the long-period comets, in particular, the comets of the Kreutz's group.

INTRODUCTION

The multi-mode character of the distributions of heliocentric radiants and velocities of sporadic meteoroids follows from analysis of meteor observational data (Andreev, Belkovich, 1987). This fact points to a complicated structure of the sporadic meteoroid complex. It in turn is the consequence of the plurality of parent bodies and origin mechanisms of meteoroids. The perturbing action of the planet and nongravitational forces influence on the structure of meteoroid complex. The analysis also shows presence of the meteoroids at orbits which have not analogues among another Solar system bodies.

METHOD OF REDUCTION OF OBSERVATIONAL DATA

Let us try to take into account these facts at least roughly and for large meteoroids (Andreev, 1988).

In the present time comets and asteroids are considered as main sources of meteoroids. The difference in point of views on the problem consists in the estimation of the relative contribution these sources (Kresak, 1967). Jupiter is the main perturbing body in the Solar system. The circular restricted three-body problem is the simplest dynamical framework allowing to take into account the principal perturbational influence of Jupiter. In our case that is the system of three bodies: Sun, Jupiter and a particle (Kresak, 1969, 1972, 1979).

On this base we represent the whole sporadic meteoroid complex as the aggregate of several groups of meteoroids. Every group is determined by the value of Tisserand's invariant

$$T = a^{-1} + 2 \cdot A_J^{-3/2} \cdot \sqrt{[a \cdot (1 - e^2)]} \cdot \cos i ,$$

and the inclination of the meteoroid orbit i to the ecliptic. In the equation A_J is the Jupiter's semi-major axis, a and e is meteoroid semi-major axis and eccentricity respectively.

Groups of meteoroids are determined as follows:

Group I : $T < T_o$ — meteoroid orbits are similar to comet ones,

group II : $T \geq T_o$, i < 90° — meteoroid orbits are similar to asteroid ones,

group III: $T \geq T_o$, i ≥ 90° — this type of orbit absents among the orbits of small bodies.

Where T_o is equal to 0.5767.

From ivestigation of the comet orbit distribution on value of T from Marsden's catalogue for 1979 year it follows that almost all long-period and parabolic comets have T < 0.36. This value of T have been taken for determination of two components of group I. Meteoroids whith $T_o >$ T ≥ 0.36 are related to subgroup Ib. And meteoroids whith T < 0.36 are related to subgroup Ia.

Let us to carry out the analysis of the meteoroid orbits of the third group. The semi-major axes are less than 1.73 AU and inclinations are large than 90° for meteoroid orbits from this group.

The investigation of the similar orbits had been carried out by Jones et al (1985) from television observations of meteors.

RESULTS

The reduction of 12 catalogues available on magnetic tapes of Lund Data Center shows that the number of such meteors increase then the masses of the meteoroids decrease.

Table 1. Data on catalogues and number of meteors with peculiar orbits

	Name of cata-logue	N tot.	N III	n
1	HARPHOT	1006	2	0.199
2	MCROSKY	1989	15	0.754
3	FIREBAL	359	0	0.000
4	SOVPHOT	551	11	2.00
5	TVJONES	434	53	12.2
6	HAR6165	18453	2127	11.5
7	HAR6869	19219	1773	9.23
8	OBNINSK	8424	1553	18.4
9	KHARKOV	5114	1622	31.7
10	ADE6061	2040	87	4.26
11	ADE6869	1414	146	10.3
12	MOGADIS	5180	845	16.3

$$\Sigma = 8234$$

In the table $N_{tot.}$ is the number of sporadic meteors in the catalogue, N_{III} is the number of meteors of the third group in the catalogue, Σ is the total number of meteors of the third group in all catalogues, $n = N_{III} / N_{tot.}$ for the catalogue, per cent.

The catalogue of the sporadic meteors is a result of extraction of meteors of six meteor showers: Lirids, η-Aquarids, Perseids, Orionids, Leonids and Geminids. The value of D is equal or less than 0.2 is the criterion of belonging to a meteor shower (Southworth, Hawkins 1967).

Catalogues with the numbers from six to eleven will be considered only in the analysis because of sufficient quantity of the third group meteors.

Data on meteoroids with the smaller masses are presented in the KHARKOV catalogue and meteoroids with the greatest masses are in the MOGADIS catalogue. It is follows from the comparision of the distributions of pre-atmospheric velocities, heliocentric velocities and radiants, Tisserand's invariants, and orbital elements a, e, q, and i for these two catalogues that character of semi-major axis and eccentricity distributions depends on meteoroid masses. The dependence corresponds to the scheme of the Pointing-Robertson effect. In this point of view one can note that this effect does not influence on orbital inclination and the distributions of inclination angles have practically similar shape for the meteoroids of the third group in all catalogues.

Analisys of the observational bias due to intersection probability of the Earth's orbit by meteoroids with orbits satisfied to conditions

$$a \cdot (1 - e) \le 1 \; AU \le a \cdot (1 + e).$$

had been carried out.

In the present time we do not know the evolutional mechanisms drastically changing orbital inclinations exept close encounters with the major planets. Therefore it is naturally to look for the parent bodies for these meteoroids among small bodies already moving on orbits with inclinations greater than $90°$. These small bodies known now are comets.

Mechanism of the origin of meteoroids is the desintegration process of comets during their perihelion passage. According to Whipple's model of comet nucleus velocities of ejected meteoroids are the large the less masses of particles. It is evidently that the larger velocities of ejected particles the larger deviations of meteoroid orbits from comet's one. These deviations only can form orbits with small semi-major axes similar to ones for considered meteoroids.

CONCLUSION

Analisys of desintegration processes during perihelion passage on Sekanina's scheme (Sekanina, 1967) shows that the third group meteoroids can be formed by desintegration of nucleus of

long-period and parabolic comets with very small perihelion distances. The Kreutz' group comets are likely the main contributor.

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