81st ANNUAL MEETING
OF THE METEORITICAL SOCIETY
JULY 22-27, 2018
MOSCOW, RUSSIA

SMALL METEOR SHOWERS INDENTIFICATION WITH NEAR-EARTH ASTEROIDS

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Introduction

Currently, Near-Earth Objects (NEO), small bodies of the Solar system including asteroids and comets with elongated orbits and perihelion distances shorter than 1.3 AU, are subjects of great interest. At present, more than 15 thousand of NEOs are discovered and this list keeps growing [1]. The mineralogical composition of asteroids is mainly stone or iron and stone bodies, however, there is also a possibility that some of NEOs are nuclei of faded comets of the Jupiter family. According to MDC IAU data, there are no parent bodies for about 80 meteor showers observed in the terrestrial space. A link between orphan showers and asteroids is usually sought for in Athen, Apollo, Amor, Atira asteroid groups crossing the Earth's orbit. Using statistical and robust analysis we have defined Apollo and Atira groups as most probable ones that may contain nuclei of sleeping or faded comets [1] among their terms. In this paper, the genetic connections between Athen, Apollo, Amor, Atira groups and k-Cygnids, δ-Cancrids and Virginids meteor showers are studied. The initial base of asteroids contained 17800 orbits. The statistics for the showers is as follows: k-Cygnids – 700, δ-Cancrids (NCC, SCC branches) – 170, Virginids – 12.

Methods

During the studies, the D-criterion by J.D. Drummond [2], K.V. Kholshevnikov metrics [3] as functions of distances between the orbits, Tisserand's parameter, and 2 quasi-stationary parameters of the restricted three-body problem were applied. Application of the D-criterion lies in determining the distance between the reference orbit and meteoroid's one. An orbit is represented as a point in five-dimensional phase space of orbit elements. Two meteors are considered to belong to meteor shower or complex if the value of D is defined as a function of distance and does not exceed a certain threshold value. The probability of asteroids orbits being identified with meteoroids ones was defined as full probability of occurring joint events if all the 5 criteria are fulfilled with a specified accuracy. The initial hypothesis was accepted or declined depending on the fulfillment of the critical values of the criteria. In their turn, critical values were defined on the basis of determining the showers' mean orbits within each orbit catalogue with taking into account its mistakes.

Results

As a result, with a probability of more than 0,6 the following results are obtained. With the orbits similar to k-Cygnids, the asteroids 2001MG1, 2002LV (noted in works by other authors) from the Apollo group and 2002GJ8, 2012QH49, 2010QA5 from the Amor group are marked out. For δ-Cancrids only asteroids from the Apollo group are marked out: northern NCC – 2212 Hephaistos 1978SB, 2014RS17, 2011SR12; southern SCC - 2015PC, 1991AQ, 2006BF56. For the general δ-Cancrids complex 2006BF56, 2014RS17, 1991AQ, 2003RW11, 2001YB5 are marked out. For Virginids only asteroids from the Apollo group are marked out: 2006UF17, 2008VL14, 2010VF. Asteroids in groups for each shower have been identified with a probability of less than 0,2.

The initial base of asteroids contained 17800 orbits. The statistics for the showers is as follows: k-Cygnids – 700, δ-Cancrids (NCC, SCC branches) – 170, Virginids – 12. Analysis of the modern NEOs orbits shows that the majority of them are formed in the main asteroid belt located between the orbits of Mars and Jupiter [1].

As we see, the orbits of the marked-out asteroids are elongated and comet-like. The size of 153311(2001 MG1) and 385343(2002 LV) asteroids are also typical of comet nuclei, while 2014 RS17 and 2006 BF56 asteroids having small size are probably the products of larger body disintegration. For newly discovered asteroids, orbit elements are reliably determined, but other parameters, such as taxonomic index (TI) and diameter (D), are determined less reliably or unknown. The diameters are indirectly determined using the absolute stellar magnitude (H) and geothermal albedo (p) with a significant scatter in the values.

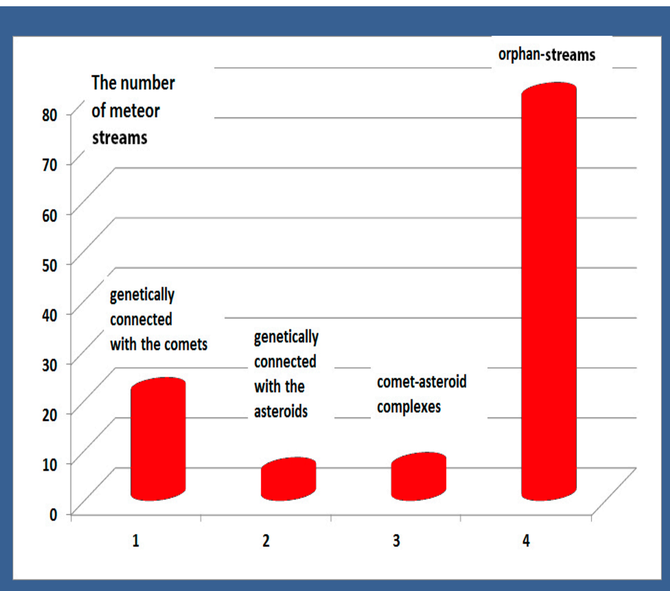

Fig.1 Registry of meteoroid streams

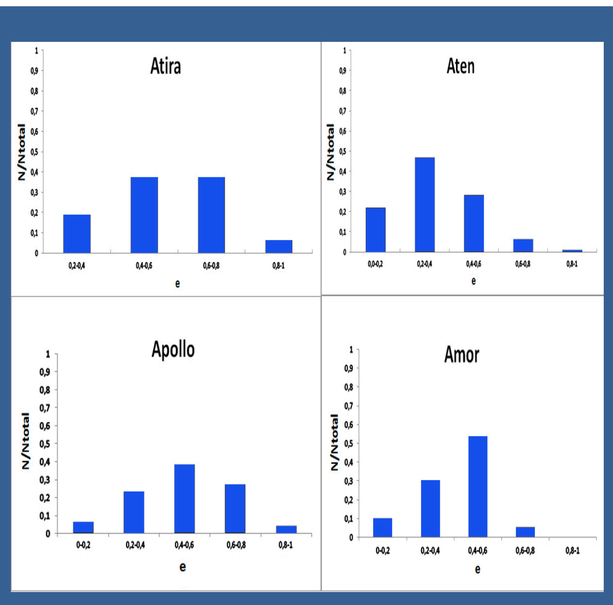

Fig.2 Relative distribution of asteroids for eccentricity in groups.

Conclusion

In the present paper, the search for parent bodies for k-Cygnids and δ-Cancrids was carried out using a large amount of statistical data of television and photographic catalogues of meteor orbits and involving the new D-criteria by Kholshevnikov whose orbits proximity metric takes into account evolutional perturbations with time. The reliability of the results obtained is confirmed by the studies carried out by other authors and at the same time allows for a reduction of the number of pretenders to be parent bodies for orphan showers: for k-Cygnids – 53311 (2001 MG1) and 385343 (2002 LV) asteroids, for δ-Cancrids – (2014 RS17) and (2006 BF56) asteroids. Establishment of the asteroids genetically connected with meteor showers marks out those asteroids whose observation and investigation are necessary for refining their dynamic, chemical, and physical parameters in terms of assessing the danger for the Earth and developing methods of its protection from NEOs.

Acknowledgements

The work is performed according to the Russian Government Program of Competitive Growth of Kazan Federal University. This work was partially supported by the Russian Foundation for Basic Research, grant nos. 18-32-00895 mol_a.

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