

Assessing the accuracy and range of validity for semi-analytic mean motion resonance width formula

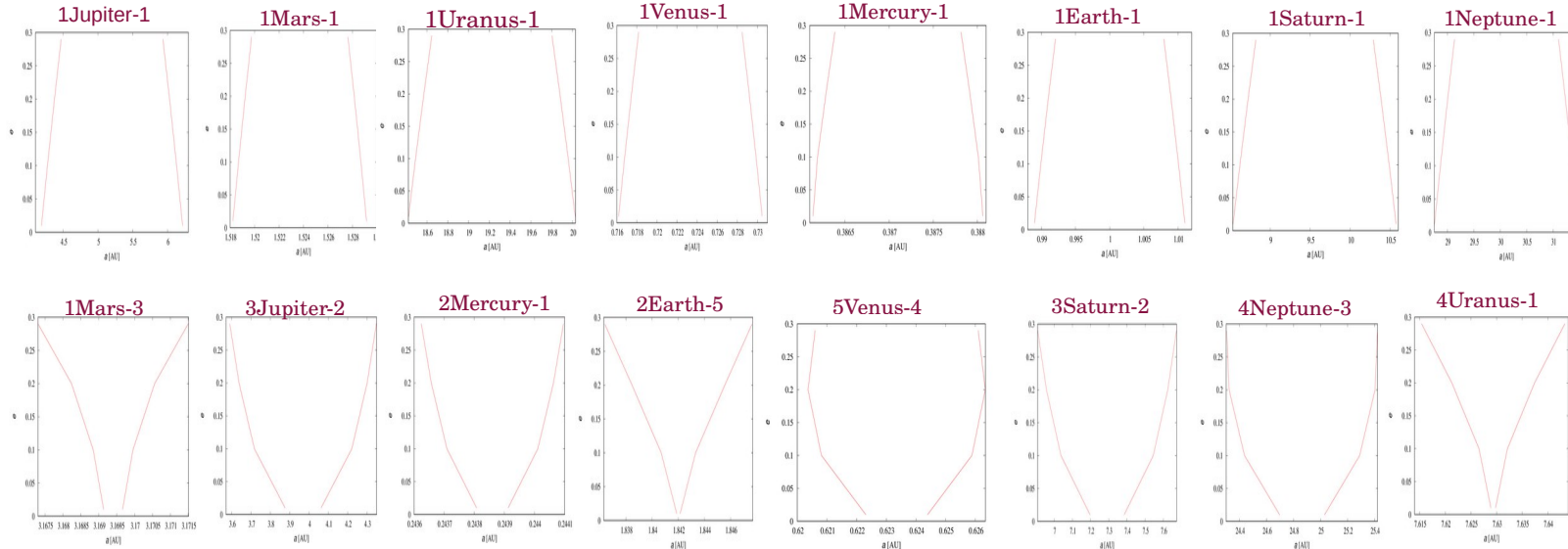
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Summary: Building on the analytical framework for mean motion resonance (MMR) width established by Murray and Dermott (1999) and the resonance strength calculations of Gallardo (2006), Soja et al. (2011) derived a functional relationship between resonant width and strength. While Soja et al. (2011) defined the model's validity for eccentricities below ~ 0.3 and low inclinations, our research identifies further limitations, specifically regarding 1:1 resonances and high-intensity resonant zones. This study presents analytical MMR width calculations and validates these results through a comparative analysis with numerical simulations conducted in *Orbit9*.

Results



$$\delta a_{\max} = \pm \left(\frac{16}{3} \frac{S R_{\text{approx}} a^3}{G M_{\odot}} \right)^{\frac{1}{2}}$$

(Soja et al., 2011)

Rezonanca	$da_{e=0.025}^n$ [AJ]	$da_{e=0.1}^n$ [AJ]	$da_{e=0.1}^{s-a}$ [AJ]
7:3	0.00100	0.00400	0.01106845
9:4	0.00012	0.00090	0.00504008
8:3	0.00012	0.00080	0.00242426
13:6	0.00010	0.00026	0.00105127
15:7	0.00008	0.00022	0.00483206
11:4	0.00008	0.00022	0.00026959
17:8	0.00008	0.00022	0.00022302
10:3	0.00006	0.00020	0.00010276
16:7	0.00006	0.00020	0.00012777
17:7	0.00006	0.00016	0.00003266
18:7	0.00004	0.00014	0.00000810
17:6	0.00004	0.00010	0.00000377

Conclusion: In the case of 1:1 mean motion resonances, the resonance-width formula derived by Soja et al. (2011) is not applicable. Furthermore, a clear eccentricity boundary (< 0.3) could not be established using this formulation for any mean motion resonance at this stage of the analysis.

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