Different Planetary Eccentricity-Period (PEP) Distributions of Small- and Giant-Planets

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Motivation

The eccentricity of the exoplanet population, as revealed over the past three decades, differs markedly from the nearly circular orbits in our Solar System, hinting at unique attributes influenced by planetary mass and orbital period. Based on a sample of confirmed planets with RV solutions, we study the planetary eccentricity-period (PEP) distribution.

(1)

By separating the PEP diagrams for low-mass and high-mass planets, we find that while the orbits of the high-mass planets display a clear upper envelope, the orbits of low-mass planets display a flat eccentricity distribution with almost no dependence on the orbital period.

(3)

The red dashed line in the giant-planet diagram marks our upper-envelope best-fit model, based on planets with an orbital period shorter than 100 days, marked by a vertical dotted line. The red area marks the transition region along the envelope.

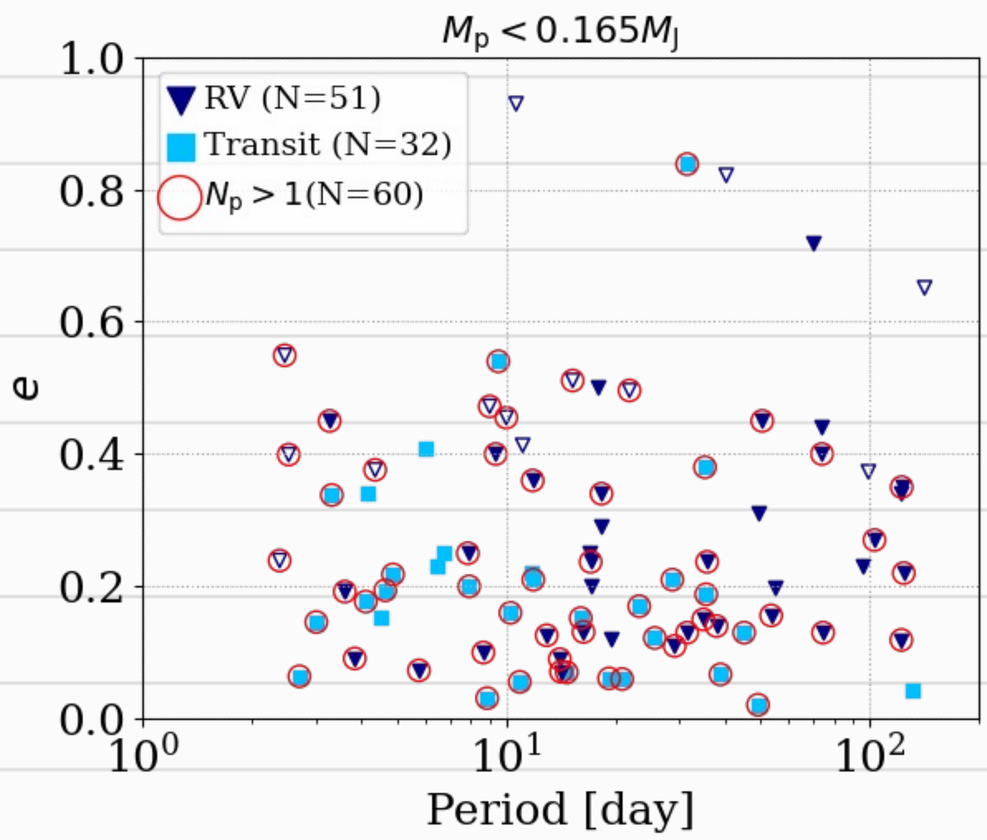
An upper envelope and a missing upper envelope?

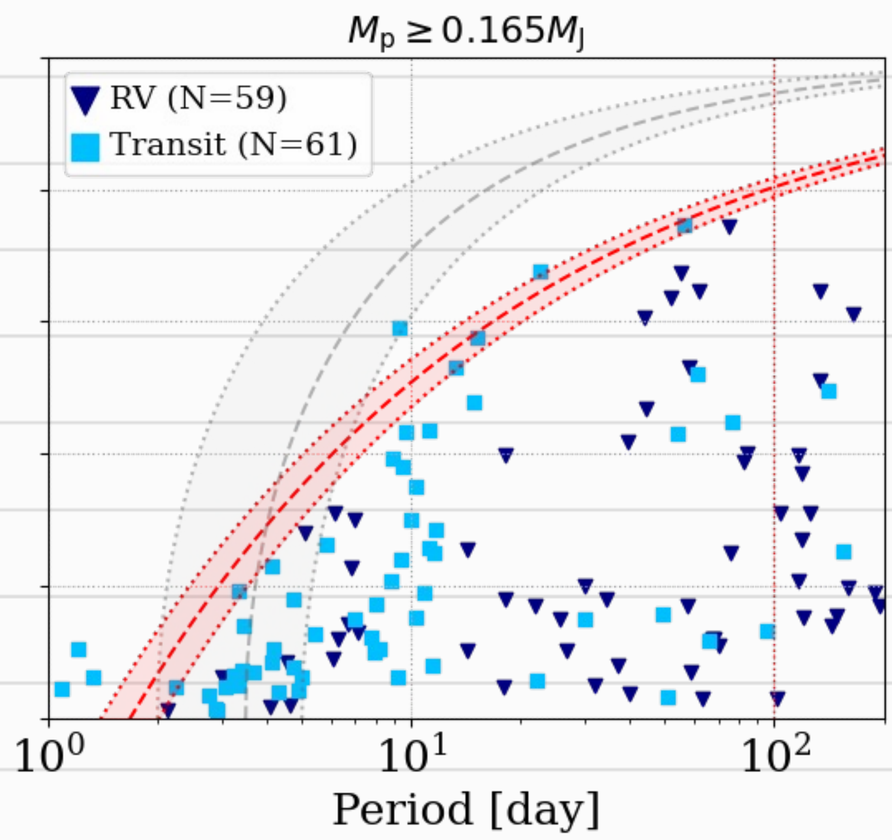
(2)

We confirm that the striking difference between the two PEPs is not due to the detection technique used (triangles and squares represent planets discovered by transit and RV methods).

We mark the expected constant angular momentum evolutionary tack by a grey dashed line, assuming a scenario of a high-eccentricity migration (HEM) ending up with the typical orbital periods of hot Jupiters.

(4)





Conclusions

High-mass planets exhibit a monotonic upper envelope, indicating tidal circularisation, while the low-mass PEP distribution suggests that the circularisation was ineffective, probably because of dynamical interaction with neighbouring planets (marked by red circles).

Our results have important implications for our grasp of tidal effects, planetary system configurations, and interactions with neighbouring planets.

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