A new vision of the mean motion resonances in the Solar System

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The interest in the mean motion resonances (MMRs) is historically related to the existence of macroscopic (Kirkwood) gaps in the asteroid belt, to the almost resonant orbits of pairs of giant planets, which made difficult an analytic computation of their ephemerides, and to the Laplace resonance among the Galilean satellites of Jupiter. While for the 3:1 and 5:2 Jovian MMRs, it was understood that the secular dynamics driven by solely Jupiter opens gaps in few Myr, the clearing of the 2:1 resonance requires 0.1–1 Gyr and a different dynamical mechanism. As the orbital motions of two planets and of the asteroid are involved in this mechanism, the resonances giving rise to the instability were named the *three–body MMRs*. It was further shown why the quasi–resonant structure of the outer planets orbits favour a basically regular dynamics of both the 3:2 MMR with Jupiter in the asteroid belt and the 2:3 MMR with Neptune in the Kuiper belt. One of the most interesting recent findings was however that the three–body resonances are dense in the small–body belts causing strong chaos of orbits of many real objects (40% in asteroid belt have LCE $> 10^{-5}\mathrm{yr}^{-1}$) and slow chaotic evolution of their eccentricities. The three–body resonances are different from the Laplace resonance of the Galilean satellites as they do not necessary involve two coupled two–body MMRs as in the case of Europa which is in the 1:2 resonance with Io and in the 2:1 resonance with Ganymede.