



Dynamics of polar-aligned Circumbinary Discs with applications to Planet Formation

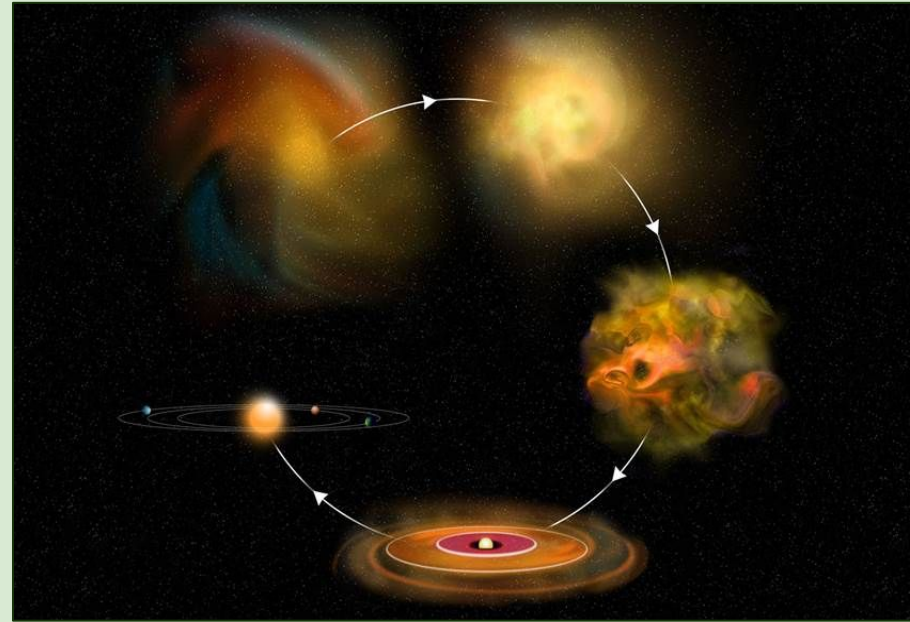


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June 10th, 2025

Protoplanetary Disks

- ★ Disks of gas and dust form around stars during collapse
- ★ Spin of disk usually in direction of host star's angular momentum vector
- ★ Disks can also form around **binary systems**

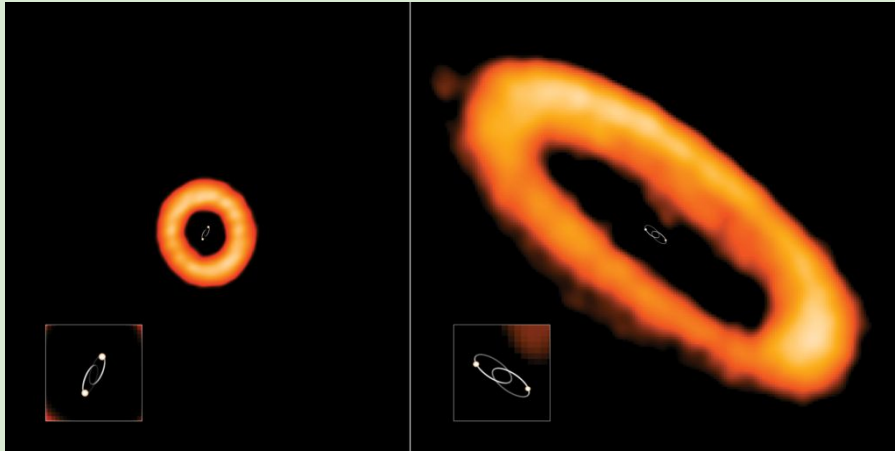
Star Formation



Bill Saxton, NRAO/AUI/NSF

Left: HD 98800 B (polar)

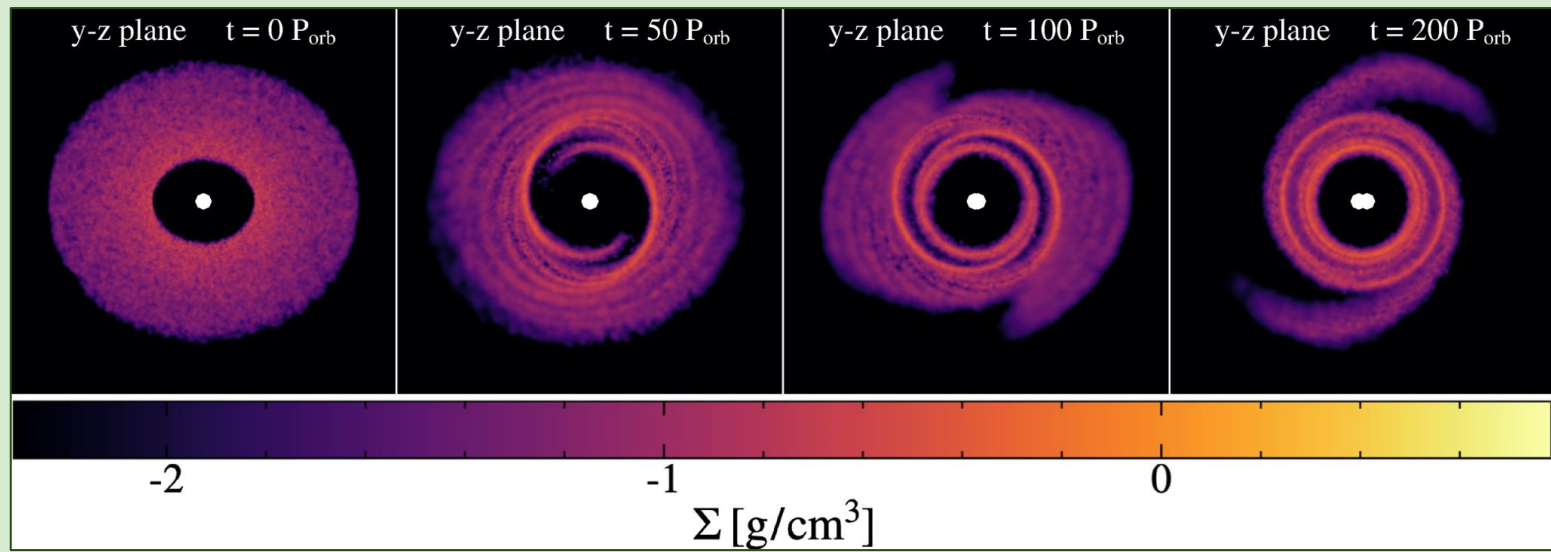
Right: AK Sco (coplanar)



ALMA (ESO/NAOJ/NRAO), I. Czekala and G. Kennedy; NRAO/AUI/NSF, S. Dagnello

Binary Systems

- ★ Stars are more commonly found as binary systems
- ★ Disk initially forms misaligned to the binary plane
- ★ Can evolve over time to be coplanar or **polar**



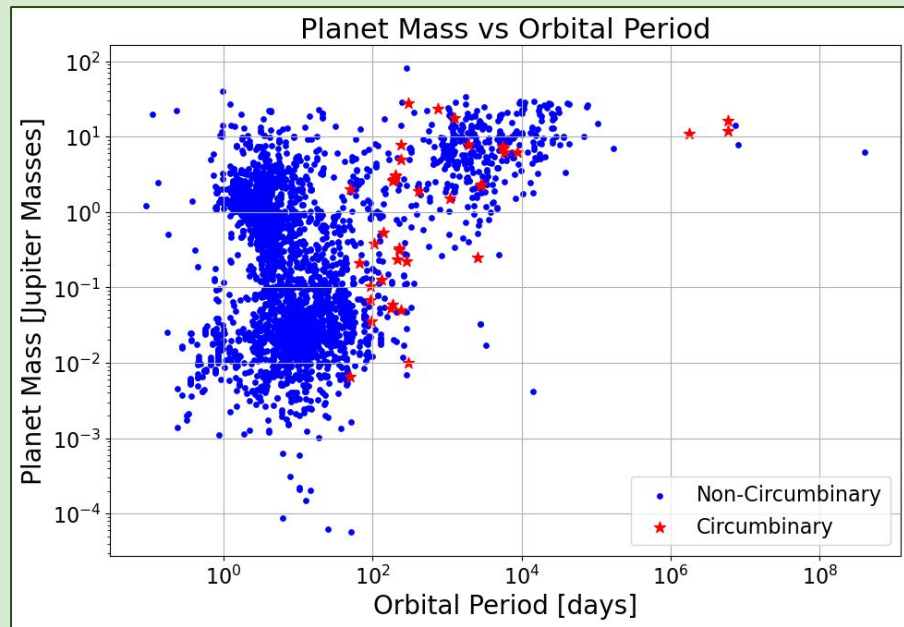
Smallwood et al (2024),
MNRAS

Dust Rings

- ★ Dust is coupled with gas, larger grains experience drag
- ★ These grains accumulate to form rings
- ★ These dust rings have the potential to grow polar planets

Why does this matter?

- ★ Can provide insight into dust ring formation and binary-orbit dynamics
- ★ Bias in exoplanets discovered: almost all from single star systems



Data: NASA Exoplanet Archive

Simulations with PHANTOM

Price et al. (2018)

PHANTOM is a Smoothed Particle Hydrodynamics (SPH) used to simulate a variety of astrophysical systems

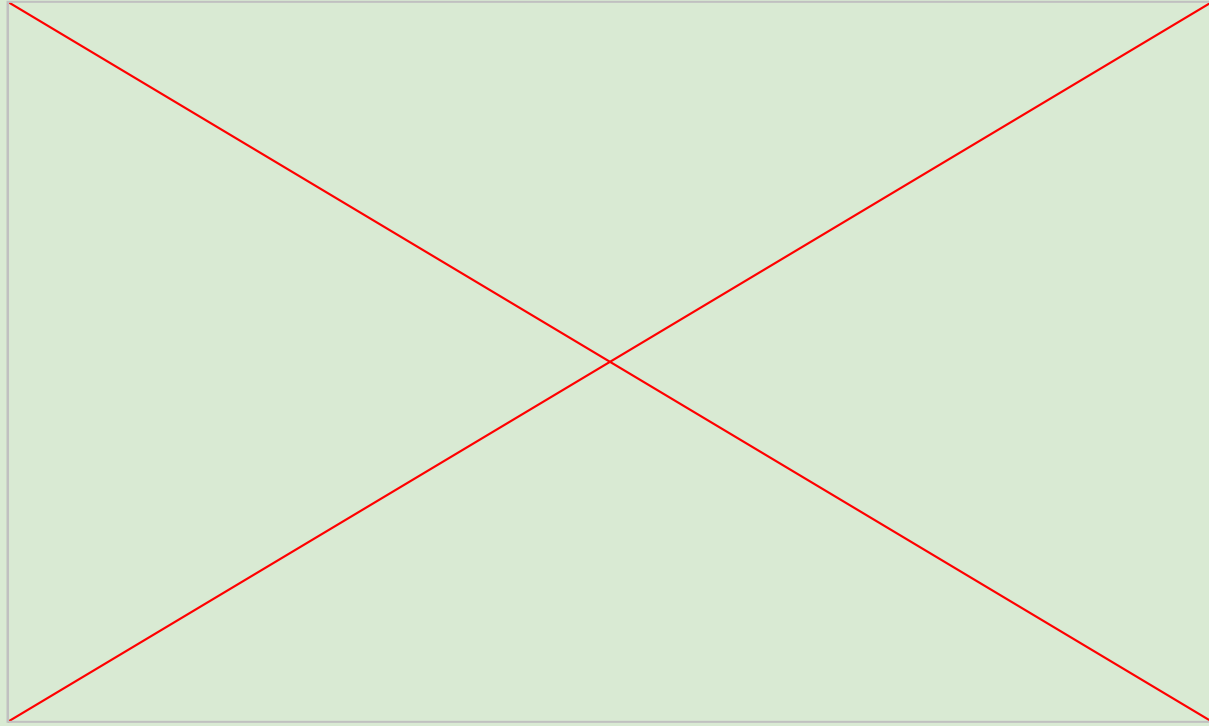
Goals

Model a
binary system
& disk with
varying
masses for
each

Run analysis
code to
obtain data
on dynamics
for each

Generate a
script plotting
values such
as inclination
over time

Test simulation



Equal mass binary: $M = 0.5M_{\odot} + 0.5M_{\odot}$

Disk radius: 2-5au

Initial inclination: $i_0 = 60^\circ$

Conclusions

- ★ Analyze simulation results for each run
- ★ Run additional simulations if needed
- ★ Observe disk and binary evolutions



Questions?