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A comparative analysis of the D-criteria used to determine genetic links of small bodies

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Abstract

In this article the D-criteria, which can be used to determine the genetic relationships of small bodies with their parent bodies in the solar system, are estimated. Drummond (1981), Southworth and Hawkins (1963), Jopek (1993), dynamic (Kalinin and Kulikova, 2007; Holshevnikov and Titov, 2007) D-criteria were analysed. It was found that the Drummond criterion is less sensitive to errors of observations and its upper limit does not exceed 0.2. The Southworth–Hawkins and Jopek D-criteria are more stable and have good convergence. Limiting values, which vary in the range of 0.3–0.6 (except for the Lyrids), were determined on the basis of the analysis of six meteor showers for the Southworth–Hawkins and Jopek criteria.

Keywords: Meteoroids; Meteoroid streams; Small bodies of the solar system; The orbits evolution; D-criteria

1. Introduction

Under the influence of many cosmogenic factors the evolution of orbits of small bodies of the Solar System leads to the formation of meteoroid complexes. A set of criteria is used to find the genetic relationships. The criteria are based on the determination of the Tisserand constant or D-criteria as functions of the distance between the bodies' orbits in the five-dimensional phase space of elements of orbits. There are several problems. Firstly, which criteria should be used for the research, as they can be unstable in the different geometries of orbits or can give ambiguous results? Secondly, what maximum limiting value of the criterion should be taken under which values would allow the assumption that two bodies are genetically linked?

Limiting values of the criteria are estimated on the basis of modelling of the meteoroid complexes for a given mechanism of the particle ejection from a parental body. Several works devoted to the evolution of modelling of meteoroid swarms have been published recently. We note the article by Kulikova et al. (2003) about making stochastic models of the formation and evolution of meteoroid complexes which make it possible to distinguish the region of the space where this complex evolves and thus to determine the theoretical limiting value of the criteria of its fragments community. However in the case of using these models the limiting values of the criteria are directly dependent on the velocity of a fragment's emission. In addition a model of the subsequent orbit evolution does not consider all factors and features which affect the particles' dispersion in the swarm. As a result the real values of the D-criteria obtained from the observational data of the orbits of the meteors differ from the theoretical ones even taking into account the errors of the observations. The comparison of theoretical and observational data will make it possible to determine the limiting values of D-criteria for each meteor

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