Excluding interlopers from asteroid families

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Introduction: Asteroid families are believed to have originated from catastrophic collisions among asteroids. They are a very important subject of Solar System investigation, because practically any research topic carried out in asteroid-related science sooner or later encounters problems pertaining to asteroid families. One basic problem encountered when dealing with families is to determine reliably the list of its members, i.e. to reduce the number of interlopers as much as possible. This is an important problem, because many conclusions derived from analyses of the physical properties of family members must be necessarily based on firm and well established membership. However, as the number of known asteroids increases fast it becomes more and more difficult to obtain robust list of members of an asteroid family. To cope with these challenges we are proposing a new approach that may help to significantly reduce presence of interlopers among the family members. This method should be particularly useful once additional information become available, including primarily spectro-photometric data. This is exactly the kind of information that will be provided by Gaia.

Metodology: Families (and their members) have been commonly identified by analysing the distribution of asteroids in the space of proper orbital elements, using the Hierarchical Clustering Method (HCM) [1]. A well-known drawback of the HCM based on the single linkage rule is the so-called chaining phenomenon: first concentrations naturally tend to incorporate nearby groups, forming a kind of 'chain'. Thus, any family membership obtained by the pure HCM must unavoidably include some interlopers. The method we are proposing here could be used to identify these interlopers, with its main advantage being an ability to significantly reduce the chaining effect. The method consists of three main steps. First we determine an asteroid family members by applying the HCM to the catalogue of proper elements obtained from AstDys database. Next, all family members that do not meet adopted criteria (based on physical and spectral characteristics) are excluded from the initial catalogue. Finally, the HCM analysis is performed again using the improved catalogue.

Results: We apply this approach to the Themis family. In the first step the HCM links 3061 asteroids to the family. Among them we identify 113 potential interlopers. After removing interlopers, in the second run of the HCM, the total number of members has decreased to 2847. Thus, 101 extra objects have been excluded from the membership list (see Figure).

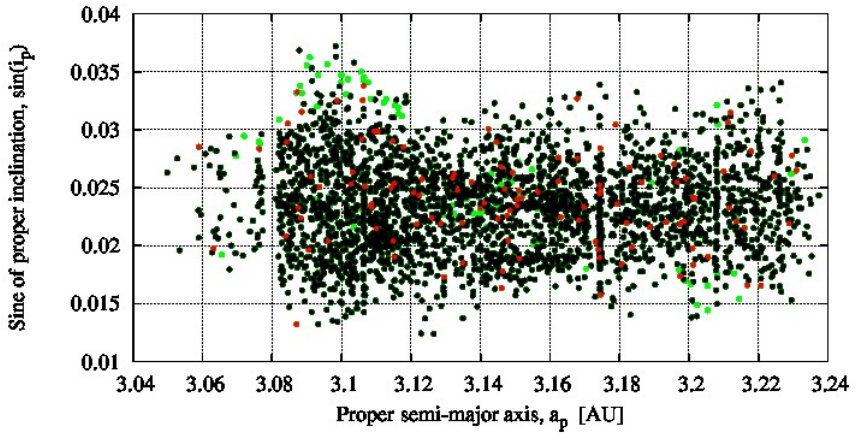

Figure: Projection of the members of the Themis family on the semi-major axis vs eccentricity plane. The red points depict possible interlopers, and the green points represent objects linked to the family through some of suspected interlopers.

References: [1] Zappala V., Cellino A., Farinella P., Milani A., 1994, AJ, 107, 772.