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Mapping of the asteroid families

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Abstract. In this work we map one of the most populated regions in the main belt - the asteroid family Themis. Computed with a good choice of parameters, the map enables us to get a refined picture of the dynamics in the family, to reexamine the role of resonances therein, to understand better the distribution of asteroids inside the region and to identify dynamical pathways along which particles can drift away.

1. Map of the Themis asteroid family

Asteroid family Themis, discovered one century ago by Hirayama (1918), is one of the most populous (close to 6000 identified members) and most studied asteroid families. Themis family is located at low eccentricity ($0.11 < e < 0.184$) and low inclination ($i < 3$) in the semi-major axis range $a \in [3.14, 3.22]$ AU, on the outer edge of the main belt. It is bordered by the strong 2A:1J mean motion resonance with Jupiter and intersected by numerous weaker resonances, which all have some contribution in sculpting the family.

For a better understanding of the evolution of its members, it is very helpful to observe dynamical structures in the region with good precision. Therefore, we compute clear stability maps, that are produced using a realistic Solar System model, a high precision integrator - ORBIT9 and a sensitive short term numerical tool for chaos detection - FLI (Froeschlé *et al.* (1997)).

We map the family in the (a, e) plane in the domain that slightly exceeds the boundaries of the family i.e. for $[a \times e] = [3, 3.25]AU \times [0.11, 0.2]$. We divide this segment in a grid of equidistant points and for each point on the grid we calculate the corresponding FLI value for 200 Kyrs. The map is colorized according to FLI values, in a sense that larger chaoticity implies larger FLIs. The remaining four orbital elements: inclination i, longitude of the node Ω, argument of the pericenter ω, and mean anomaly M are fixed to $(i, \Omega, \omega, M) \sim (0.75, 36, 107, 280)$ which are the corresponding angles for the asteroid 24 Themis, the parent body and largest member of the family. In all calculations, we use osculating orbital elements for the epoch 2456200.5 MJD, which is another argument to have a realistic situation on the map. In this way we obtain exact structures of the resonances in the region, their separatrix borderlines and stability domains. This will contribute to an easier identification of places with higher diffusion abilities, i.e. to localize those regions along which particles drift apart in an efficient way.

References

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Hirayama, K. 1918, *ApJ*, 31, 743

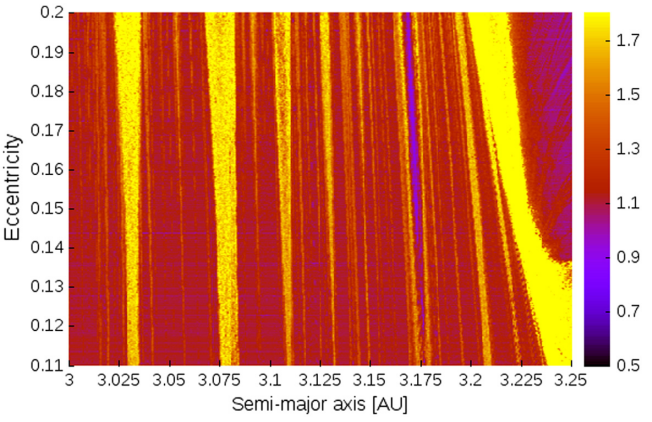

Figure 1. FLI map of the Themis family region.

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