1 Introduction

- Migration and MMR capture in disks
- Observations of Kepler-88, K2-19 show apsidal alignment
- What conditions are necessary for alignment?
- **Goal:** Constrain disk aspect ratio with observations of aligned systems

2 Restricted problem

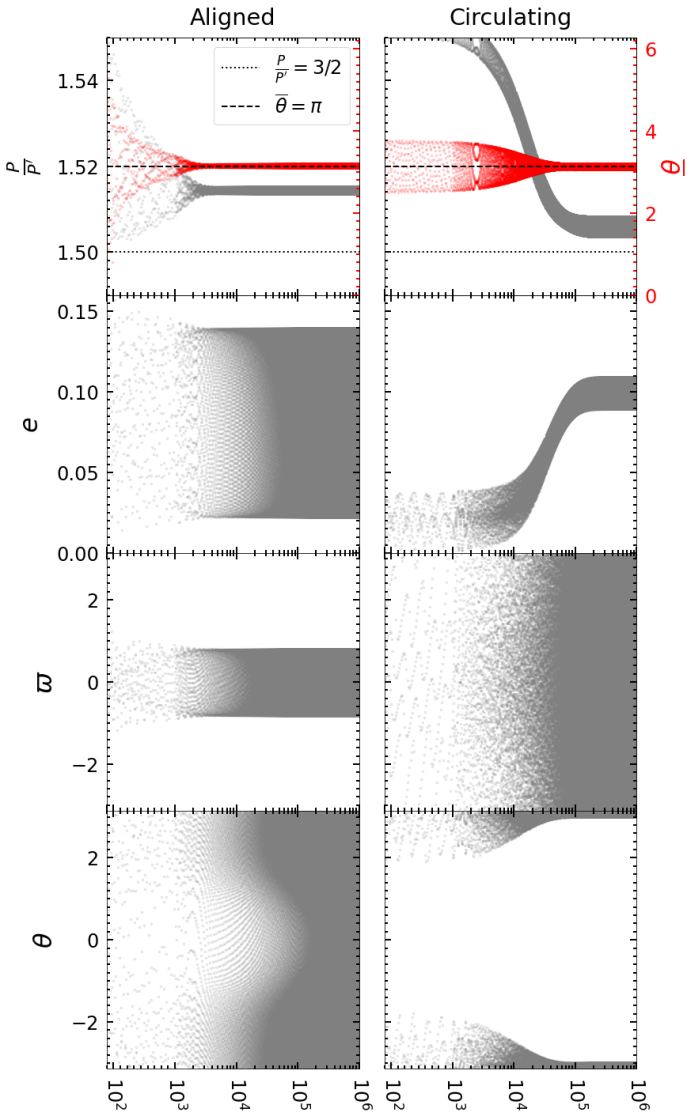
- Background formalism, Wisdom's Hamiltonian
- Summarize shifted resonance and resonant variables ($\overline{\gamma}$, $\overline{e}$, $\overline{\theta}$)

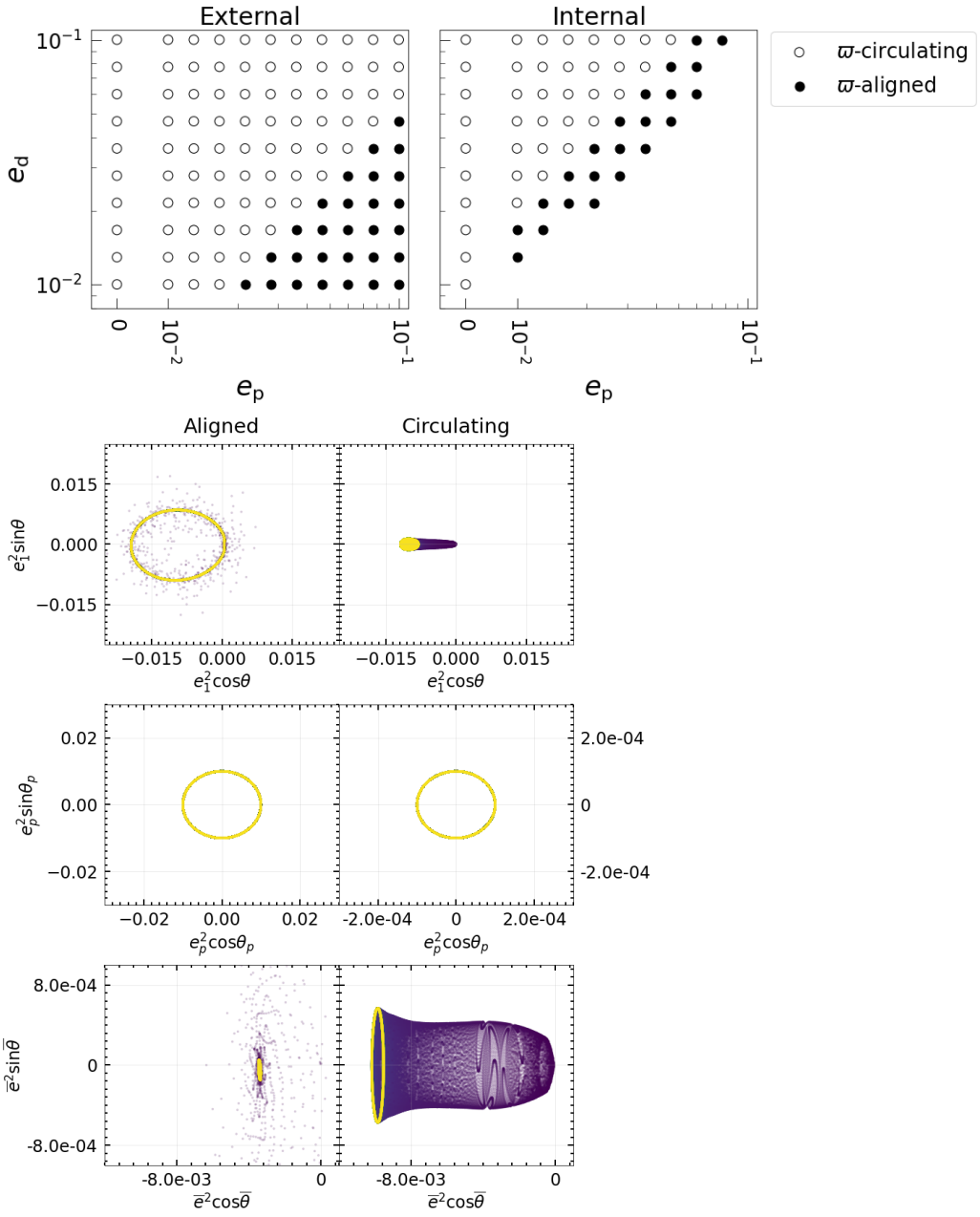
2.1 Disk forces

- Dissipative forces from protoplanetary disk conditions
- Connect parameters T_m and T_e to disk aspect ratio and density
- Equilibrium eccentricity e_d for $e_p = 0$

2.2 External MMR

- Heuristic explanation with equation of state
- Plot of gamma components


Aligned
Circulating
$\frac{P}{P'} = 3/2$
$\overline{\theta} = \pi$
$\frac{P}{P'}$
e
ϖ
θ
$|\theta|$
1.54
1.52
1.50
0.15
0.10
0.05
0.00
2
0
−2
6
4
2
0
10^2
10^3
10^4
10^5
10^6



2.3 Internal MMR

- Similar to external

- Migration model fails for $e_p < e_d$

3 Two massive planets

- Work in progress

4 Observations

- K2-19 b,c have $\delta\varpi \approx 0$, $e_b, e_c \approx 0.2$, but θ_b and θ_c both circulate

5 Conclusion