Use of Various Metrics in Orbital Spaces while Finding a Common Origin of Celestial Bodies

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Finding a common origin of various celestial bodies, and first of all relations between meteoroid streams, comets, and asteroids (possibly extinct comets) remains one of the important problems of the Solar System astronomy. Different criteria starting with one by Southworth–Hawkins were used for this purpose.

Ideally they must represent some kind of metrics in a 5-dimensional space of orbits. Unfortunately they are not ideal. We have examined properties of majority of criteria. It turns out that they all represent pseudometrics for which the triangle axiom does not fulfill. Besides, they are inapplicable if at least one of orbits is circular. We propose metrics free of all pointed drawbacks. In addition metric properties of three factorspaces (where orbits are identified irrespective of: values of longitudes of nodes; values of arguments of pericentres; values of both longitudes of nodes and arguments of pericentres) are examined. Results are applied to the problem of searching minor bodies of the Solar System having a common origin. Relationship between comet 2P/Encke and several asteroids is established, and a conclusion was made on a belonging of asteroids to the Taurid asteroid-meteoroid complex. Using all considered criteria and new metrics leads to practically identical results. It is explained by the fact that only close and essentially non-circular orbits are examined. Besides, the measure of orbit triples for which the triangle axiom failed is likely small, though it does not established yet theoretically, as well as empirically.

Key words: Keplerian orbits, metric spaces, asteroid, comet