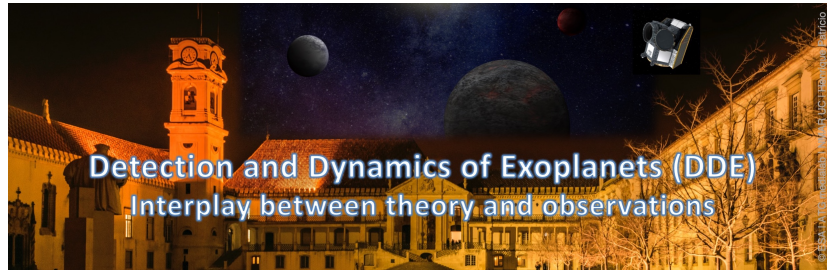


Detection and Dynamics of Exoplanets (DDE): Interplay between theory and observations



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Dynamical Instability of Multi-planet Systems and Free-floating Planets

Tuesday 8 July 2025 15:00 (15 minutes)

The ejection of planets by the instability of planetary systems is a potential source of free-floating planets. We numerically simulate multi-planet systems to study the evolution process, the properties of surviving systems, and the statistics of ejected planets. For systems with only super-Earth planets, we find that the time (in units of the orbital period of the innermost planet) for the system to lose the first planet by collision or ejection increases with the semimajor axis of the innermost planet. In contrast, the time (in the same units) for the first close encounter between two planets is identical. These two timescales also have different dependence on the orbital spacing between the planets. Most systems with only super-Earths do not have planets ejected. In systems with super-Earths and a cold Jupiter, we discover that a cold Jupiter significantly increases the probability of ejection of the super-Earths by close encounters. For the super-Earths that are ejected, most of their velocities relative to their parent stars are smaller than 6 km/s. We conservatively estimate that more than 86% of the surviving two-planet systems in the super-Earths plus cold Jupiter sample are long-term stable by using empirical criteria. Most super-Earths in the remaining two-planet systems are on highly elliptical but stable orbits and have migrated inwards compared with their initial states.

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