Volume and mass distribution in selected families of asteroids

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Members of five asteroid families (Vesta, Eos, Eunomia, Koronis, and Themis) were identified using the Hierarchical Clustering Method (HCM) for a data set containing 292,003 numbered asteroids. The influence of the choice of the best value of the parameter $v_{\rm cut}$ that controls the distances of asteroids in the proper elements space a, e, i was investigated with a step as small as 1 m/s. Results are given in a set of figures showing the families on the planes $(a, e), (a, i), (e, i)$. Another form for the presentation of results is related to the secular resonances in the asteroids' motion with the giant planets, mostly with Saturn. Relations among asteroid radius, albedo, and absolute magnitude allow us to calculate the volumes of individual members of an asteroid family. After summation, the volumes of the parent bodies of the families were found. This paper presents the possibility and the first results of using a combined method for asteroid family identifications based on the following items: (i) Parameter $v_{\rm cut}$ is established with precision as high as 1 m/s; (ii) the albedo (if available) of the potential members is considered for approving or rejecting the family membership; (iii) a color classification is used for the same purpose as well. Searching for the most reliable parameter values for the family populations was performed by means of a consecutive application of the HCM with increasing parameter $v_{\rm cut}$. The results are illustrated in the figure. Increasing $v_{\rm cut}$ in steps as small as 1 m/s allowed to observe the computational strength of the HCM: the critical value of the parameter $v_{\rm cut}$ (see the breaking-points of the plots in the figure) separates the assemblage of potential family members from 'an ocean' of background asteroids that are not related to the family. The critical values of $v_{\rm cut}$ vary from 57 m/s for the Vesta family to 92 m/s for the Eos family. If the parameter $v_{\rm cut}$ surpasses its critical value, the number of HCM-discovered family members increases enormously and without any physical reason.

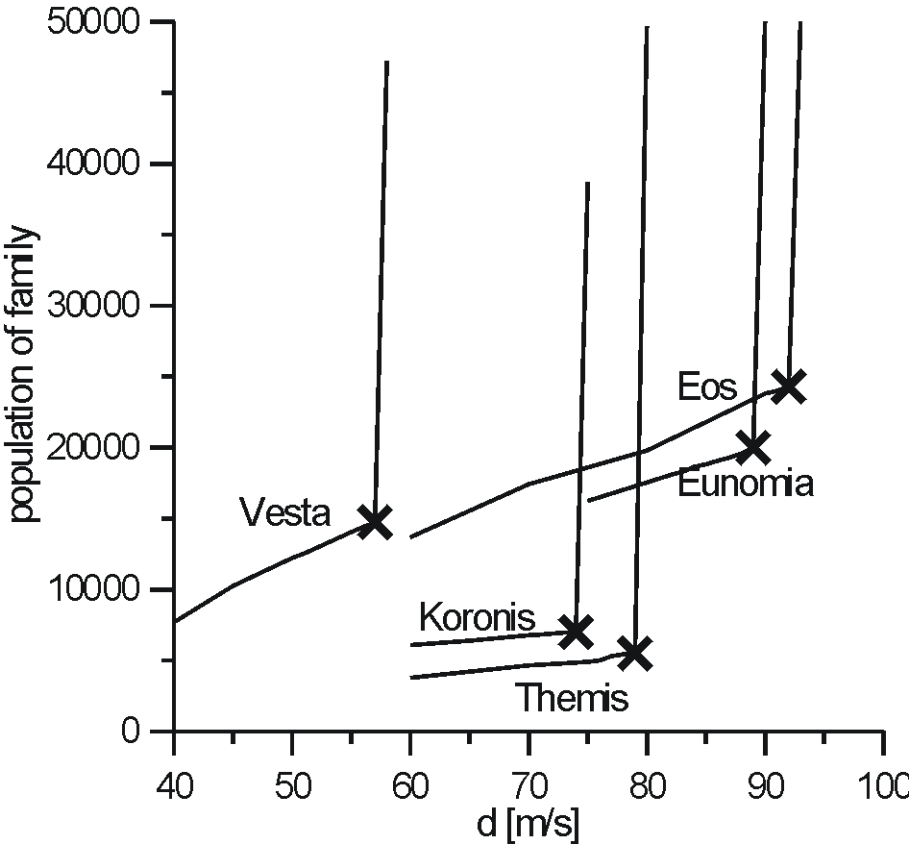

Figure: Number of asteroids in the families versus the parameter $v_{\rm cut}$. The chosen values of the parameter $v_{\rm cut} = v_{\rm cut,crit}$ correspond to the points (marked by crosses) where the slopes change from slightly inclined to almost vertical.