An analysis of the Hygiea asteroid family orbital region

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(10) Hygiea is the fourth largest asteroid of the Main Belt, by volume and mass, and it is the largest member of its own family. The Hygiea family is made mostly by low-albedo C-type asteroids, typical of the outer main belt. Recently, it has been suggested that close encounters with this asteroid may have played an important role in the dynamical evolution of members of this family. Numerical simulations of the orbital evolution of family members under the gravitational influence of all planets, several massive asteroids, and non-gravitational forces such as Yarkovsky and YORP may help in setting constraints on the family age and original ejection velocity field. But, such modeling requires good estimations of family membership that includes analysis of the local asteroid taxonomy (if available), geometrical albedos, and influence of the local dynamics, so as to minimize the errors associated with including too many interlopers.

In this work we investigated the local dynamics, by obtaining synthetic proper elements and frequencies of asteroids in the Hygiea orbital region, with their errors. We revised the current knowledge on asteroid taxonomy, including SDSS-MOC 4 data, and we take advantage of the availability of WISE and NEOWISE albedo data to i) identify asteroid family members using Hierarchical Clustering Methods (HCM hereafter) in the domain of proper elements $(a, e, sin(i))$ and in the domains of proper frequencies most appropriate to study diffusion in the local web of secular resonances; and ii) to try to eliminate possible interlopers based on taxonomical and geometrical albedo considerations.

Since large families have an associated "halo" of objects with similar SDSS-MOC 4 data that extends far beyond the border of the HCM families, we also devised a new hierarchical clustering method to identify family halos in an extended domain that includes proper elements, principal components PC_1, PC_2 obtained based on SDSS photometric data, and, for the first time, WISE and NEOWISE geometric albedo. Data on asteroid size distribution, lightcurves and rotations was also revised for the Hygiea family.

The Hygiea family is the largest group in its region, with two smaller families in proper element domain and eigthteen families in various frequencies domains identified in this work for the first time. Frequency families tend to extend vertically in the $(a, sin(i))$ plane and cross not only the Hygiea family, but also the near C-type families of Themis and Veritas, causing a mixture of objects all of relatively low albedo in the Hygiea family area. A few high albedo asteroids, most likely associated with the Eos family, are also present in the region. Finally, the new multi-domains hierarchical clustering method allowed to obtain a good and robust estimate of the membership of the Hygiea family halo, quite separated from other asteroids families halo in the region, and with a very limited (about 3%) presence of likely interlopers.