

The effect of dynamically formed binaries on young planetary systems

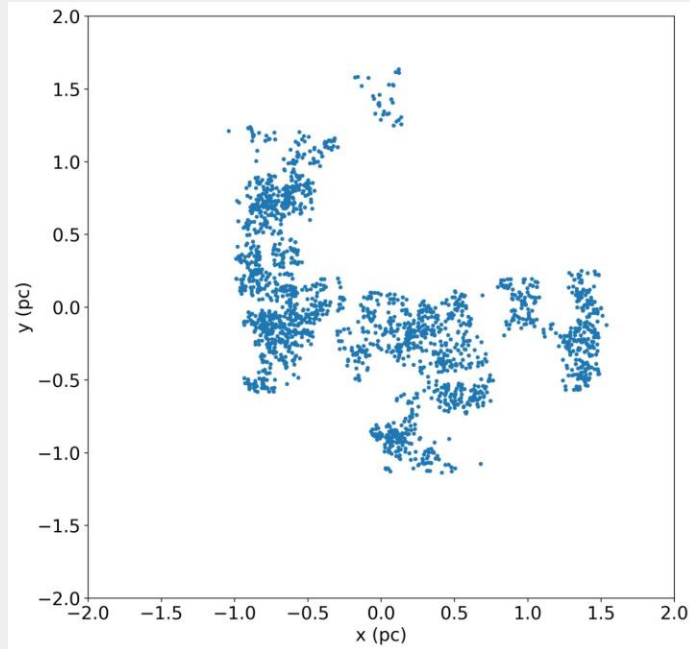
Christina Schoettler



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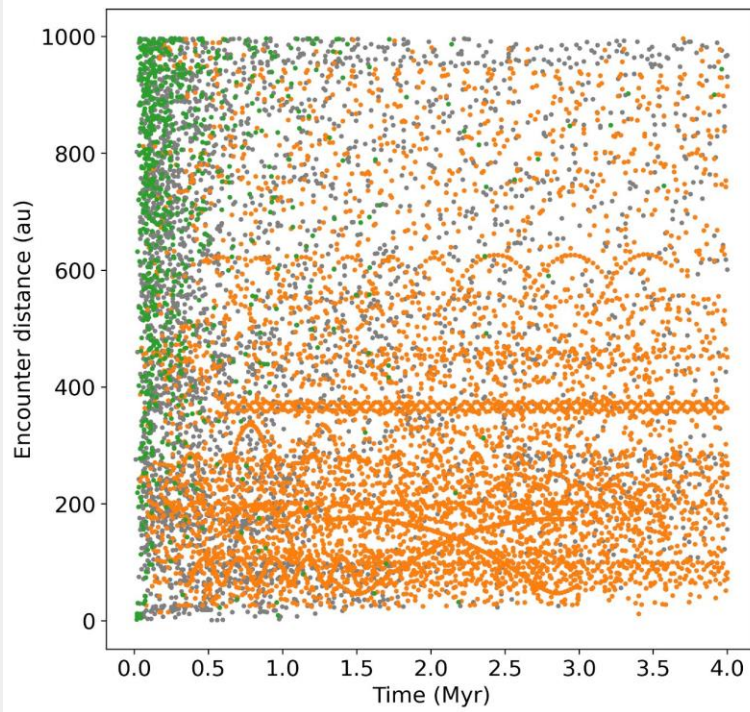
Encounters in young star-forming regions



N-body simulations with typical
cluster-like initial conditions
(substructured+ subvirial, 2000
systems)

(Orion Nebula Cluster - simulations
- Schoettler+ 2020)

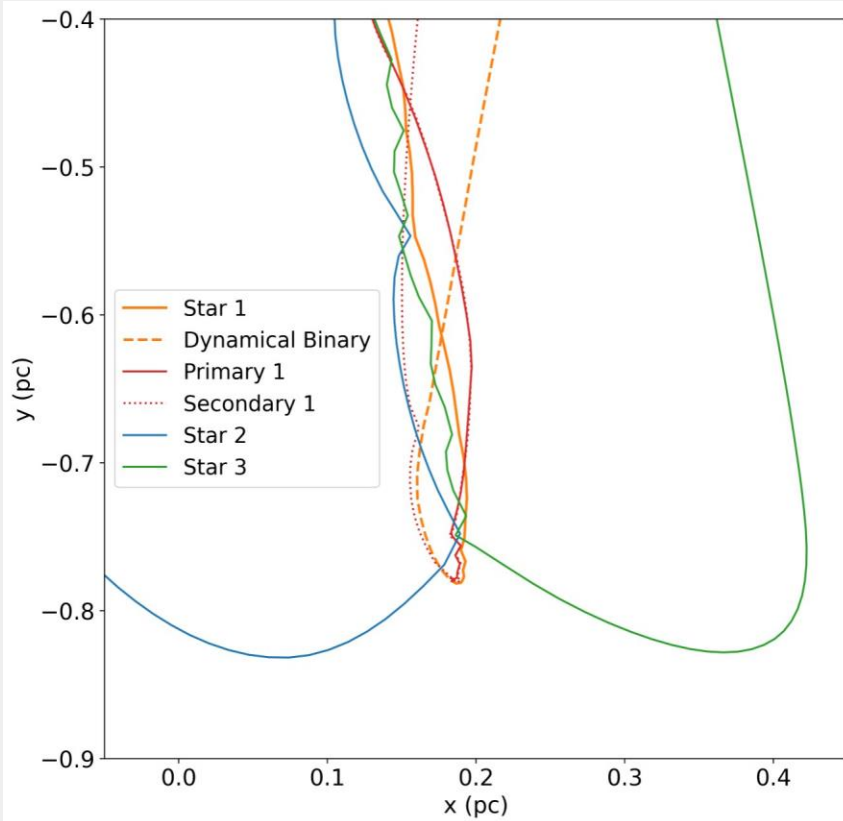
Encounters in young star-forming regions



Encounters of non-primordial binary stars:

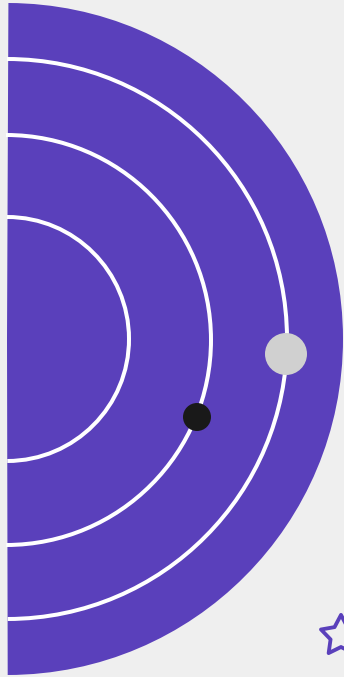
- Single encounters focussed in early times (green) and reduce at later times (grey)
- Formation of dynamical binaries with repeated encounters between the same stars (orange)

Formation of a dynamical binary example



Starting with an initially single star ($1.7 M_{\odot}$ orange solid).

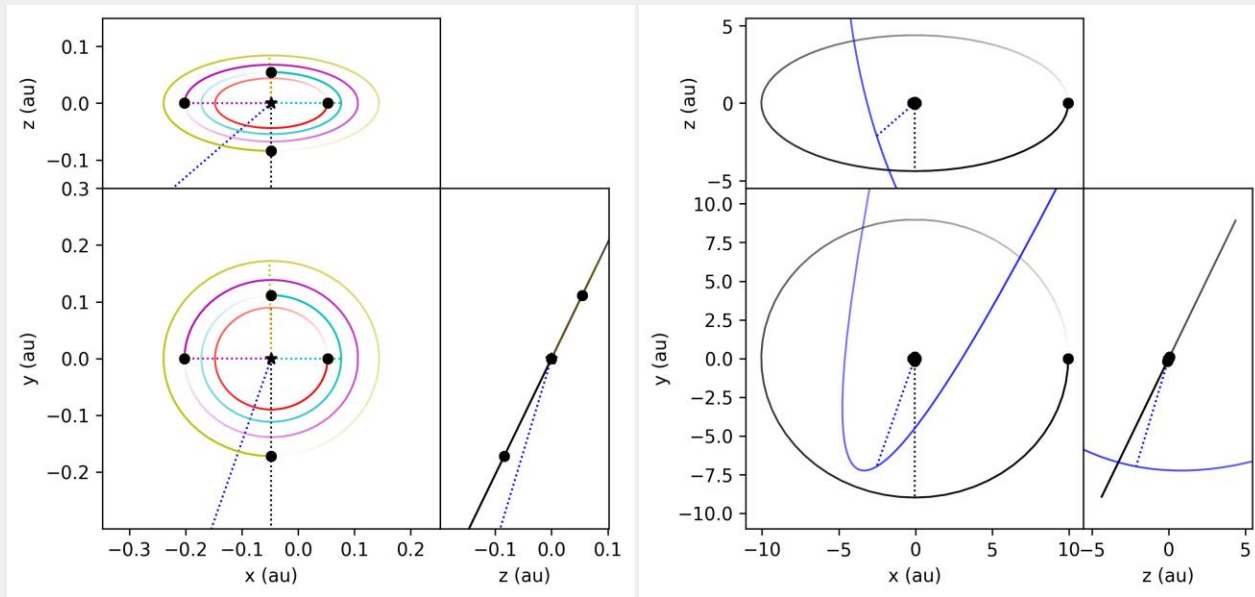
- few close interactions during the first ~ 70 timesteps (700 kyr) with two low-mass stars (blue + green) and the binary components of a low-mass binary (red).
- $0.7 M_{\odot}$ primary becomes companion, eventually unbinding the primordial binary to form a dynamical binary (**orange dashed**).



What if the single star has a planetary system before it becomes a binary?



The creation of a dynamical binary in a planet simulation



Modelled in Rebound, run to 500 Myr

Fly-bys reducing # of transiting planets in young close-in planetary systems

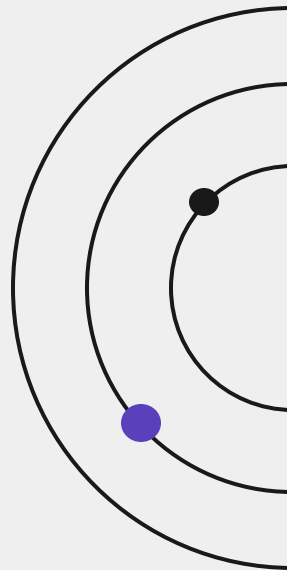
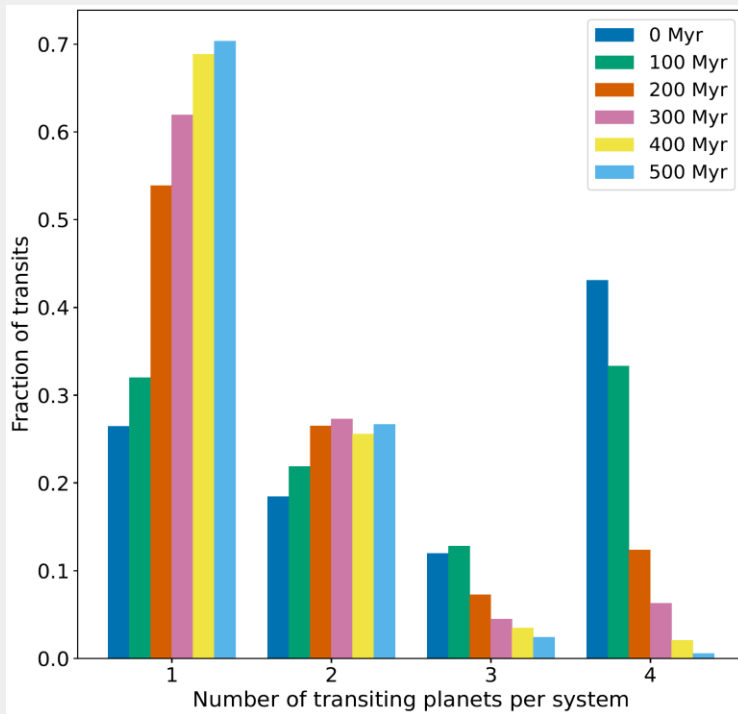
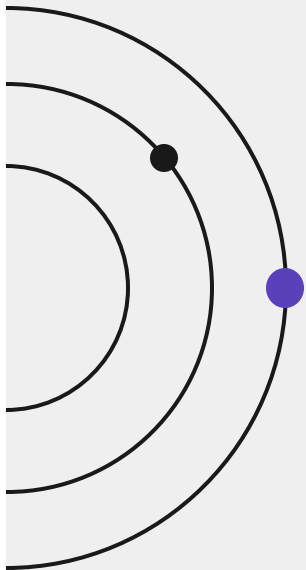
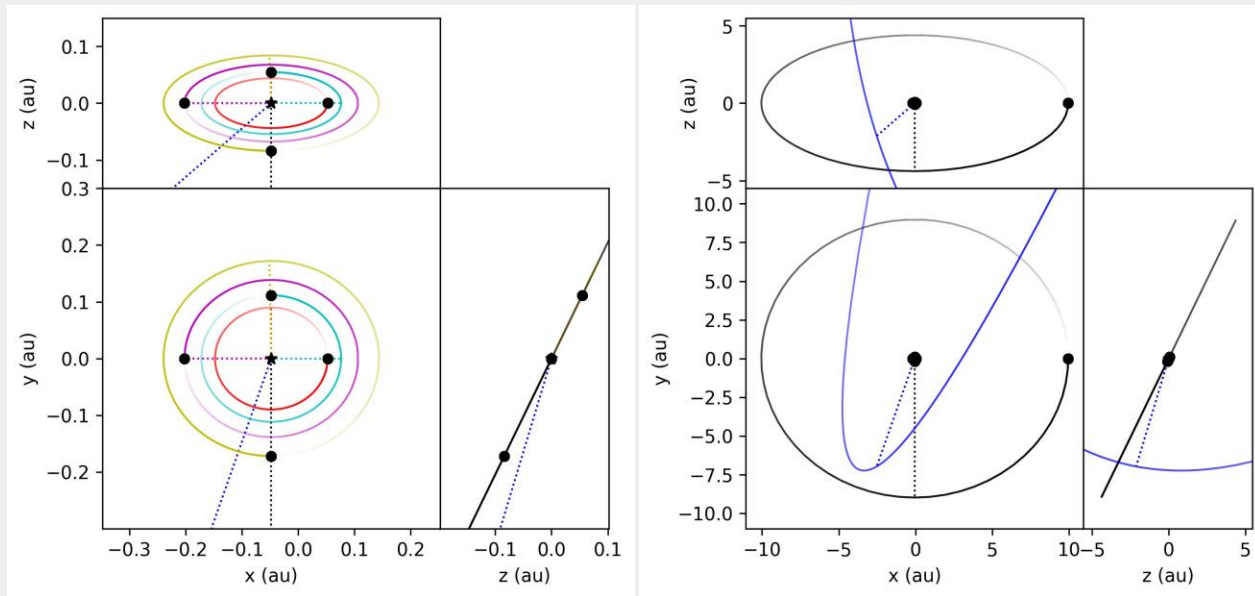
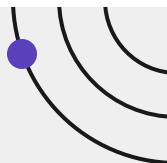


Figure credit: Schoettler & Owen 2024

The creation of a dynamical binary in a planet simulation

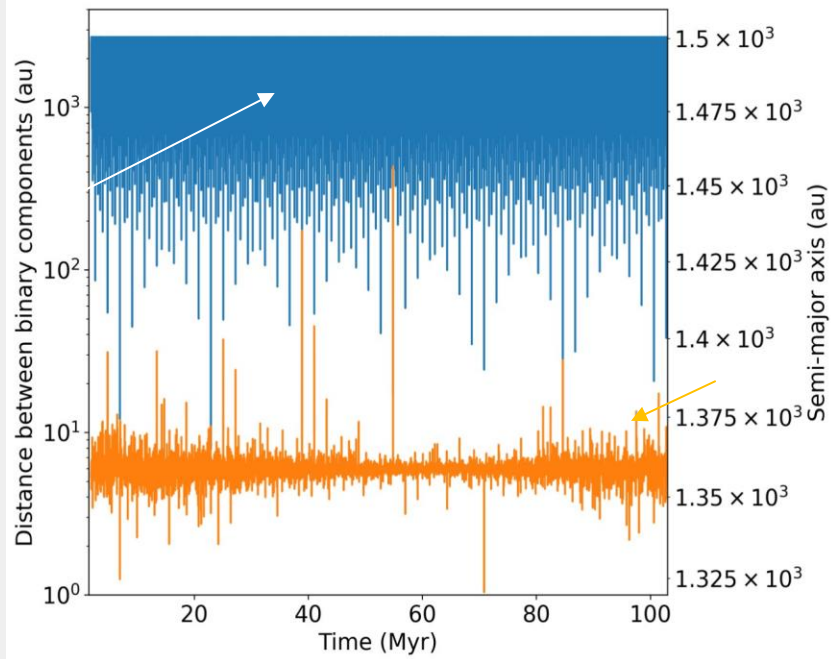


Modelled in Rebound, run to 500 Myr

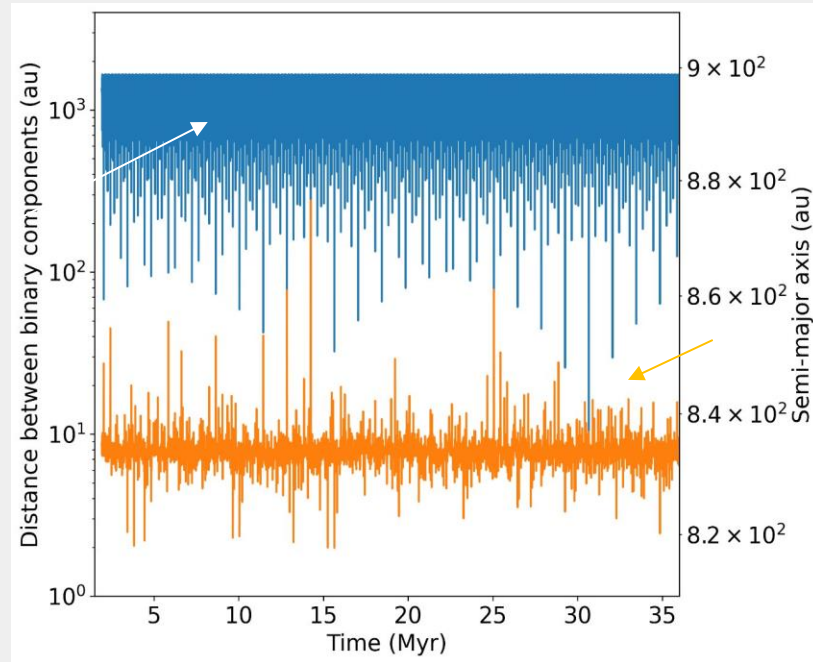


Dynamical binary properties

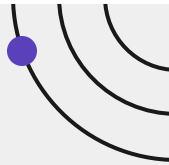
Equal-mass binary ($a = 1358$ au)



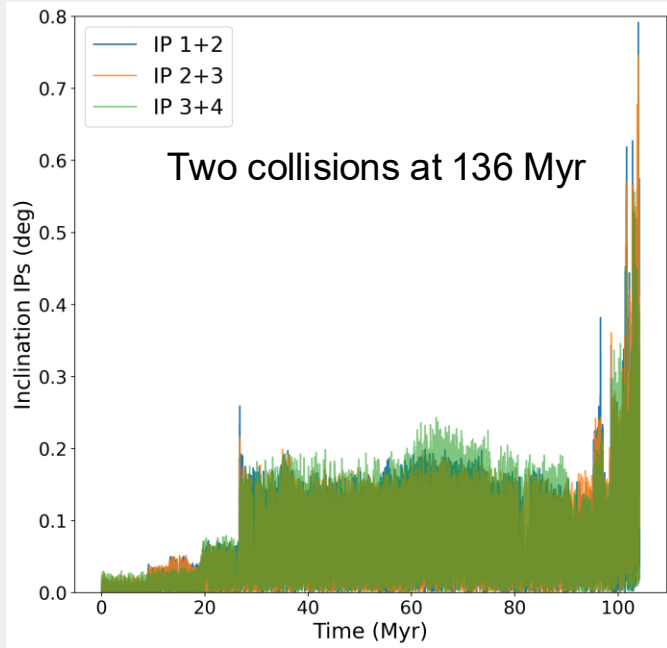
Unequal-mass binary ($a = 833$ au)



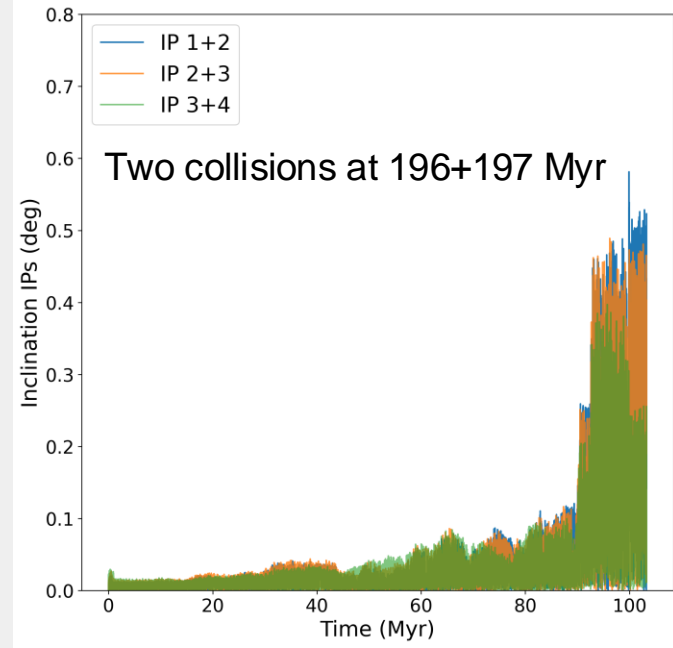
Period: 35kyr, Pericenter: ~ 8 au, eccentricity=0.99, Period: 23 kyr



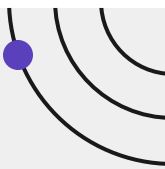
Mutual inclinations in equal-mass binary



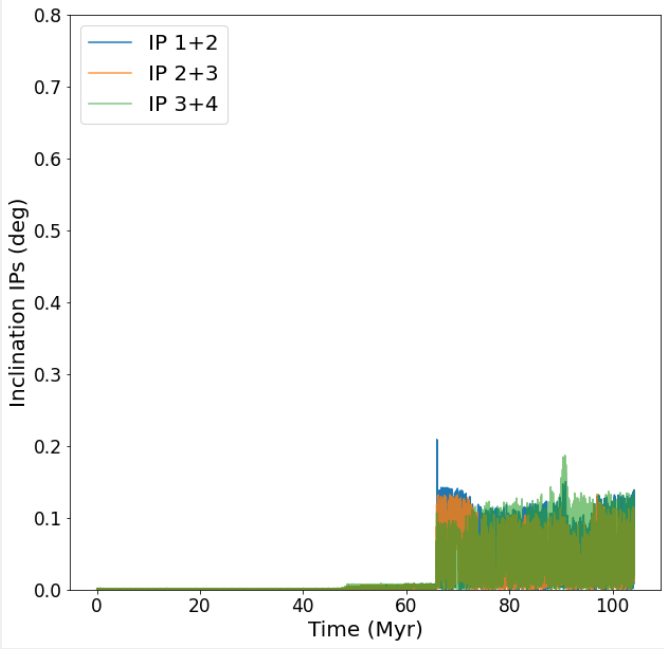
Dynamical binary



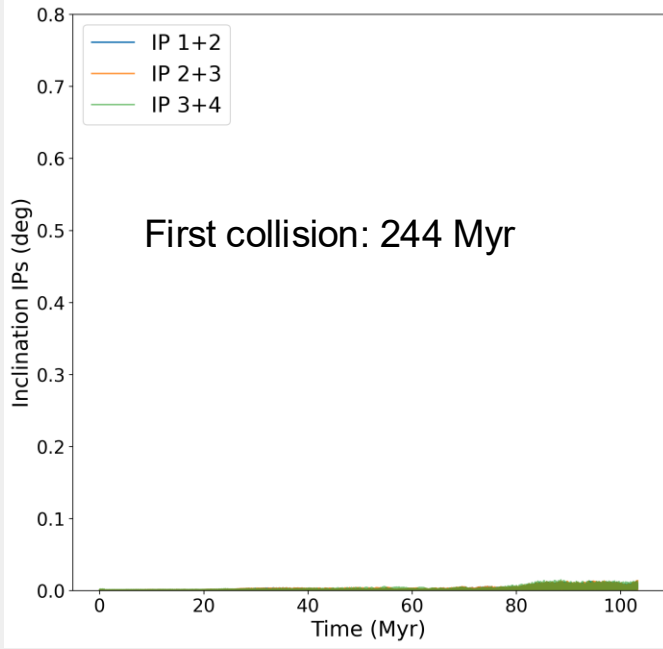
Single star



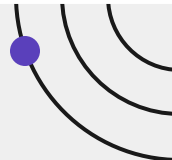
Mutual inclinations in unequal-mass binary



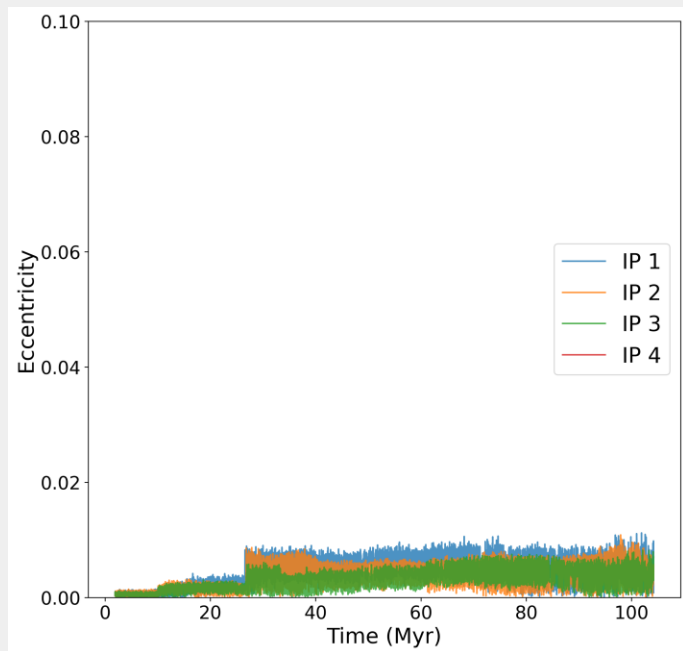
Dynamical binary



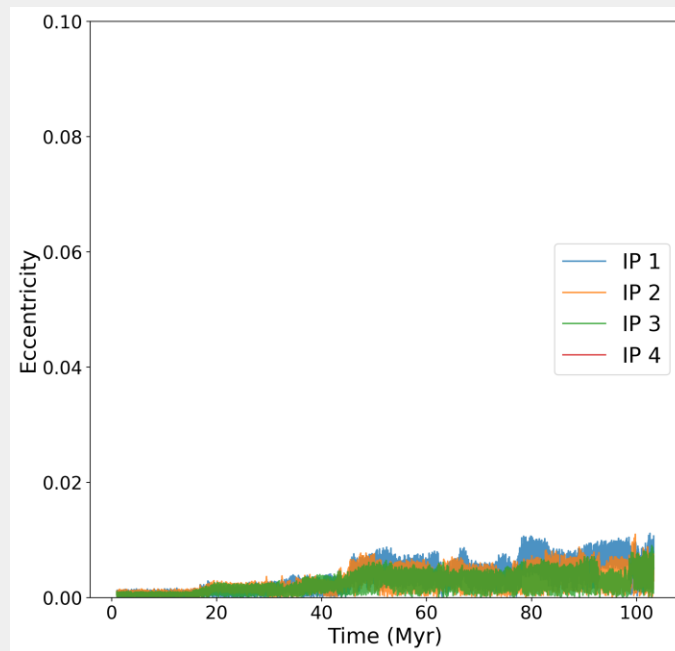
Single star



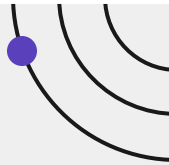
Eccentricity in equal-mass binary



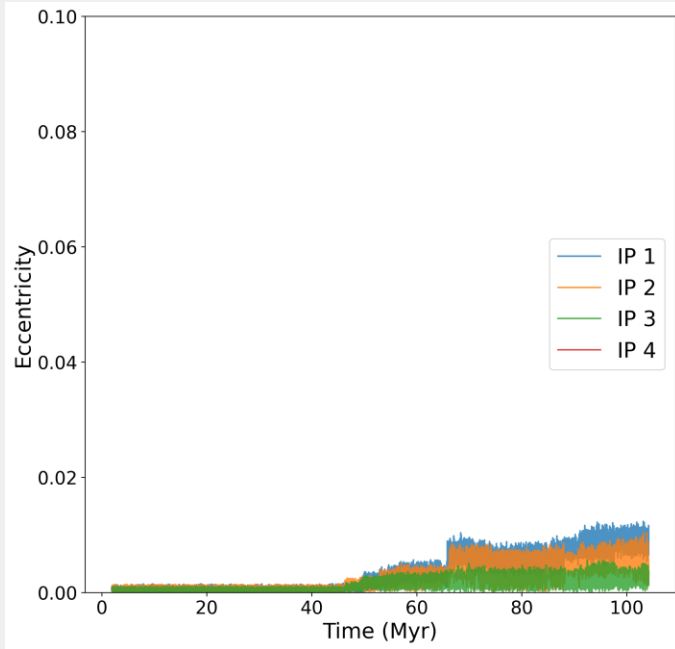
Dynamical binary



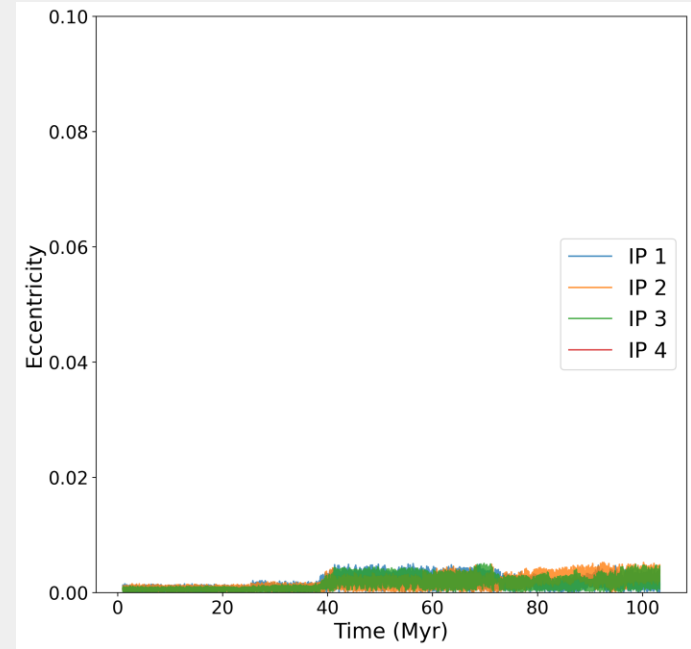
Single star



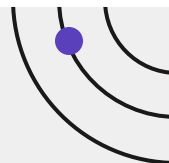
Eccentricity in unequal-mass binary



Dynamical binary



Single star



Conclusions + Next steps

- Planet system orbit evolution within a dynamical binary is sped up compared to the single star evolution case
- Equal-mass binaries are more disruptive than unequal-mass binaries
- If binary partner is lost from the wide dynamical binary at some point, no direct evidence in planet system orbits points to circumbinary evolution

--> advance primordial binary evolution to compare to dynamical case

--> further evolve the dynamical binary planet systems to 500 Myr





Thanks

Do you have any questions?

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