The relationship between the 'limiting' Yarkovsky drift speed and asteroid families' Yarkovsky *V*-shape

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Summary: The Yarkovsky effect is an important force to consider in order to understand the long-term dynamics of asteroids. This non-gravitational force affects the orbital elements of objects revolving around a source of heat, especially their semi-major axes. Following the recently defined 'limiting' value of the Yarkovsky drift speed at 7×10^{-5} au/Myr in Milić Žitnik (2019) (below this value of speed asteroids typically jump quickly across the mean motion resonances), we decided to investigate the relation between the asteroid family Yarkovsky *V*-shape and the 'limiting' Yarkovsky drift speed of asteroid's semi-major axes. We have used the known scaling formula to calculate the Yarkovsky drift speed (Spoto et al. 2015) in order to determine the inner and outer 'limiting' diameters (for the inner and outer *V*-shape borders) from the 'limiting' Yarkovsky drift speed. The method was applied to 11 asteroid families of different taxonomic classes, origin type and age, located throughout the Main Belt. Here, we present the results of our calculation on relationship between asteroid families' *V*-shapes (crossed by strong and/or weak mean motion resonances) and the 'limiting' diameters in the (a, $1/D$) plane. Our main conclusion is that the 'breakpoints' in changing *V*-shape of the very old asteroid families, crossed by relatively strong mean motion resonances on both sides very close to the parent body, are exactly the inverse of 'limiting' diameters in the a versus $1/D$ plane. This result uncovers a novel interesting property of asteroid families' Yarkovsky *V*-shapes.

Methods and Results: A key point of this analysis was to find the connection between the 'limiting' Yarkovsky drift speed and asteroid families' Yarkovsky *V*-shape slope of borders.

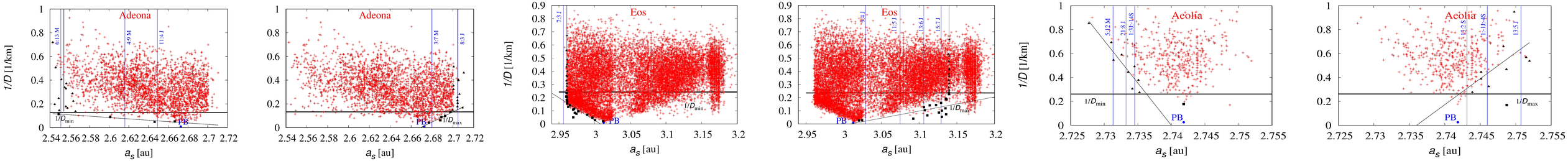
Steps: ~ 11 asteroid families crossed by 2-body and 3-body strong and weak mean motion resonances (MMRs)

~ The number of members without interlopers was obtained using the application HCM (Radović et al. 2017)

~ 2-body and 3-body resonances (Jupiter-Saturn-Asteroid) that cross all 11 families, we obtained by applying numerical methods proposed by Gallardo (2006, 2014)

~ Selection of the fit region, binning and calculation of the limiting diameters

$$\frac{\mathrm{d}a}{\mathrm{d}t} = \frac{\mathrm{d}a}{\mathrm{d}t}\bigg|_B \frac{\sqrt{a_B}(1-e_B^2)}{\sqrt{a}(1-e^2)} \frac{D_B}{D} \frac{\rho_B}{\rho} \frac{\cos(\phi)}{\cos(\phi_B)} \frac{1-A}{1-A_B}$$ Milani et al. (2014), Chesley et al. (2014), Spoto et al. (2015)



Conclusions: * In asteroid families, especially in very old ones, which are crossed by strong or relatively strong MMRs on both sides very close to the parent body, at the 'limiting' diameter exists a change in slope of *V*-shape border in the (a, $1/D$) plane (Milić Žitnik 2020). This change of the *V*-shape could be attributed to the existing necessary strength of interactions between asteroid orbital motion due to the Yarkovsky efect and relatively strong MMRs (Milić Žitnik 2019).

* In asteroid families, which are crossed only by weak MMRs on both sides very close to the parent body, the 'limiting' Yarkovsky drift speed does not have a role in changing the slope of the *V*-shape border, because of the absence of appropriate (enough strong) interaction between asteroid orbital motion under the inuence of the Yarkovsky efect and weak MMRs near to the parent body (Milić Žitnik 2020).

* Resonant asteroids with diameters larger than the 'limiting' diameter (because: $\mathrm{d}a/\mathrm{d}t \sim 1/D$) are drifting faster over relatively strong MMRs (Milić Žitnik 2020).

* The main conclusion: the location of inverse of the 'limiting' diameter $1/D_{\mathrm{limit}}$ is exactly at the place of changing the *V*-shape slope of border in an old asteroid family which are crossed in the same side by relatively strong MMR, very close to the parent body, in the (a, $1/D$) plane (Milić Žitnik 2020).

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