The Probable Ages of Asteroid Families

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There has been considerable debate recently over the ages of the Hirayama families, and in particular if some of the families are very "young". It is a straightforward task to estimate the characteristic time of a collision between a body of a given diameter, d_0, by another body of diameter $\geq d_1$. What is less straightforward is to estimate the critical diameter ratio, d_1/d_0, above which catastrophic disruption occurs, from which one could infer probable ages of the Hirayama families, by knowing the diameter of the parent body, d_0. One can gain some insight into the probable value of d_1/d_0, and of the likely ages of existing families, from the plot below. I have computed the characteristic time between collisions in the asteroid belt of a size ratio $\geq d_1/d_0$, for 4 sizes of target asteroids, d_0. The solid curves to the lower right are the characteristic times for a single object. The dashed curves are shifted to the left by a factor of the number of bodies of each size that exist in the present asteroid belt. Thus they represent estimates of the time since one such collision has occurred in the asteroid belt. Hence if one assumes a value of d_1/d_0 which results in a catastrophic disruption, the upper curves yield estimates of the time since the last family with a parent body of diameter d_0 should have been created. The lower curves can be taken to be roughly a measure of how long a family should persist, as a function of the largest remaining members. The dots plotted on the curves indicate estimates of d_1/d_0 from Housen & Schmidt (*Icarus* 94, 180-190, 1991). Adopting these values for d_1/d_0, it can be inferred that the largest family, Themis ($d_0 \approx 300$ km) should be a few $\cdot 10^8$ years old. Smaller families (Eos, Alexandra, $d_0 \approx 200$ km) should be about 10^8 years old. The Koronis family, which has numerous members but collectively sum up to only $d_0 \approx 100$ km, might be $< 10^7$ years old. since the largest individual members of the Koronis family ($d \approx 50$ km) should have lifetimes of $\sim 2 \cdot 10^8$ years, one should expect >10 such families to be presently persisting, which is not fully consistent with the observed structure of the asteroid belt.