

Secular resonances for small bodies in the planetary systems

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We investigate the secular resonances for massless small bodies and Earth-like planets in several planetary systems. We also compare the results with those of Solar System. For example, in the GJ 876 planetary system. We show that the secular resonances ν_1 and ν_2 (respectively, resulting from the inner and outer giant planets) can excite the eccentricities of the Earth-like planets with orbits $0.21 \text{ AU} \leq a < 0.50 \text{ AU}$ and render them eject out from the system in short time. However, in a dynamical sense, the potential zones for the existence of Earth-like planets are in the region $0.50 \text{ AU} \leq a \leq 1.00 \text{ AU}$, and there exist all stable orbits last up to 10^5 yr with low eccentricities. We find that the Habitable zones for Earth-like planets are related to both secular resonances and mean motion resonances in the systems.