The Stellar Eccentric Kozai-Lidov Mechanism as a Key Driver of Cold Jupiter Eccentricities

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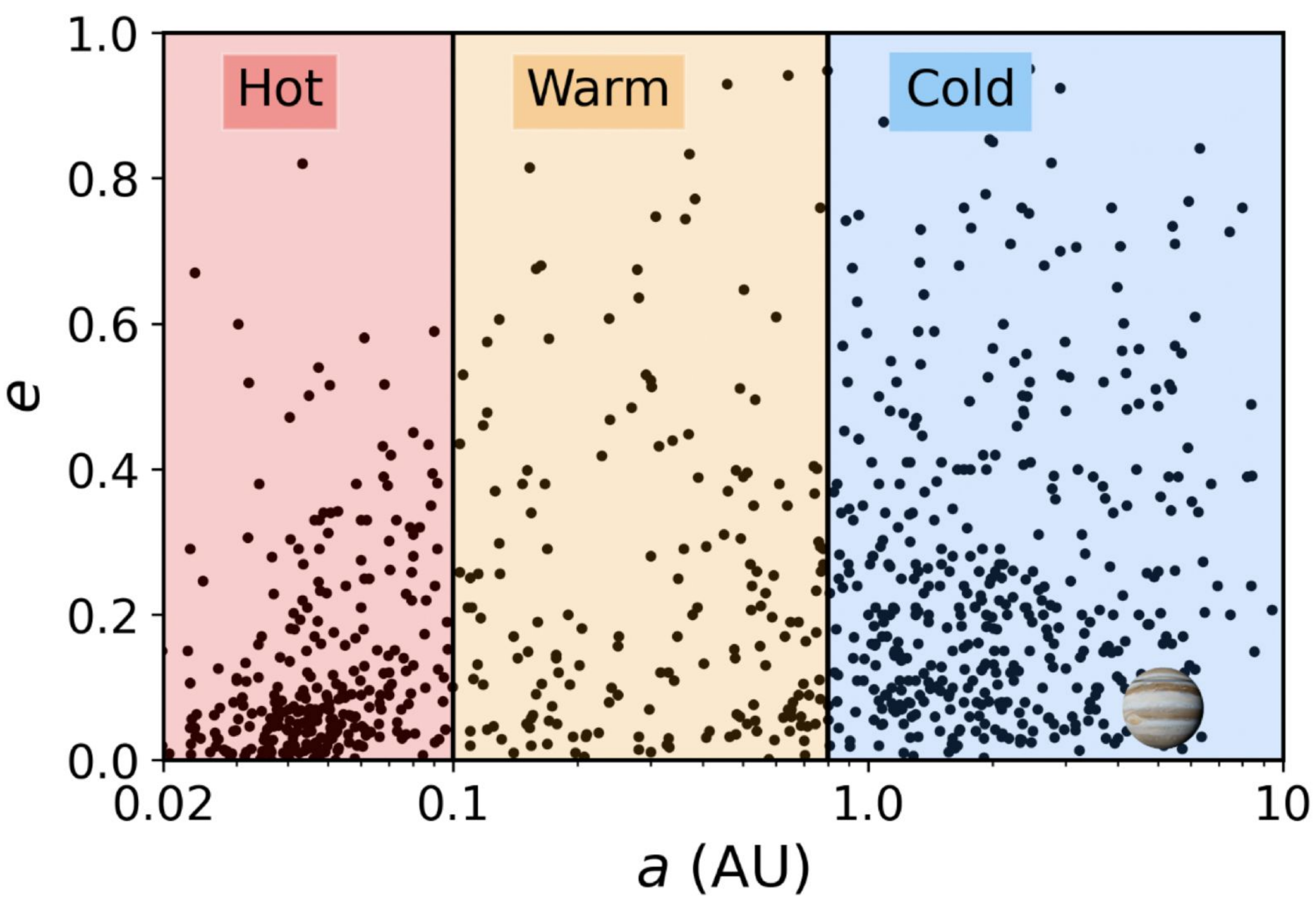
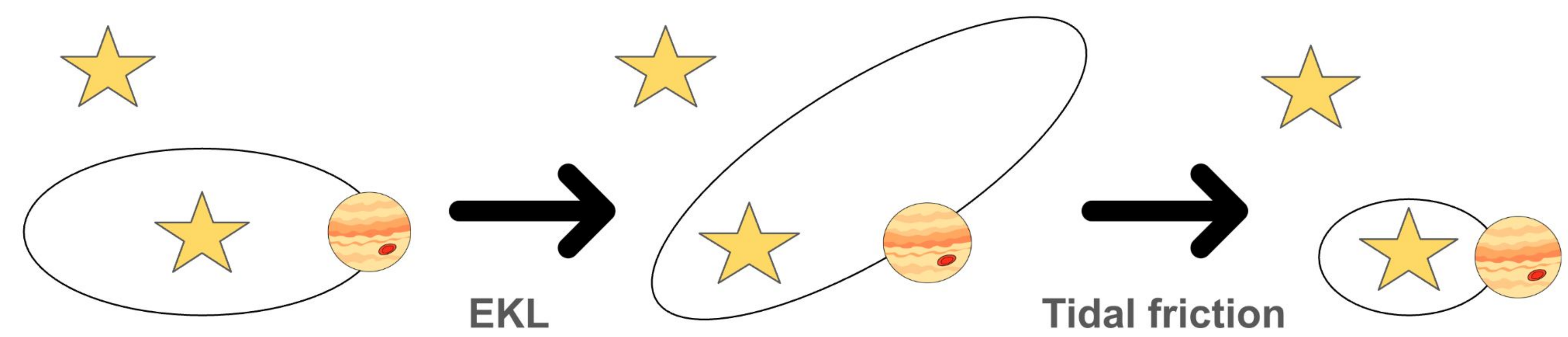


Dots show observed planets from NASA Exoplanet Archive

Background

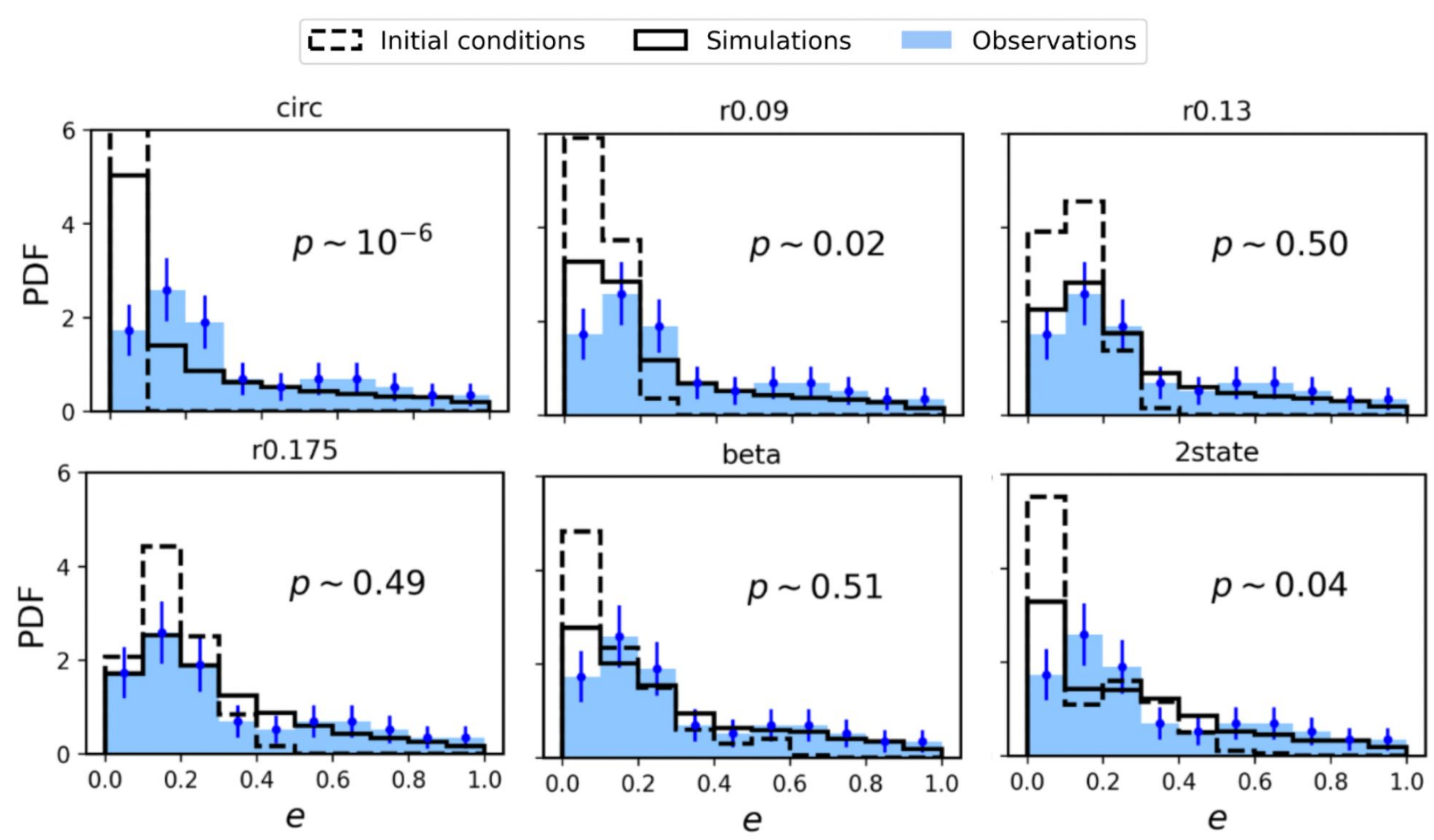
The existence of hot Jupiters and the large eccentricities of cold Jupiters challenge theories of planet formation based on the Solar System (see Dawson & Johnson 2018 for review). **High-eccentricity migration has been proposed to connect the cold and hot populations.** In this channel, initially cold giants are dynamically excited to high eccentricities, allowing tides during close pericenter passages to drag planets onto hot orbits. **Secular perturbations from wide binary companion stars may be responsible for exciting eccentricities via the Eccentric Kozai-Lidov (EKL) mechanism**, (e.g., Kozai 1962, Lidov 1962, Naoz 2016) though the contribution to the population is unclear.

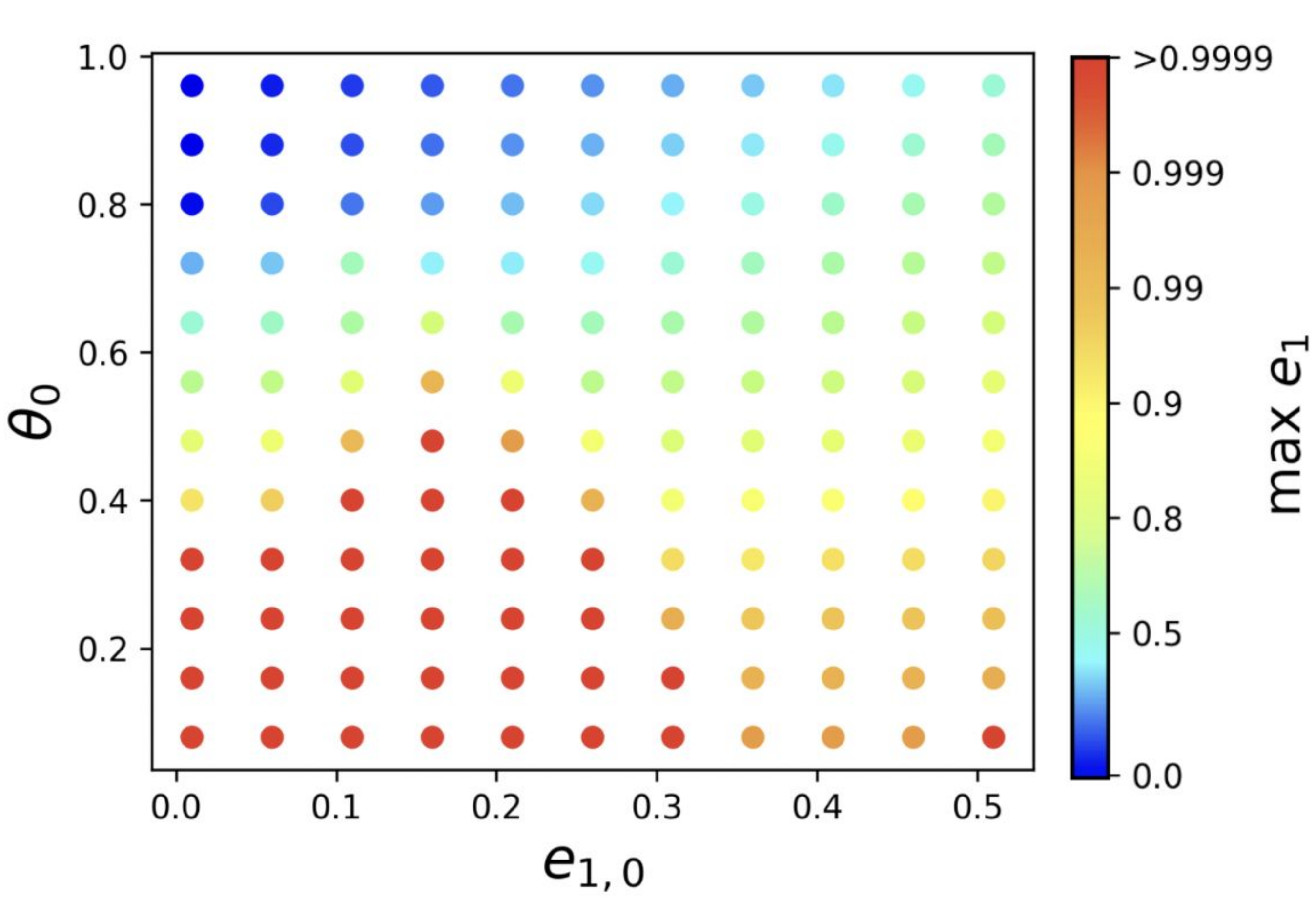


Simulations

We construct populations of initially cold giant planets (0.8-6 au) in isotropically oriented FGK stellar binaries (50-1500 au). Various initial eccentricity distributions for the planets are tested, considering that processes such as **planet-planet scattering may act on Myr timescales before EKL acts on up to Gyr timescales.**

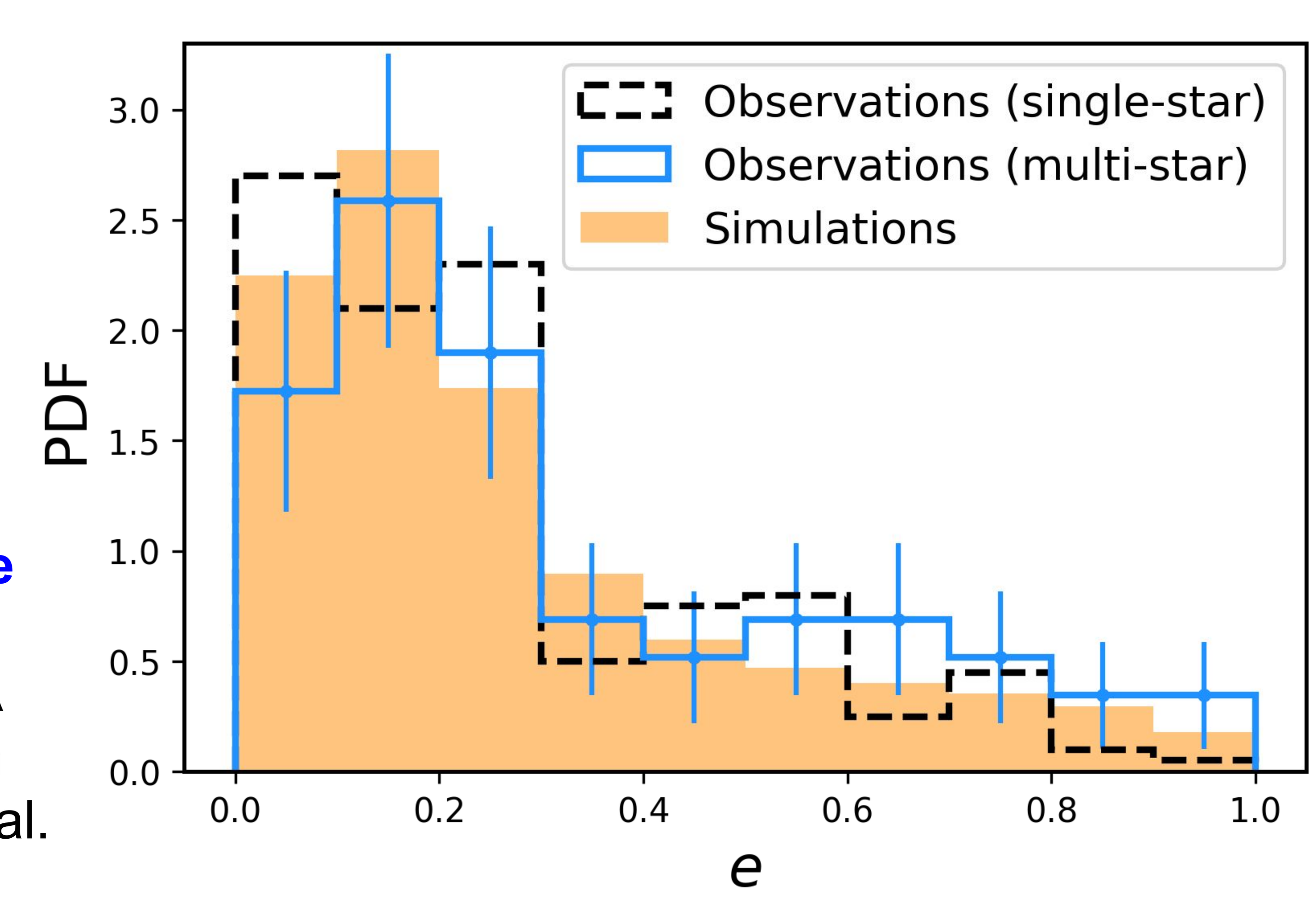
The systems are evolved in a hierarchical three-body code (Naoz 2016), including EKL, general relativity, tides, and stellar evolution. We compute the time-averaged eccentricity distribution of cold planets and find that the **simulations statistically agree with observations for small amounts of initial eccentricity.**

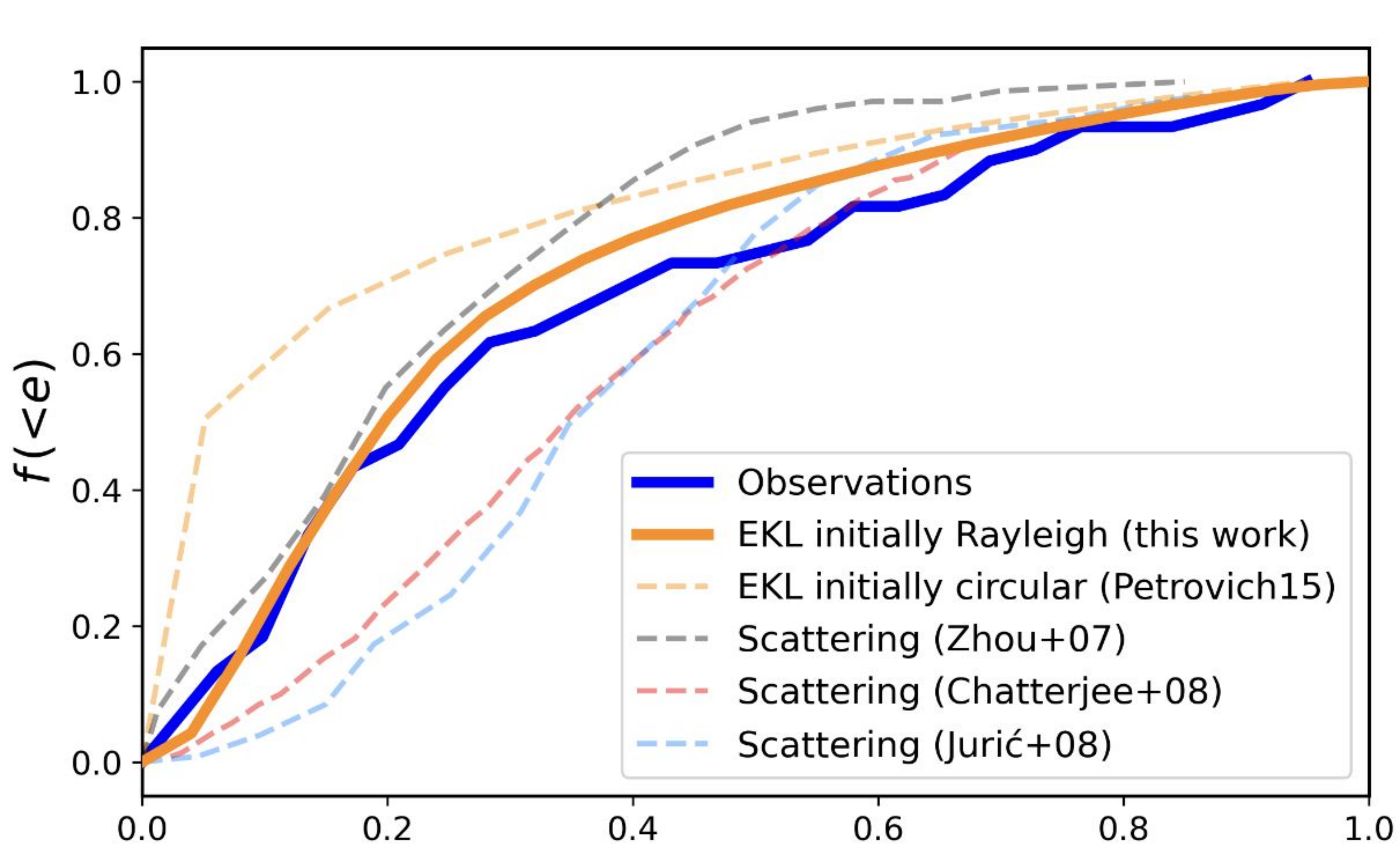




Small initial eccentricities can lower the mutual inclination between the planetary and stellar orbit (θ=cosi) for EKL to act, leading to more extreme EKL behavior in the population (see also e.g., Li et al 2014).

Planets in single-star systems have lower eccentricities than in multi-star systems (data from NASA Exoplanet Archive). Ruling out hidden companions may strengthen this signal.





These results more closely match the eccentricity distribution than in previous studies, suggesting that when scattering is first taken into account, **stellar EKL may be a more dominant driver of the giant planet population than previously thought.**

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