Imperial College London

The Effect of Disc Photoevaporation on the Evolution of Migrating Giant Planets.

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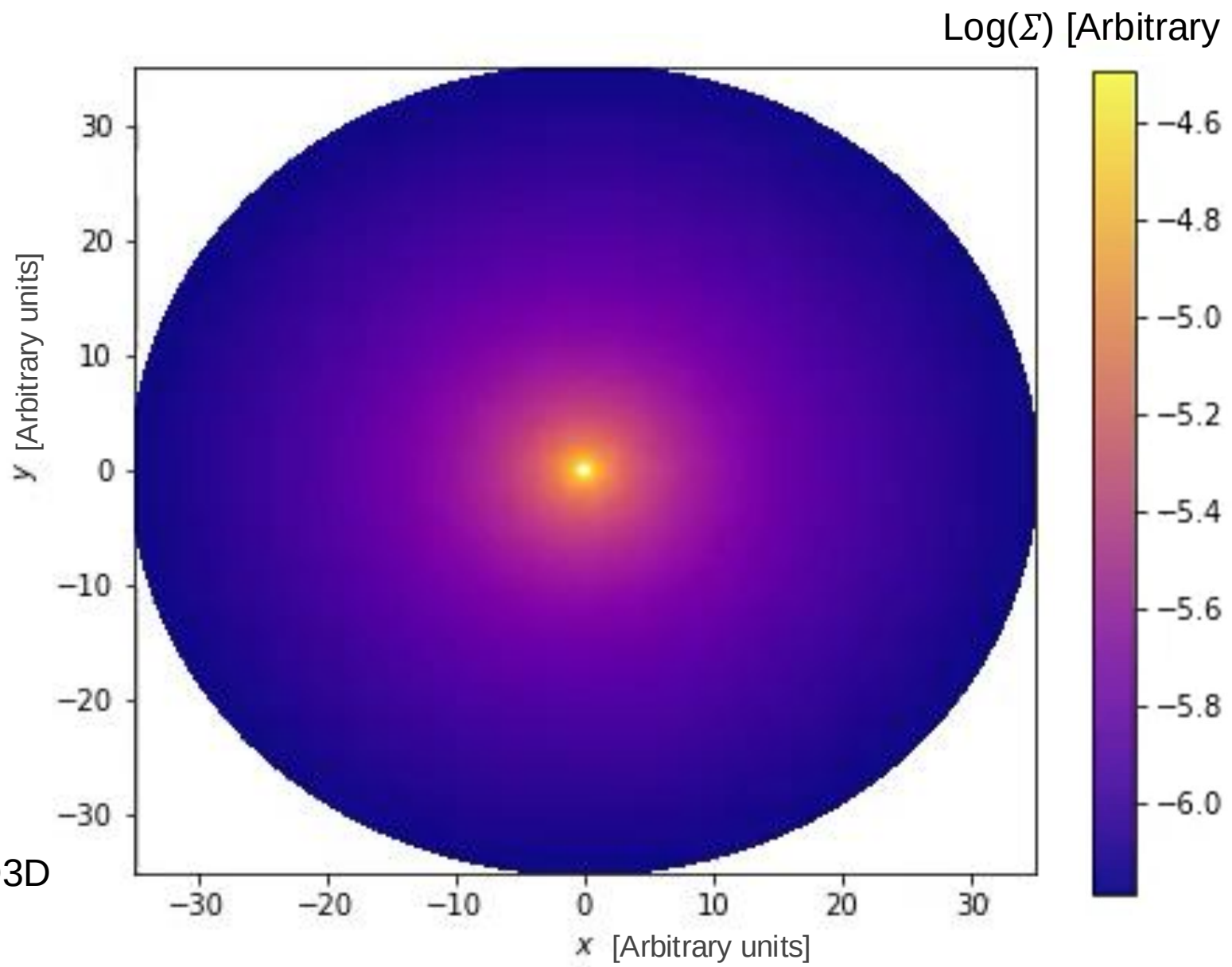
UKI Discs Meeting, September 11th 2024

Gap opening and type II migration



Made with FARGO3D

The importance of multi-planetary systems and resonances

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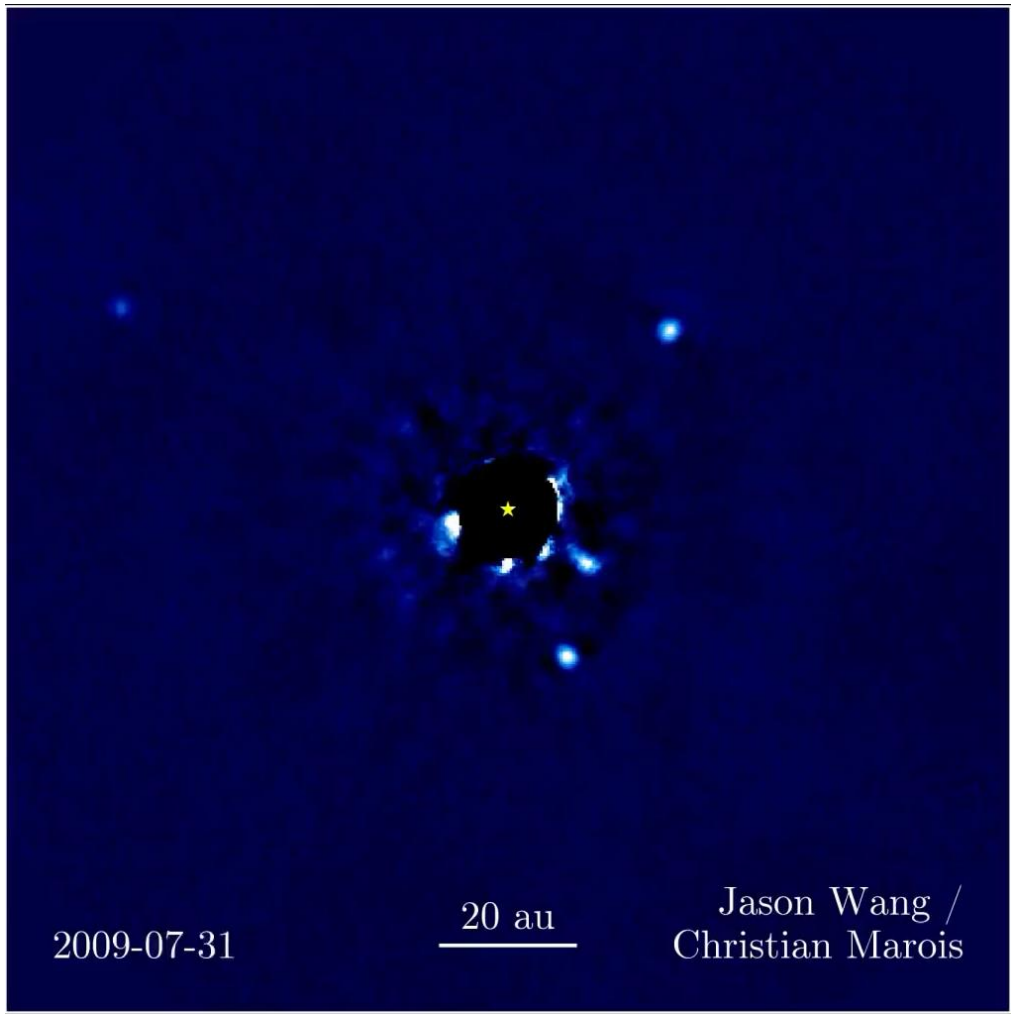
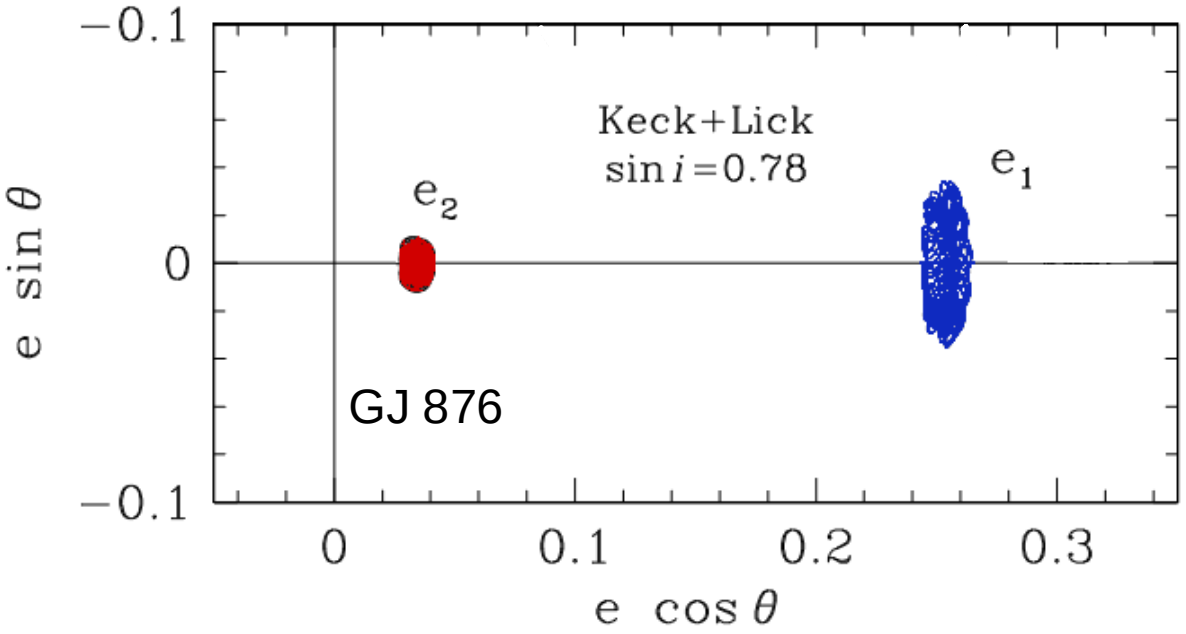
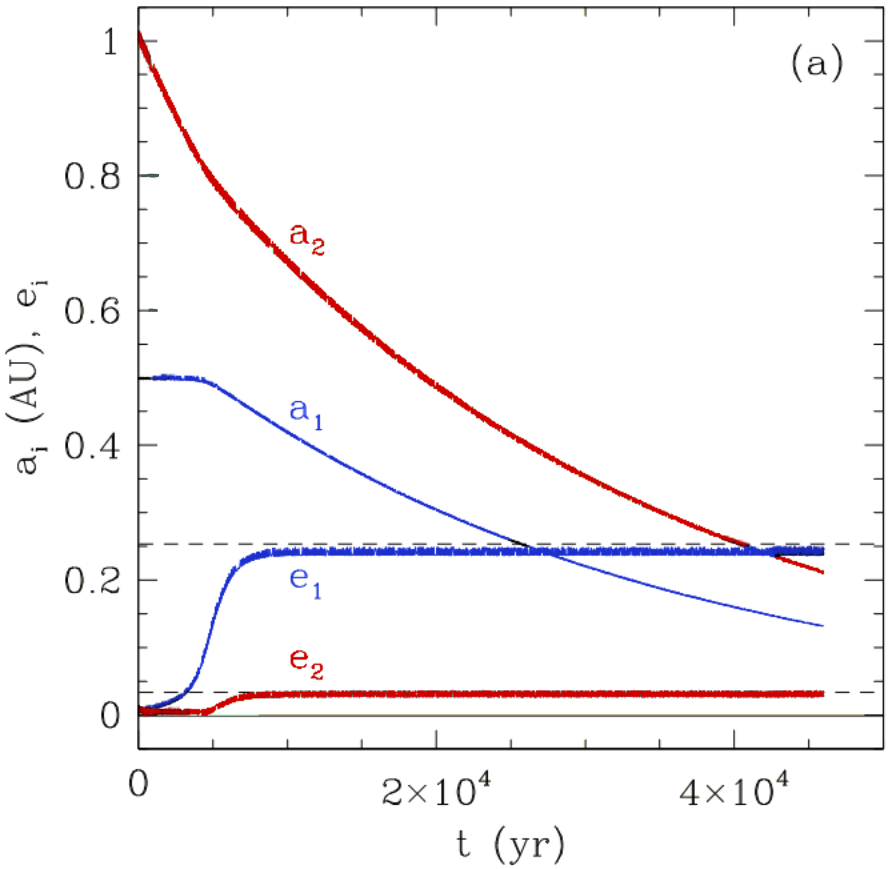


Possibly in resonance?

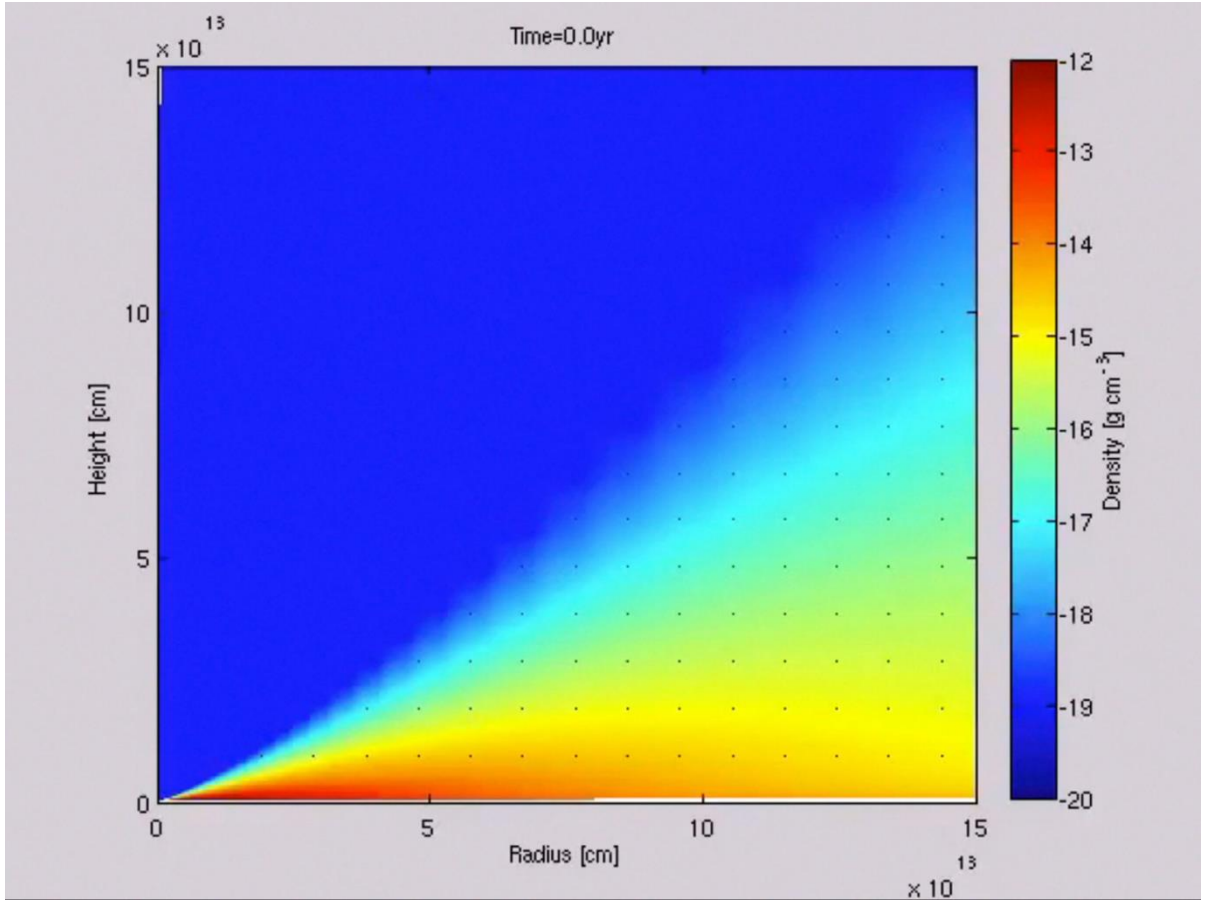
The importance of multi-planetary systems and resonances





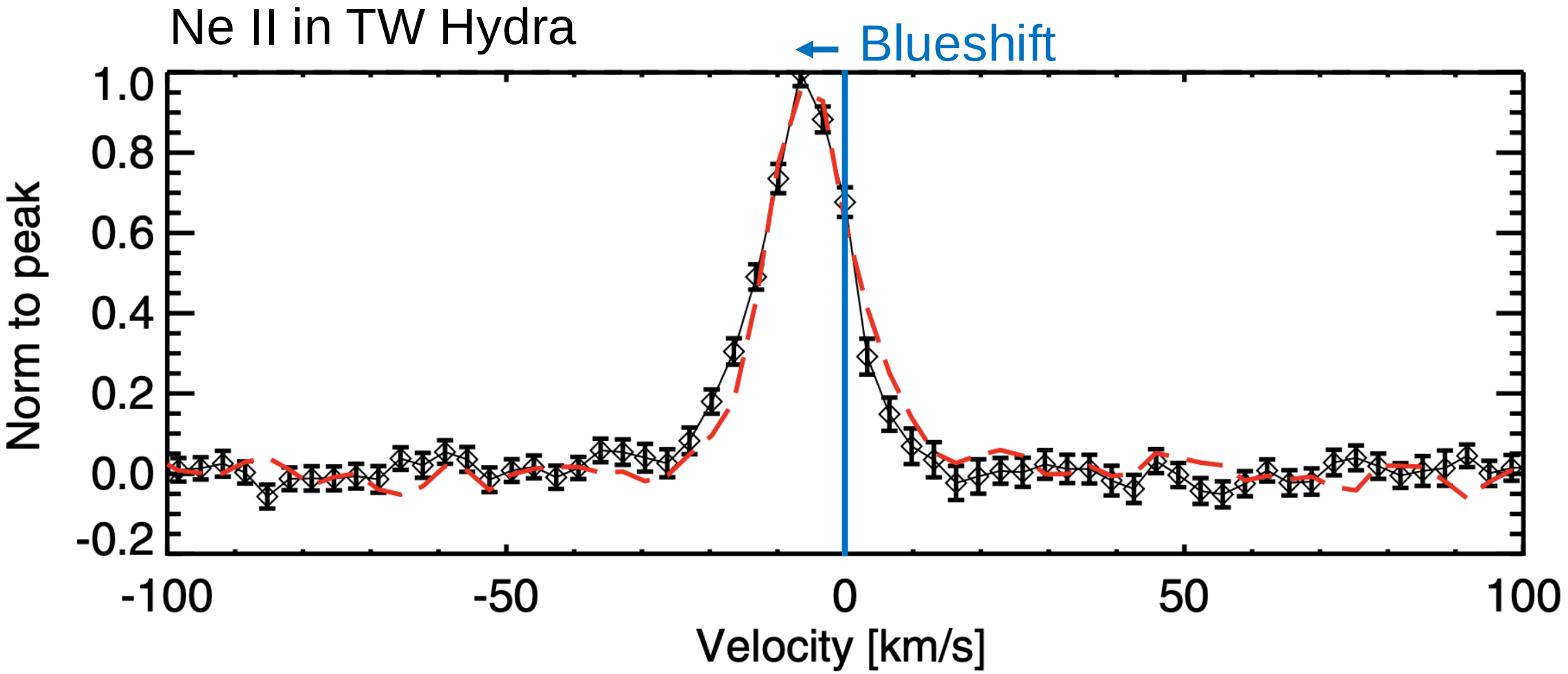
Adapted from Lee & Peale 2002

Photoevaporation – a preferred mechanism for disc dispersal



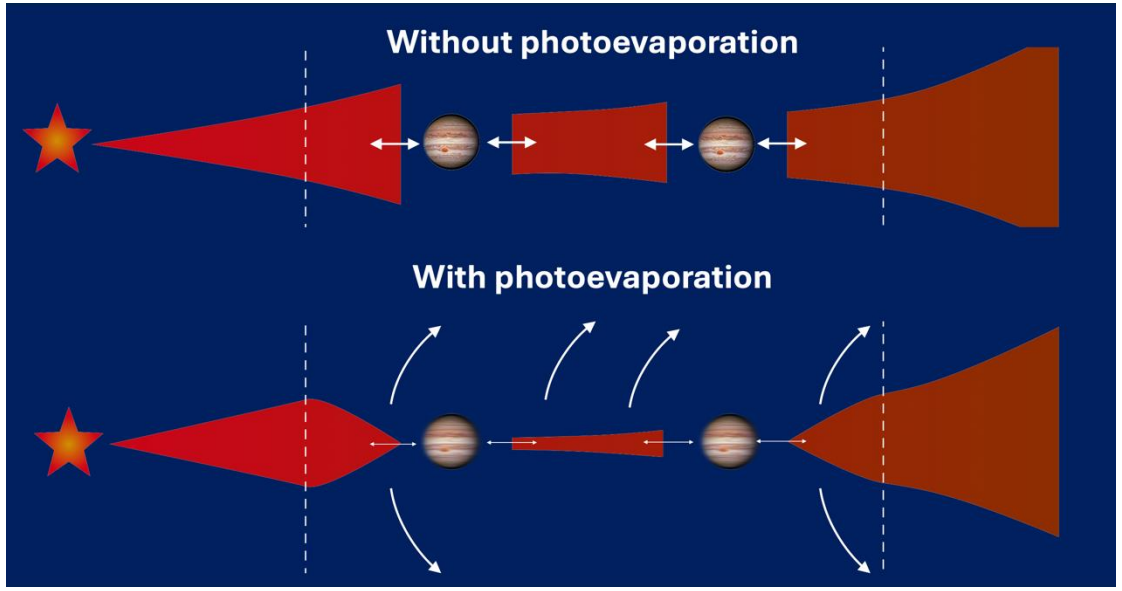
Hollenbach et al. 1994, Yorke et al. 1997, Font et al. 2004, Alexander et al. 2006, Owen et al. 2010, 2011, 2012

Photoevaporation – a preferred mechanism for disc dispersal



Adapted from Pascucci et al. 2011

The idea – disc photoevaporation



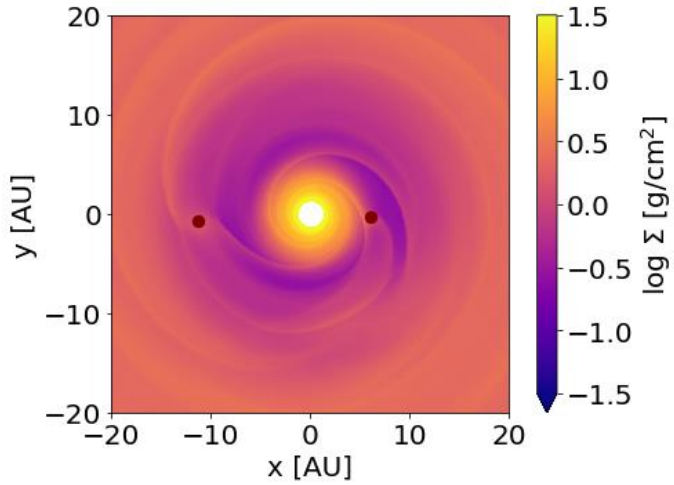
$$\frac{d\Sigma}{dt} = \dot{\Sigma}_{accretion} - \dot{\Sigma}_{PE}$$

$$\dot{M}_{accretion} \propto \Sigma$$

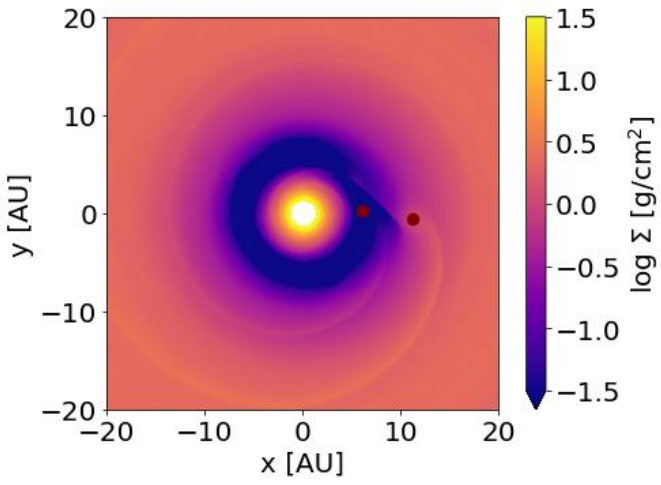
The mass loss rate due to photoevaporation dominates in the gap, where surface density is low

Resonance correlates with eccentricity

Without photoevaporation



With photoevaporation



The setup – disc photoevaporation

1 M_J planets

2D isothermal simulation

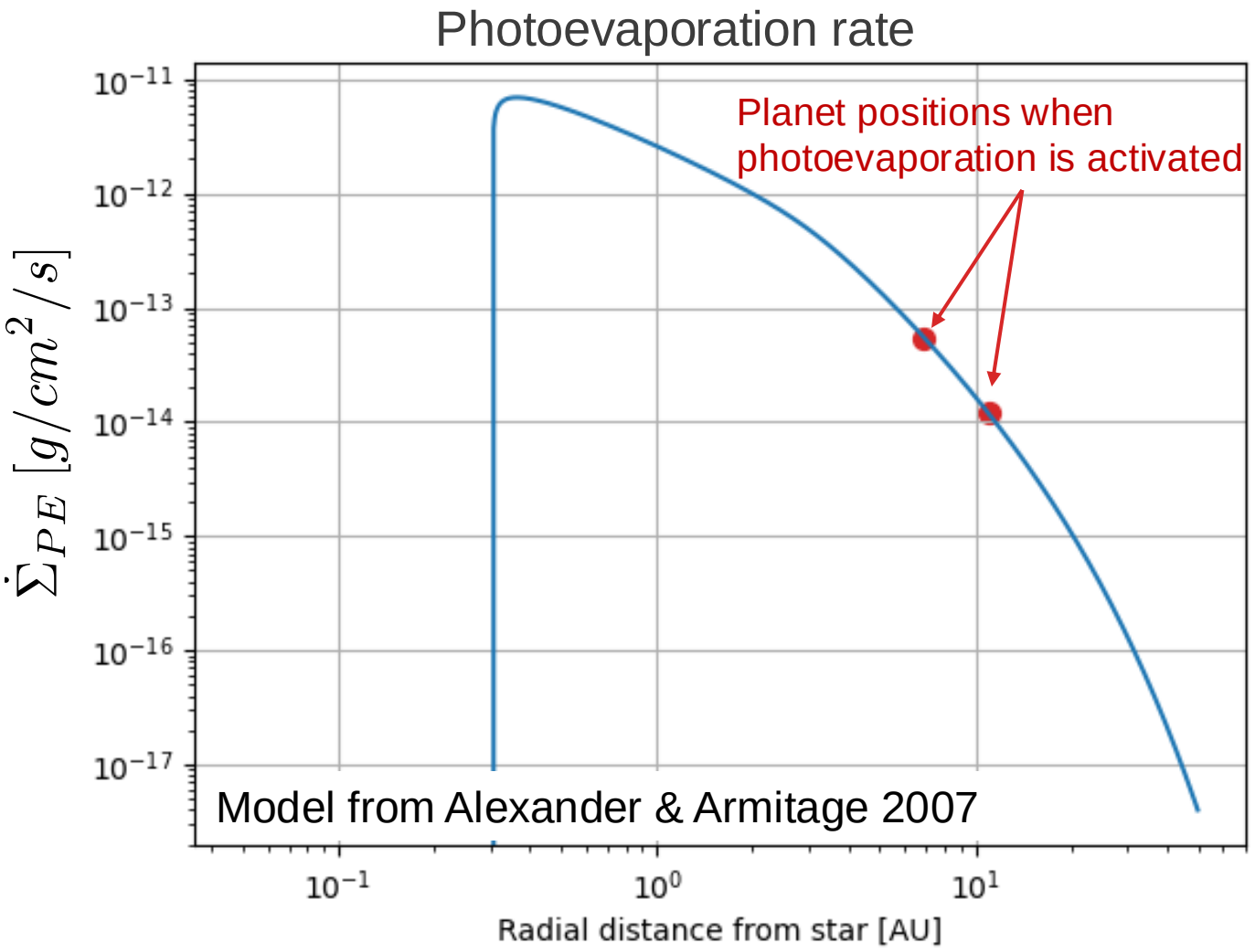
$\alpha = 10^{-3}$

3 Photoevaporation models:

No wind: $\dot{M}_{wind} = 0\ M_\odot\ .\ yr^{-1}$

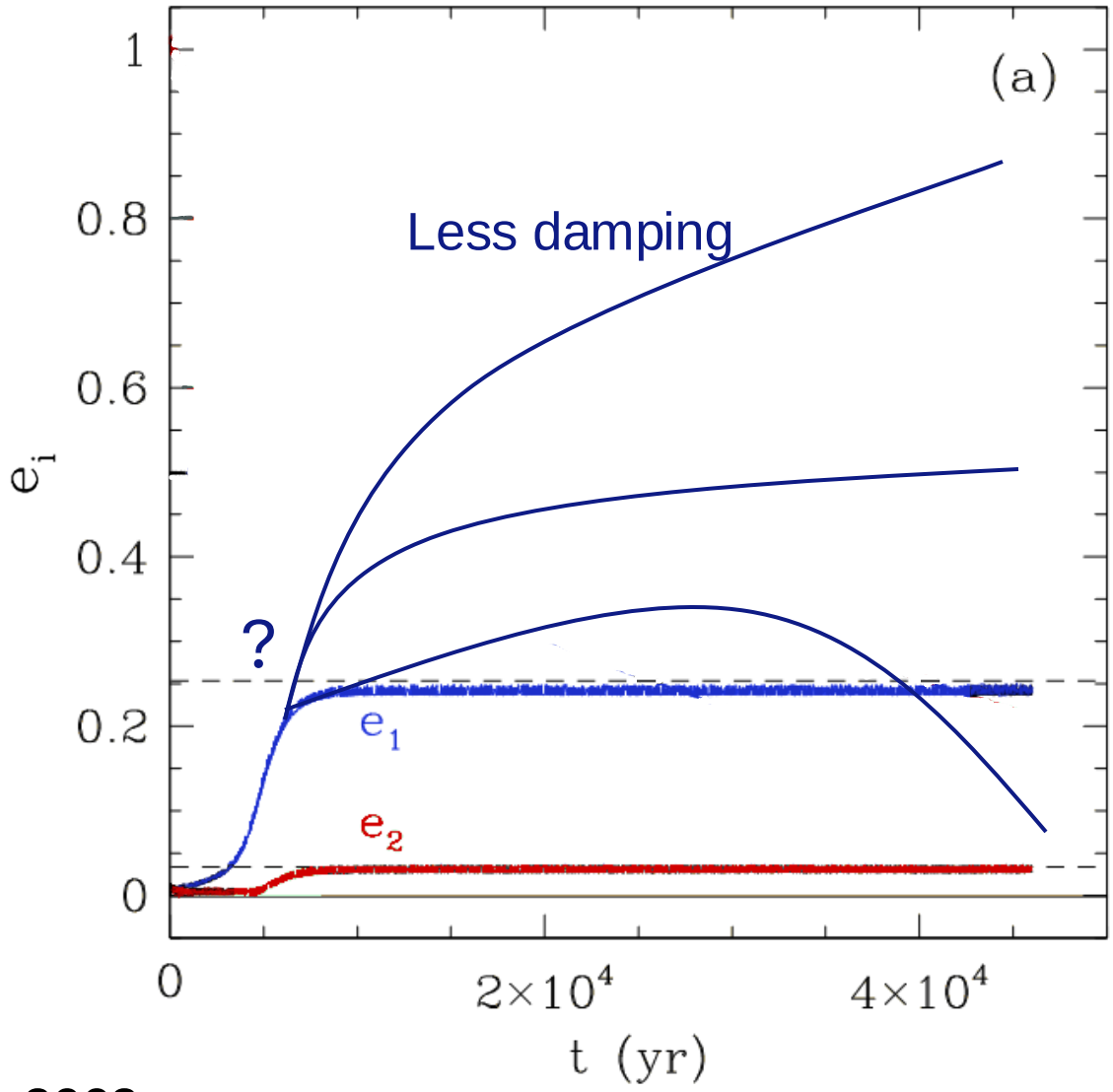
Weak wind: $\dot{M}_{wind} = 5.0\ \times 10^{-10}\ M_\odot\ .\ yr^{-1}$

Strong wind: $\dot{M}_{wind} = 5.0\ \times 10^{-9}\ M_\odot\ .\ yr^{-1}$



Photoevaporation only contributes to deepening pre-existing planetary gaps on these timescales

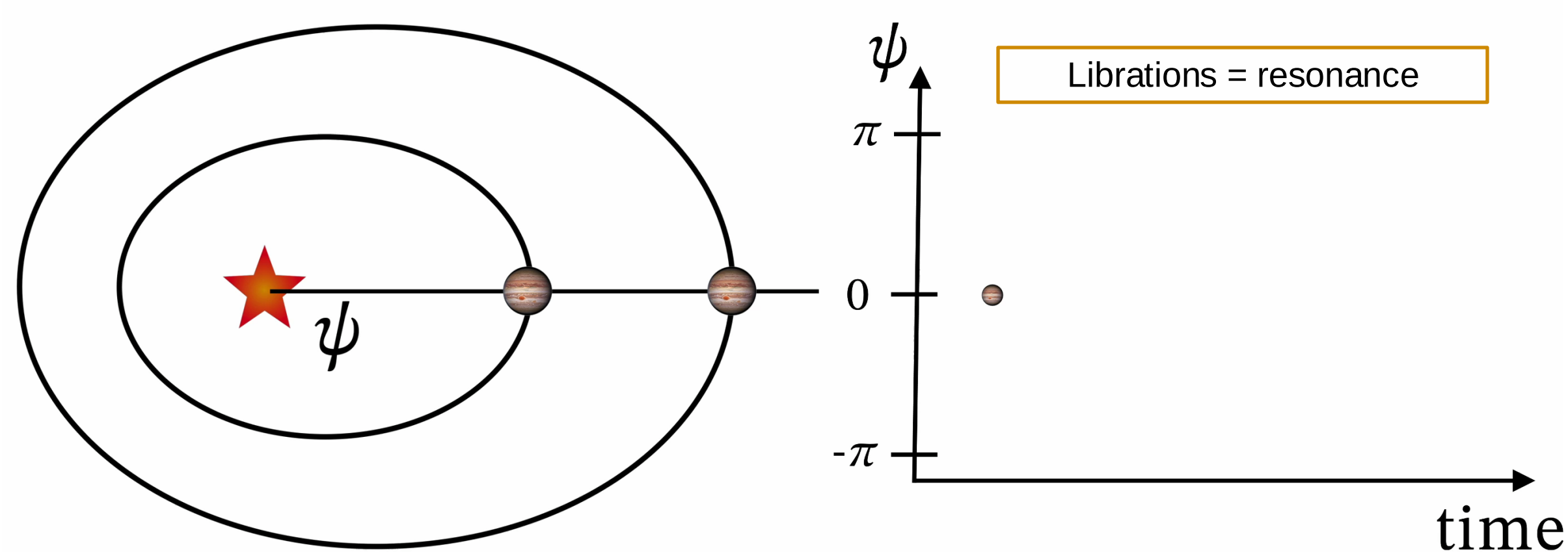
Expectation – higher eccentricities



Resonance breaking mechanisms

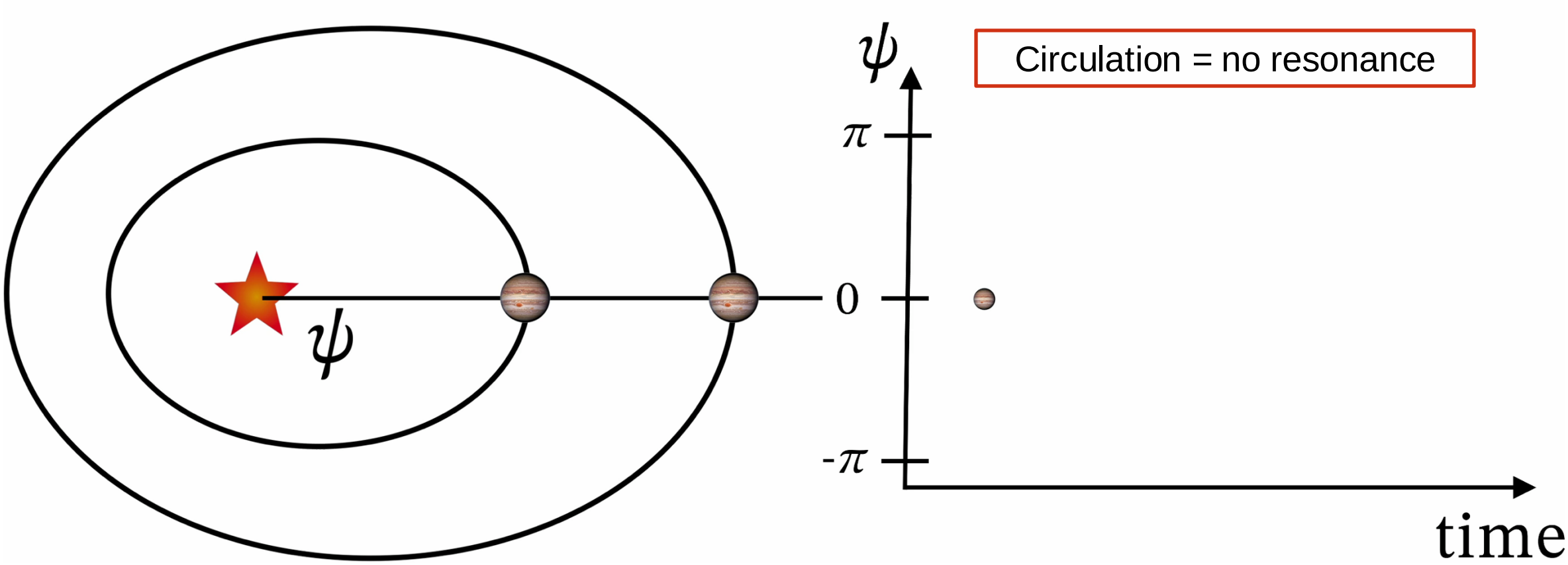
Adapted from Lee & Peale 2002

The model – the resonant angle



The resonant argument determines how deep the resonance is.
The smaller the oscillation amplitude, the deeper the resonance.

The model – the resonant angle



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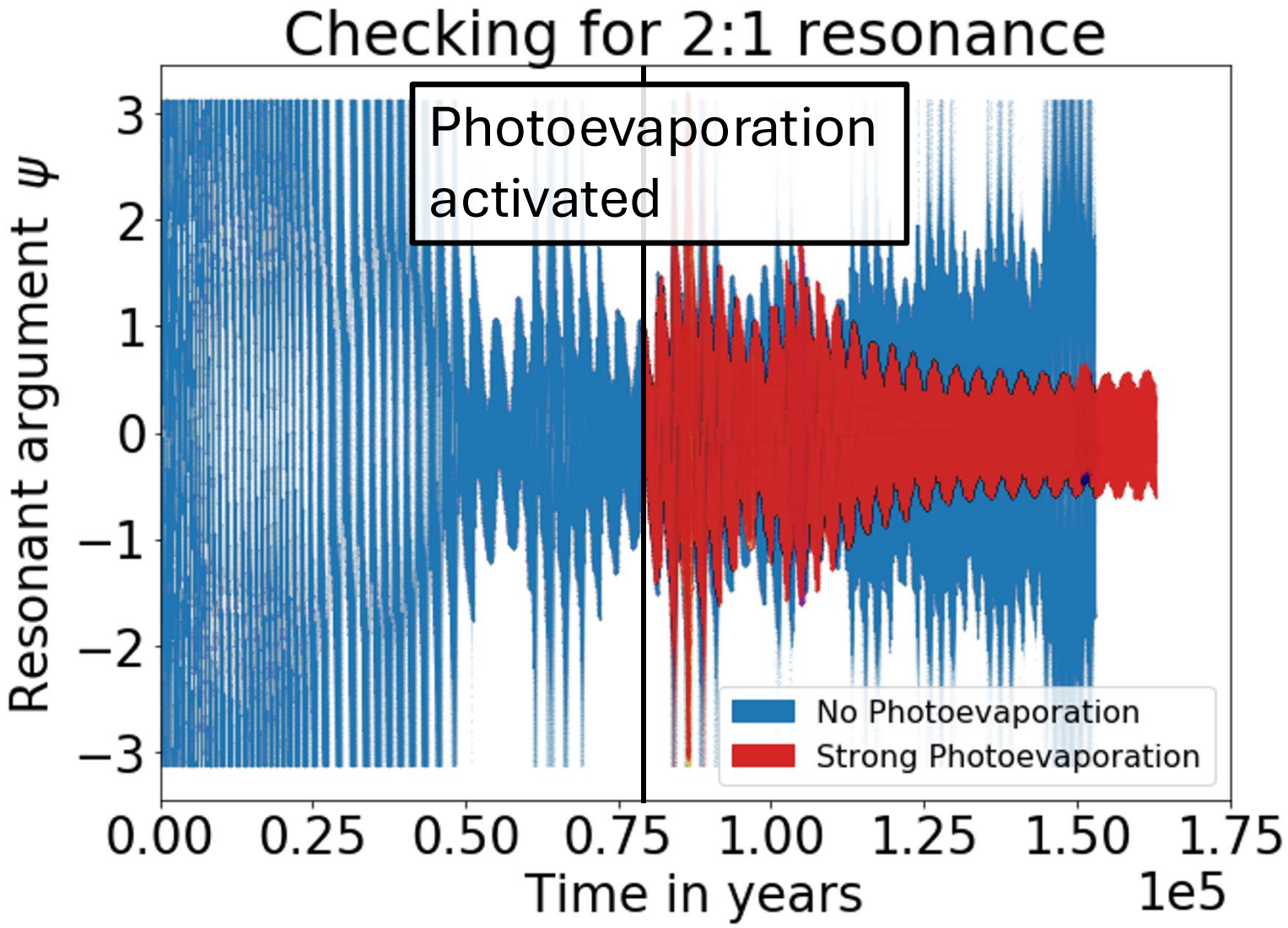
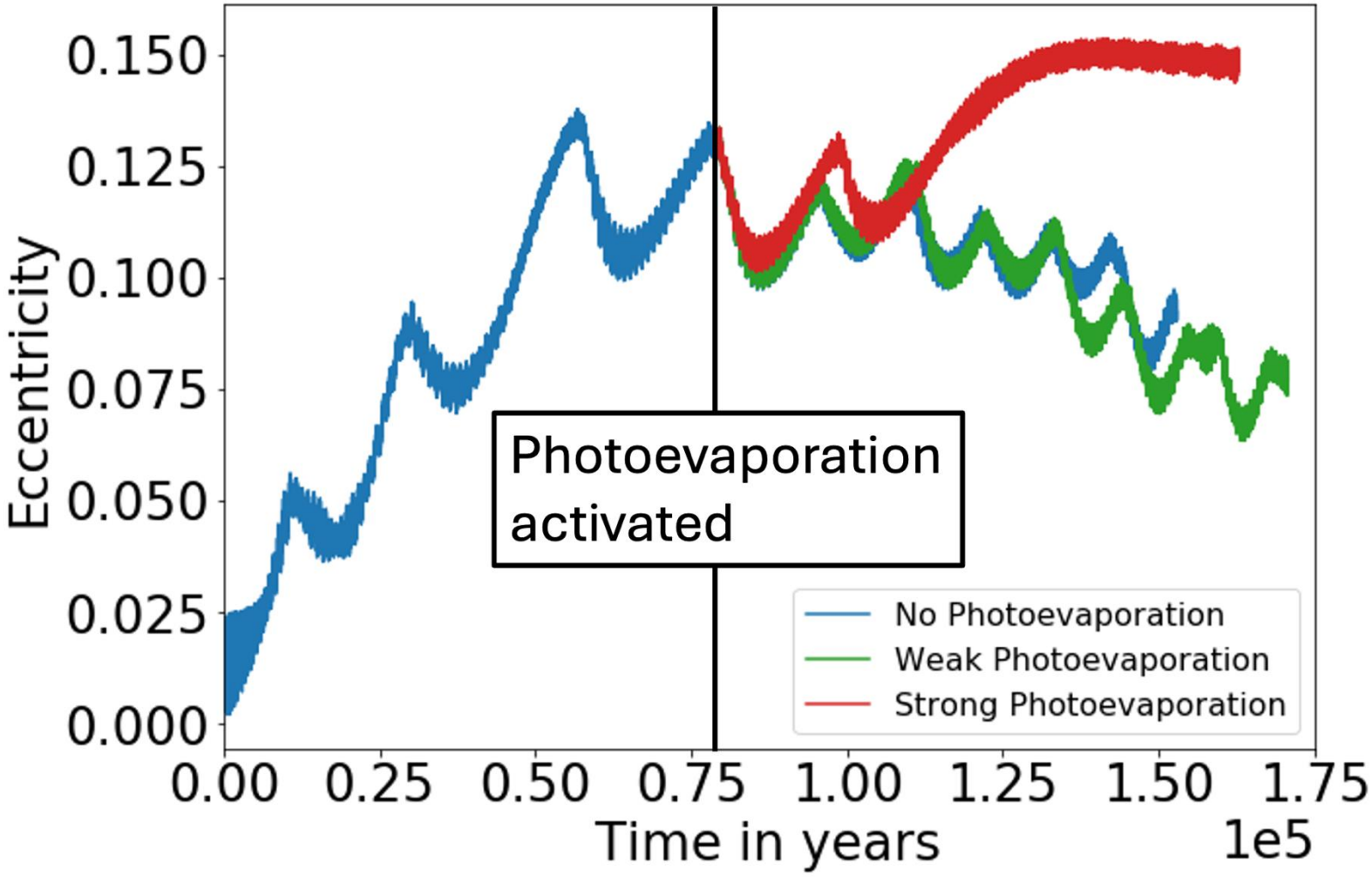
Results – deeper and more durable resonances



Results – eccentricity rise and slower decay



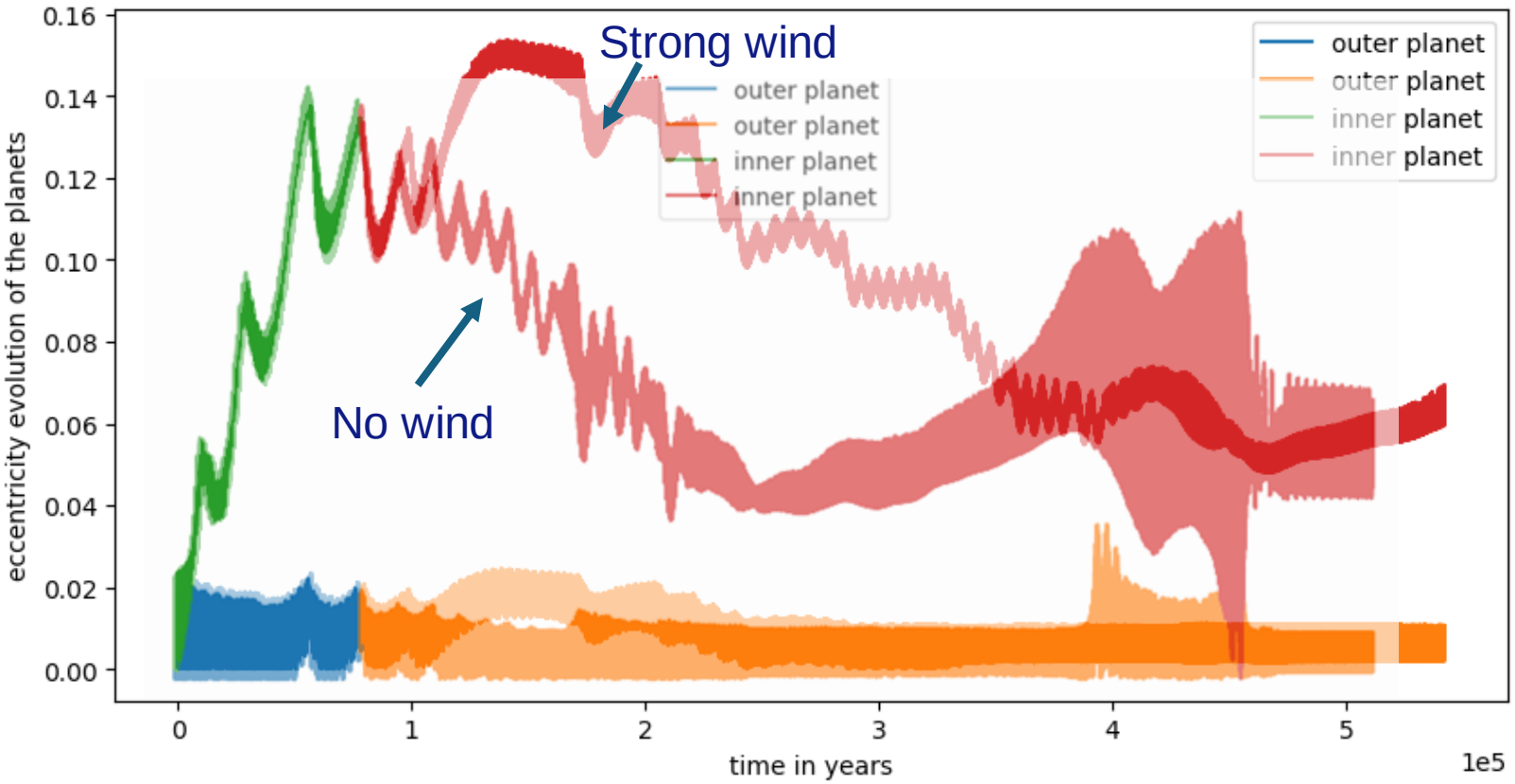
Summary

Goal: Investigate how photoevaporation affects the evolution of giant planet resonances

Result: Strong photoevaporative winds delay resonance breaking and lead to higher eccentricities associated with a deeper resonance

Next: Explore a larger parameter space to obtain more information on this phenomenon

Backup – longer simulations



Issues arise due to interactions between the spiral wakes and the inner boundary