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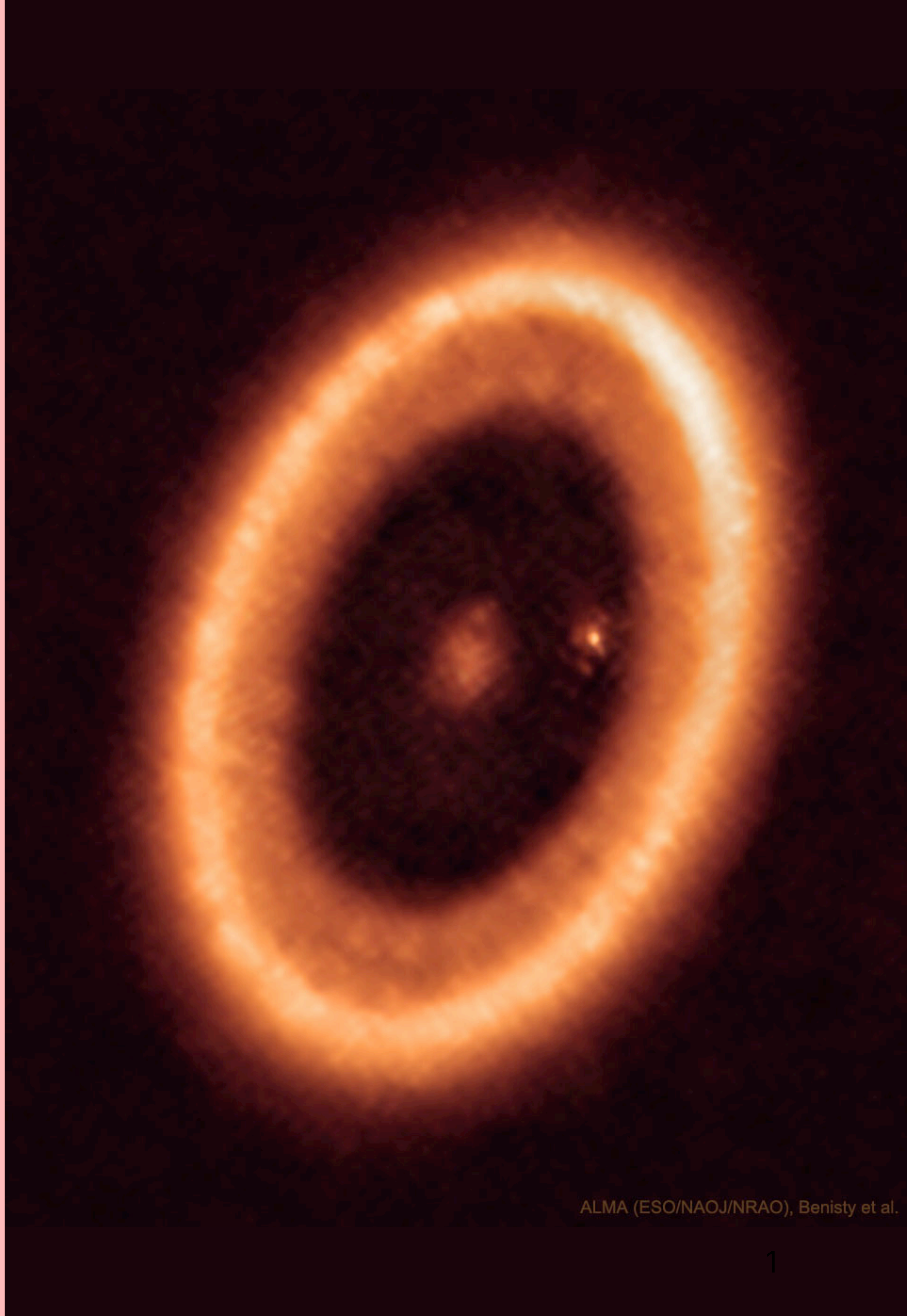
# Modelling PDS70:
## from multi-planetary dynamics to dust continuum emissions

**Philippine Griveaud**
*Max Planck Institute for Astronomy*

**In collaboration with**
Clément Baruteau, Michiel Lambrechts, Elena Lega, Aurélien Crida



# THE PDS 70 SYSTEM

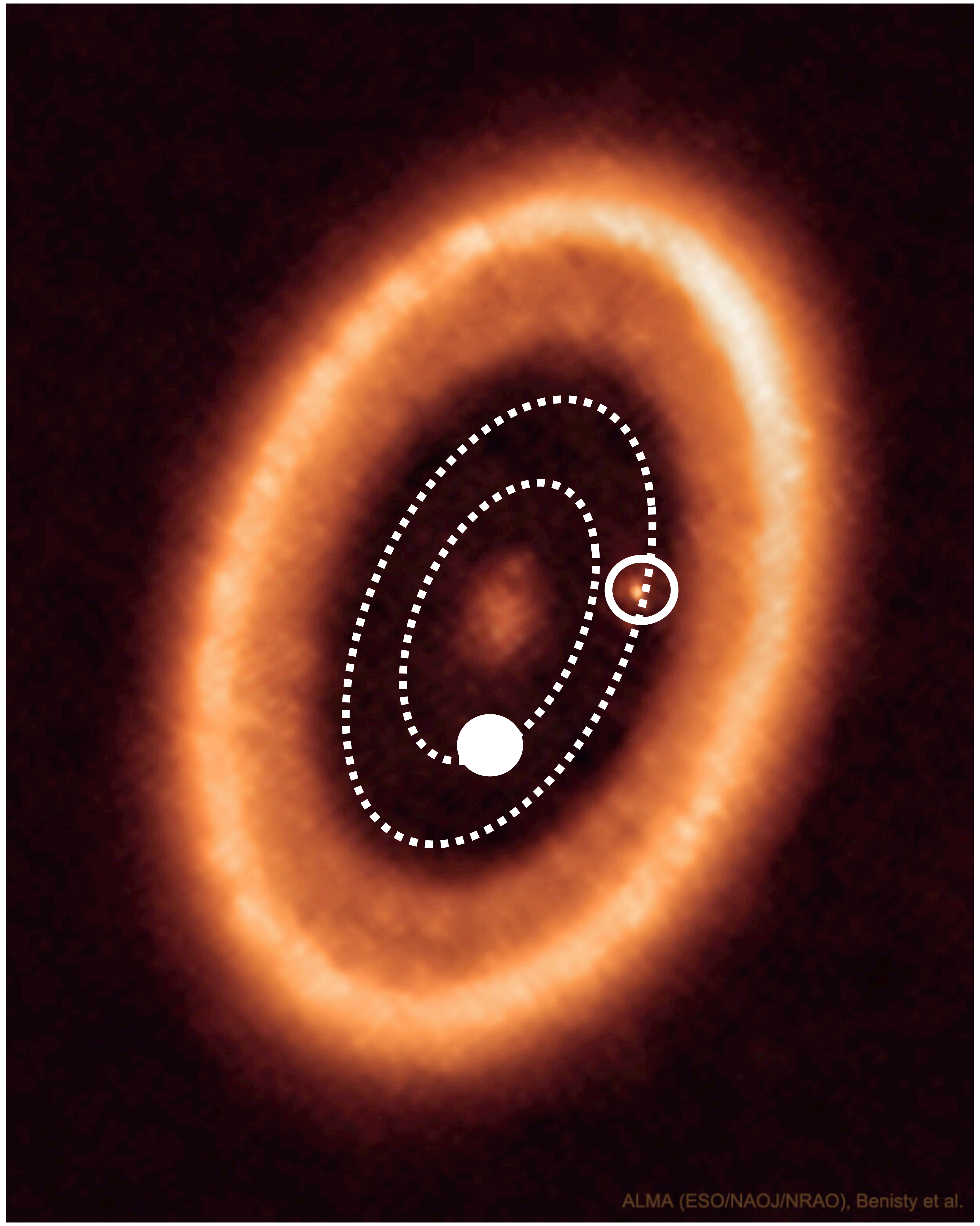
## OBSERVATIONAL CONSTRAINTS

- 2 Giant planets *in* 2:1 MMR:

| | |
|---|---|
| $a_b = 20.8^{+0.6}_{-0.7}$ au | $a_c = 33.3^{+1.0}_{-1.1}$ au |
| $e_b = 0.18^{+0.05}_{-0.05}$ | $e_c = 0.046^{+0.014}_{-0.013}$ |
| $M_b = 6^{+6}_{-4}\, M_J$ | $M_c = 9^{+9}_{-6}\, M_J$ |

**

- Bright ring ~74 au — structured: asymmetric feature, second (fainter) ring ~60au
- Cavity depleted in dust, but with gas flow & resolved inner disc with $\mu$m dust
- Turbulence level not well constrained




**Trevascus+ 2025; Isella+ 2019, Kepler+2018, Long+2018; Keppler+2019; Benisty+2021, Facchini+2021, Villenave+2025...

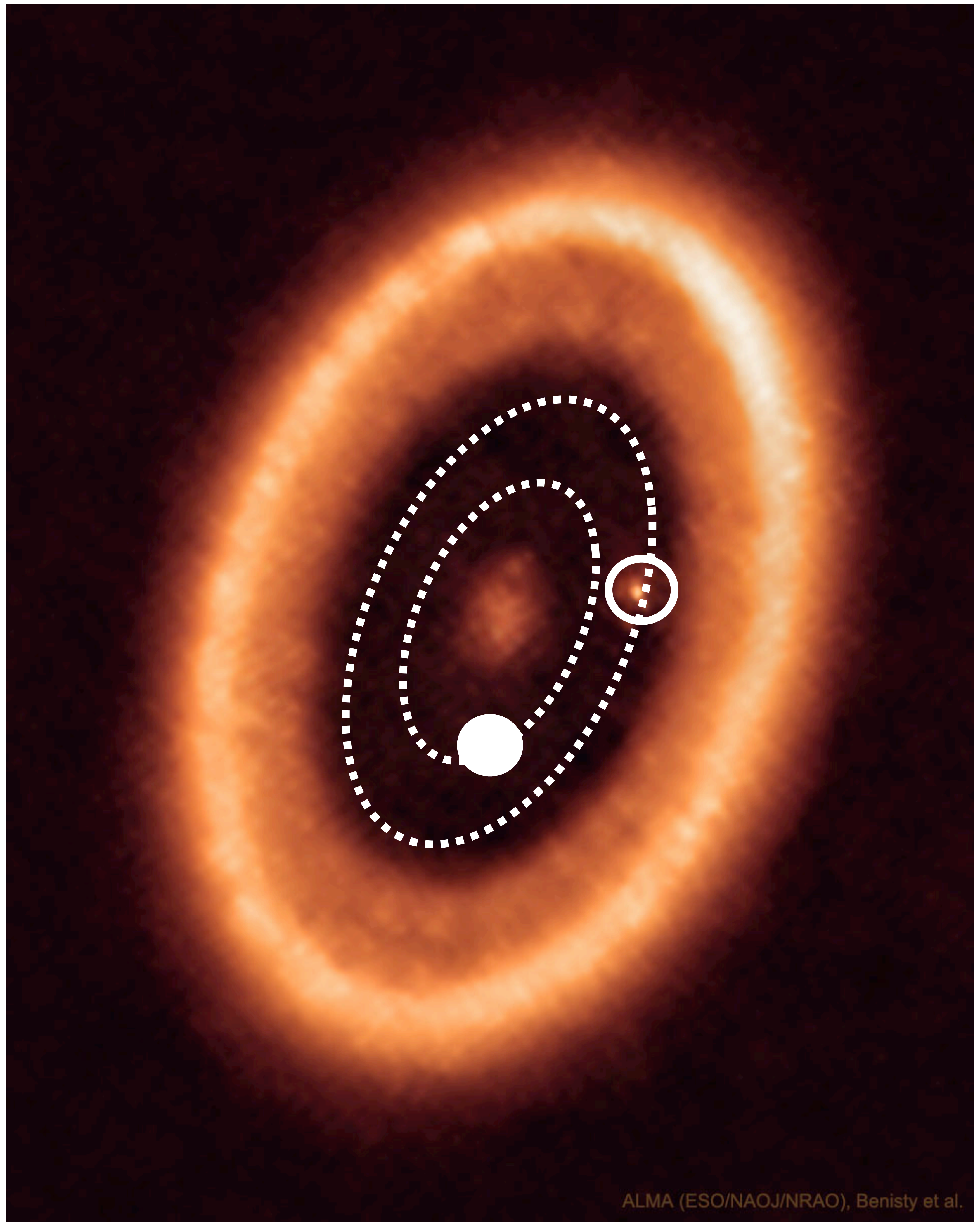
# Why modeling PDS 70 could be useful?

## Open Questions

- Can PDS 70 be a low viscosity disc? Is it compatible with the latest PPD models?
  - Low viscosity plays an important role in resonance locking

*Griveaud+2023, 2024

- Can numerical simulations help reduce (constrain?) the parameter space capable to explain the system?
  - Planetary masses & viscosity



# Method & Model

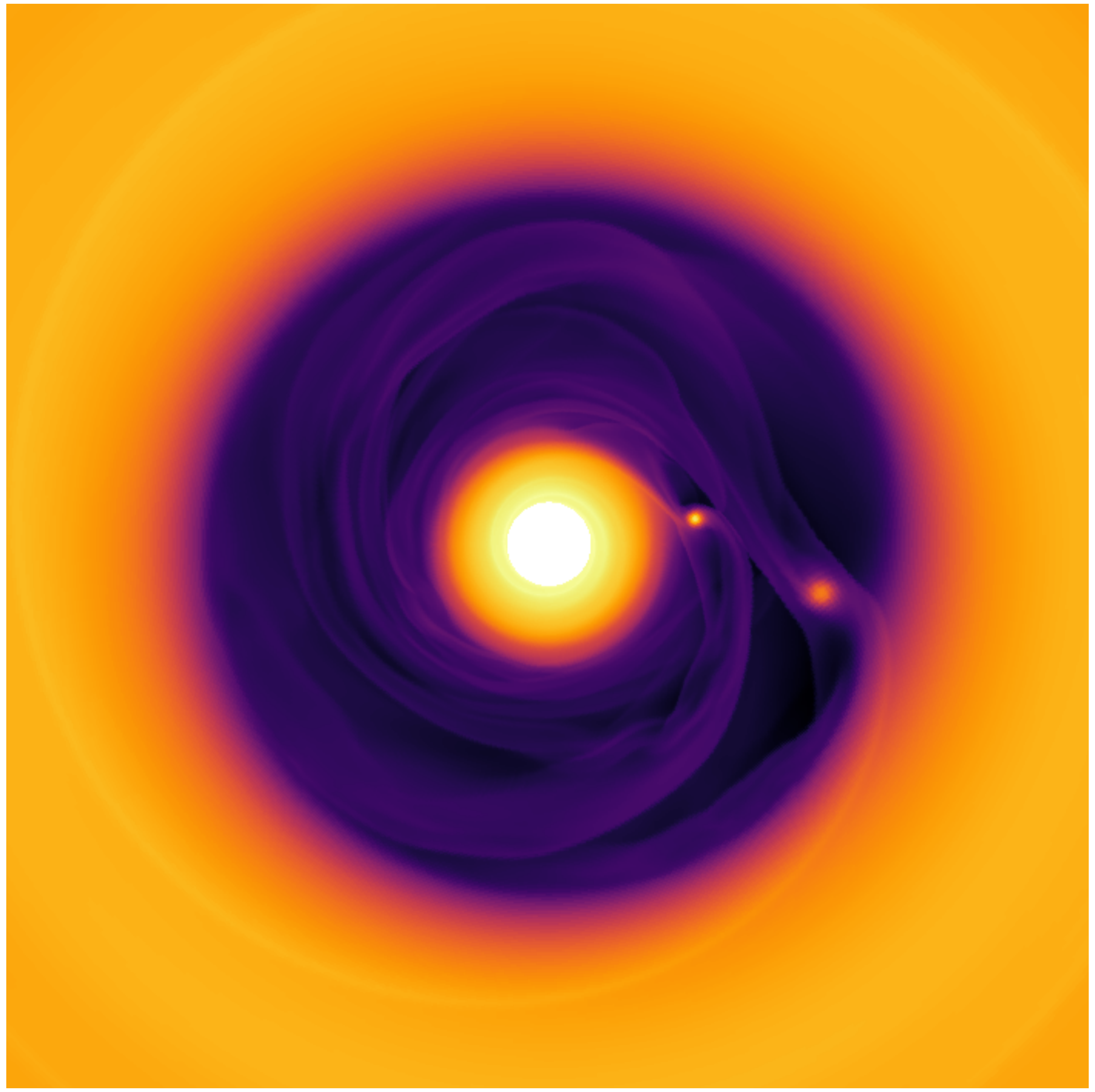
## Method

- 2D Hydrodynamical simulations with multifluid FARGO3D

Benìtez-Llambay+2019

- $\alpha$-disc laminar mid-plane, not modeling accretion layer — gas & dust in steady state
- Planets introduced sequentially — growth by *tapered* function *(no accretion)*:
  - PDS 70b: grows on fixed orbit first; then migrates
  - PDS 70c: introduced at $a_c/a_b = 2$; grows & migrates simultaneously

Following Griveaud+2023

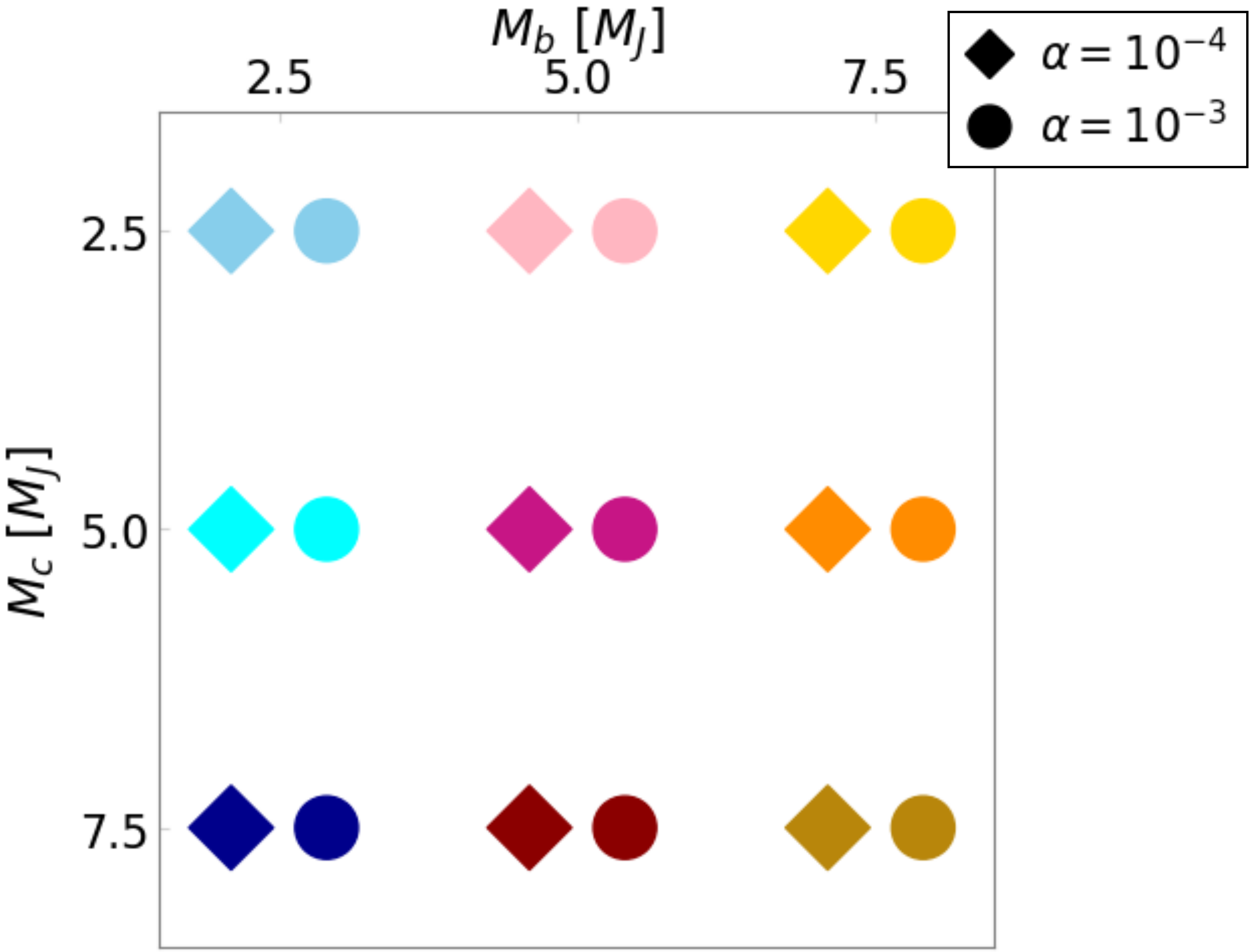


## Disc Model

Following Bae+2019

- Density Profile $\Sigma = \Sigma_0\,(r/22\,\mathrm{au})^{-1}$
- Temperature Profile $h = 0.067\,(r/22\,\mathrm{au})^{0.38}$
- Adiabatic EoS with cooling (where we use $\tau = 1$ orb. timescale, s.t. $\beta = 2\pi/\tau$)

# Dynamics & Orbital Configuration



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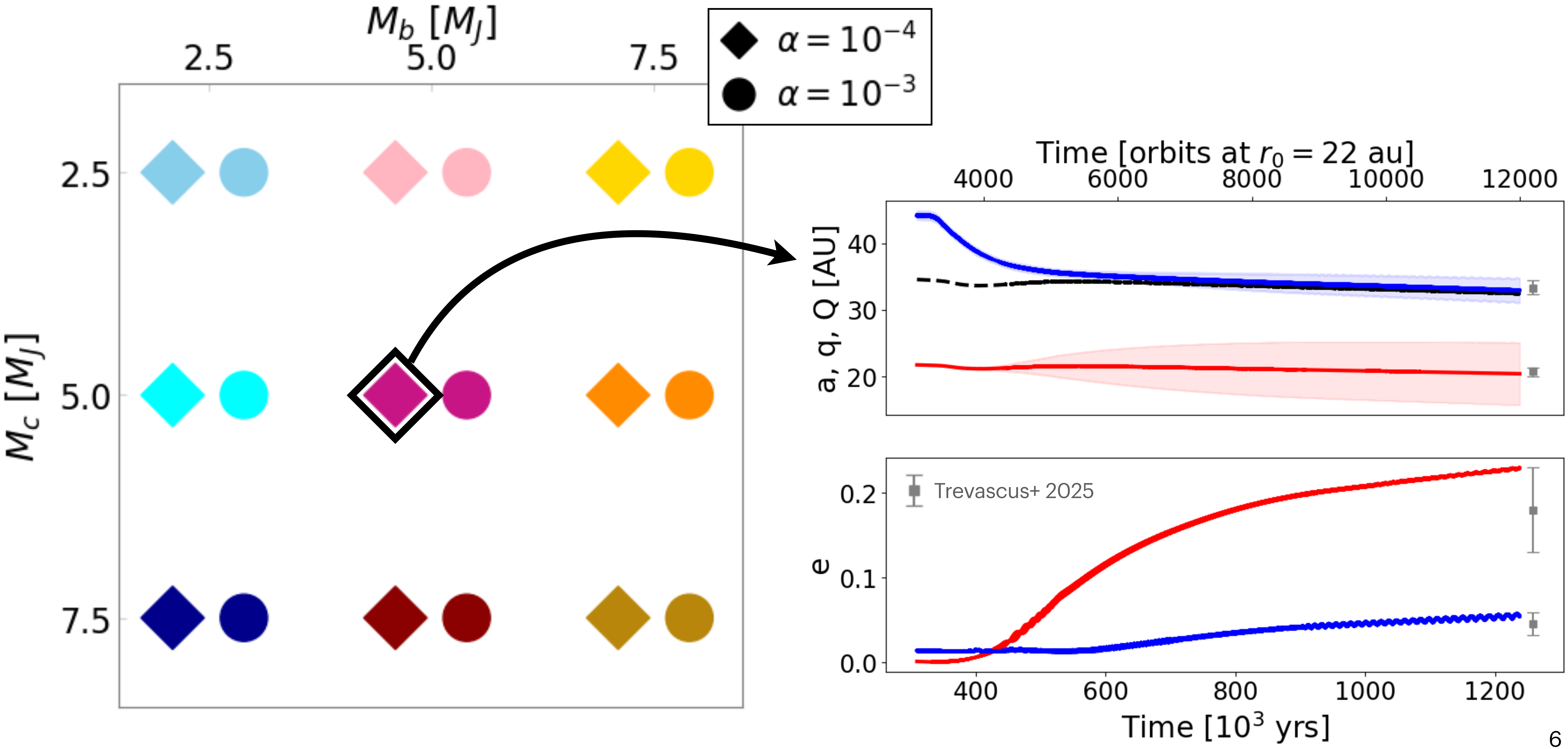

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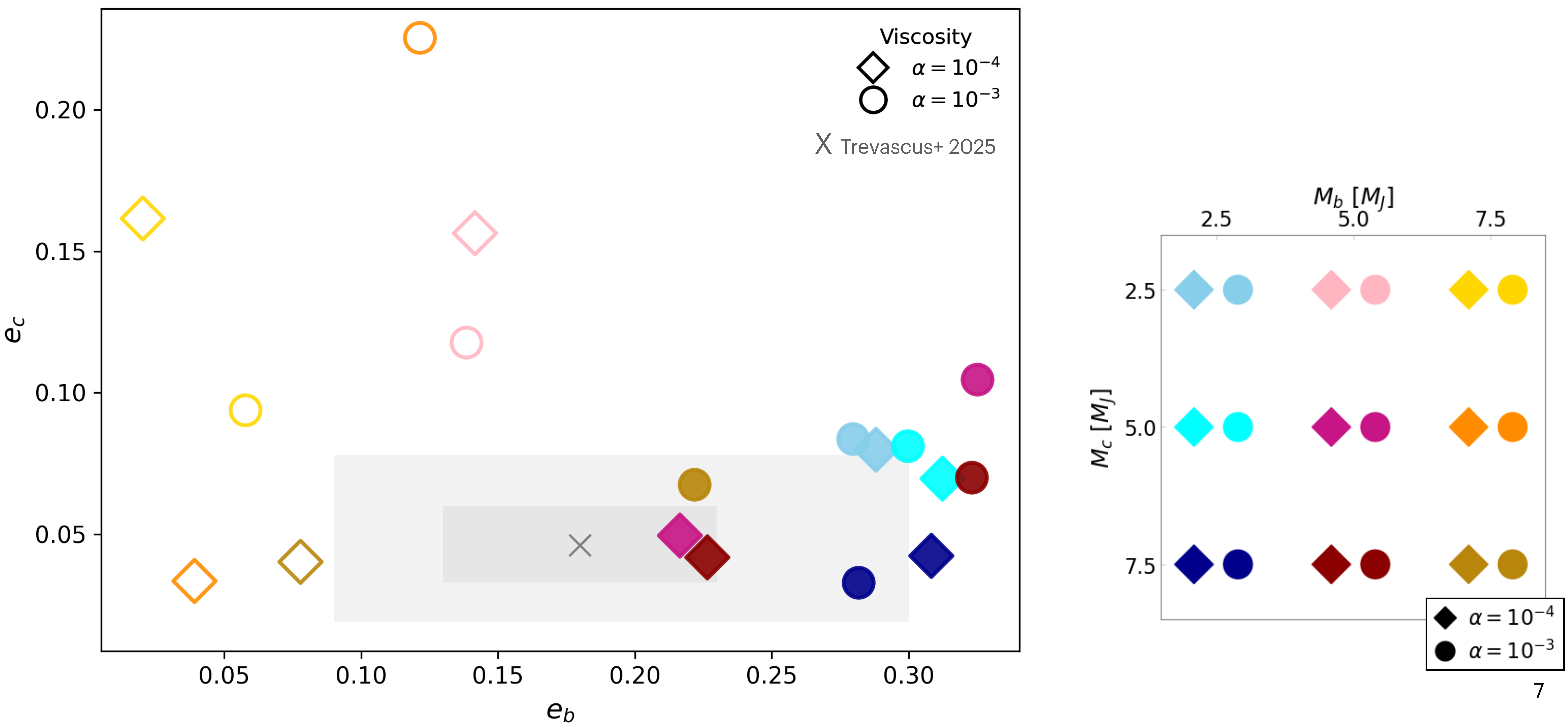

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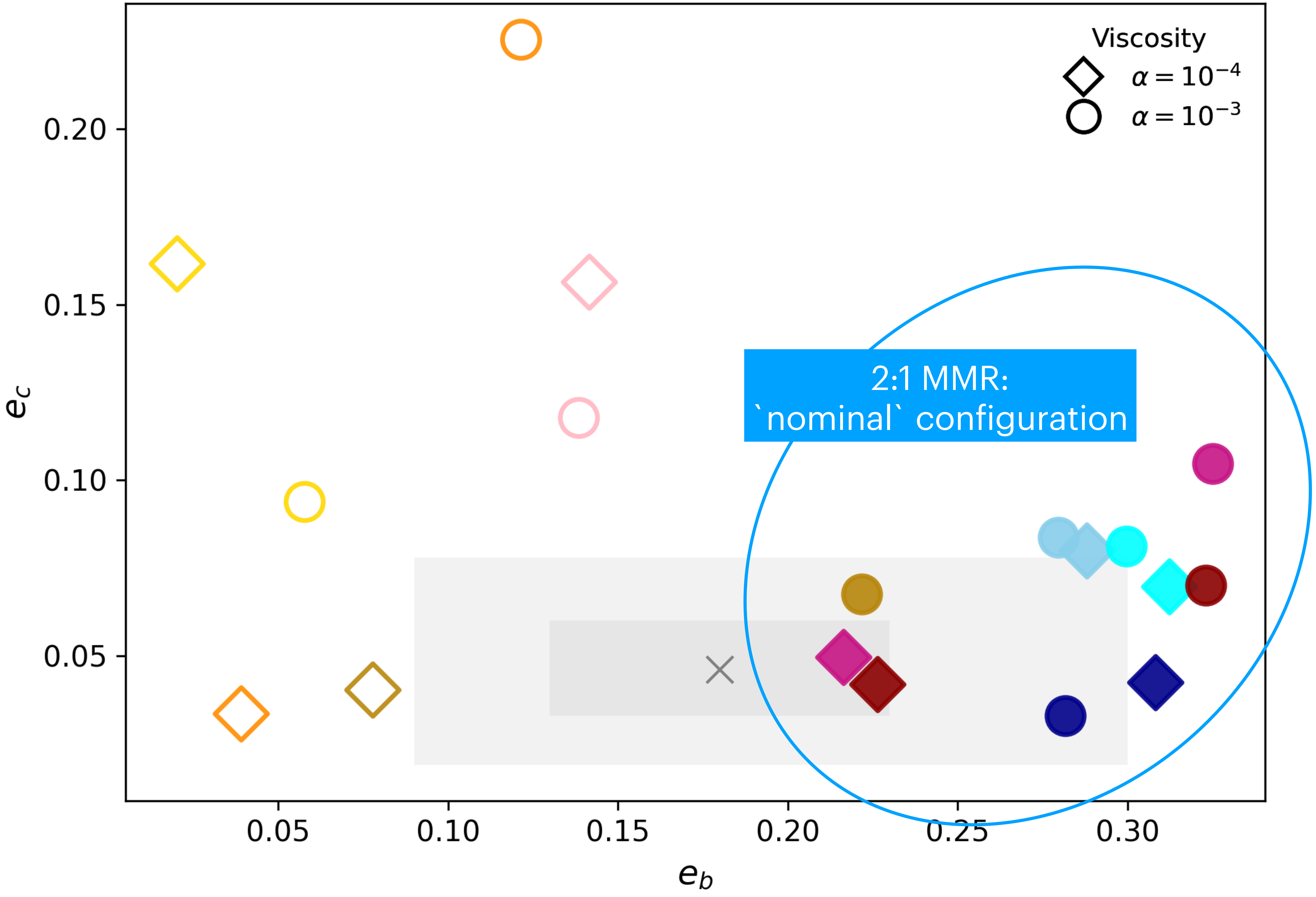


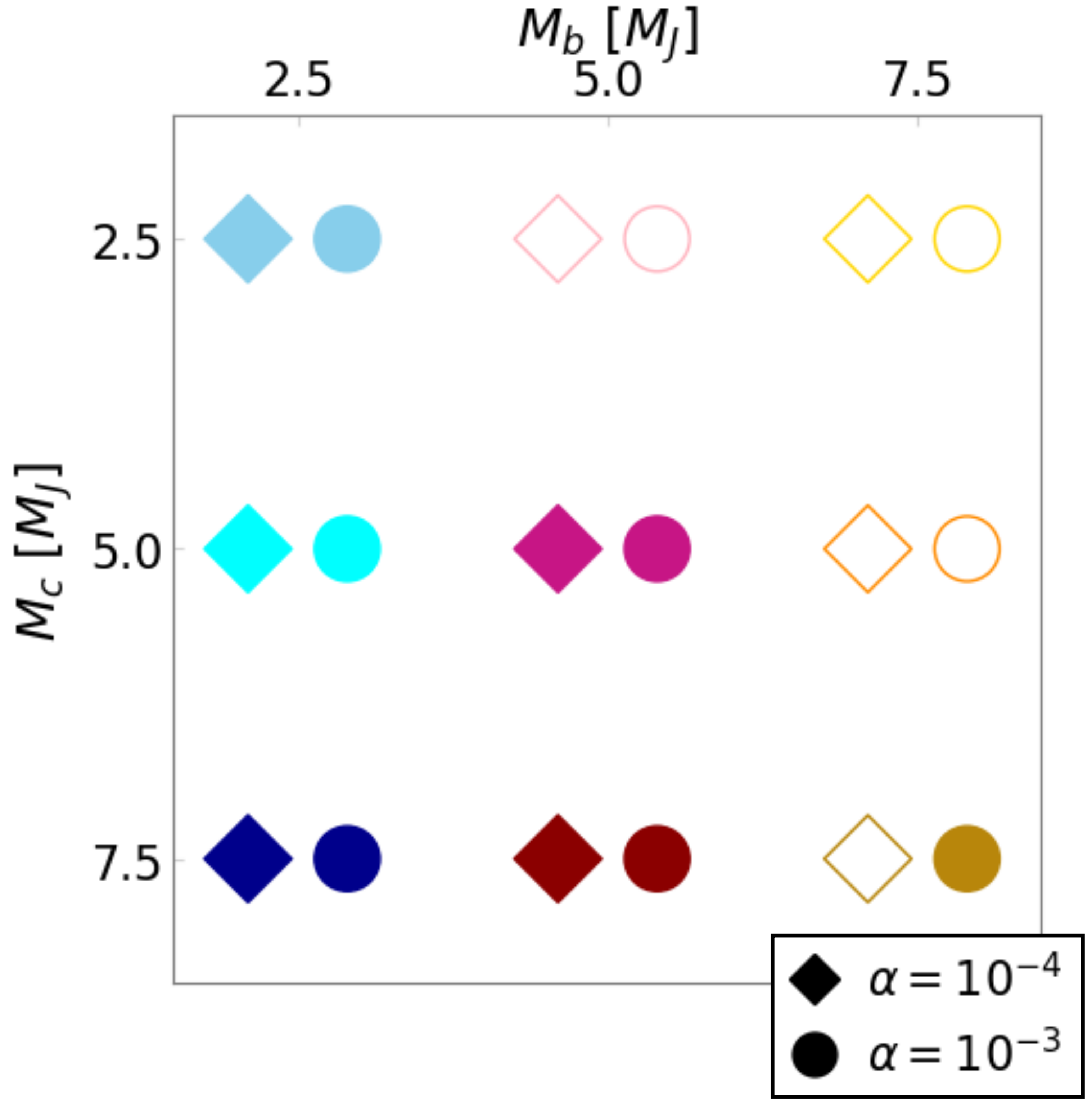

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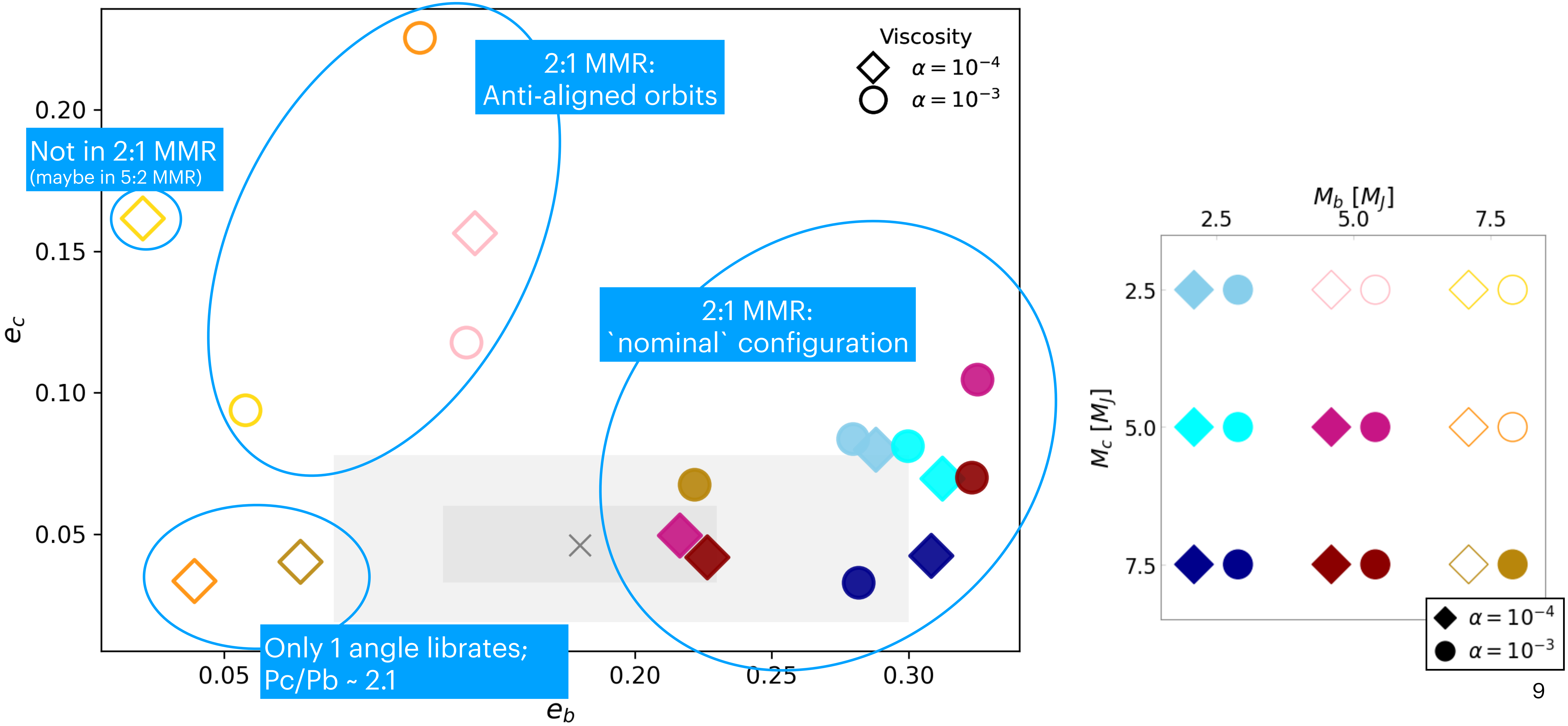
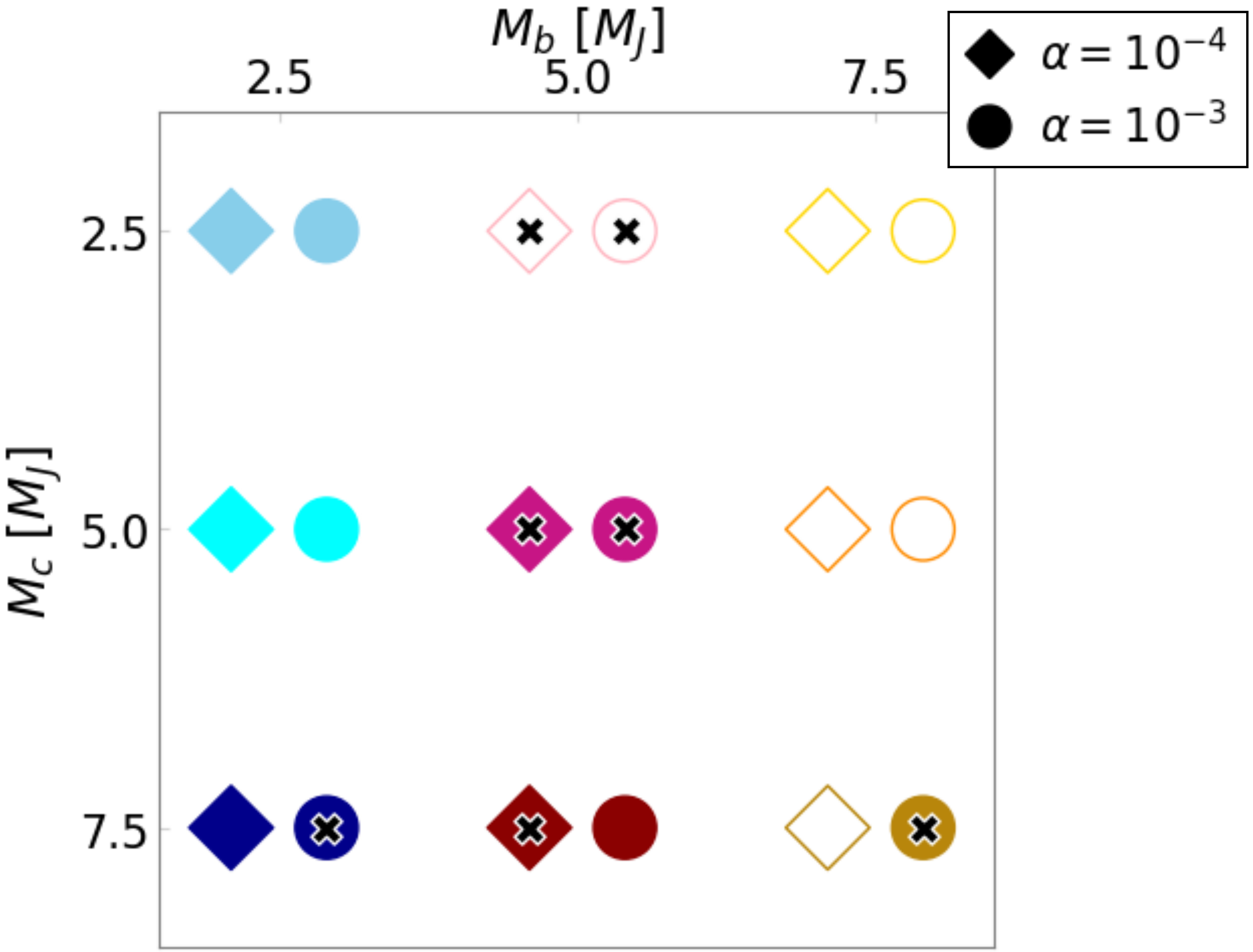
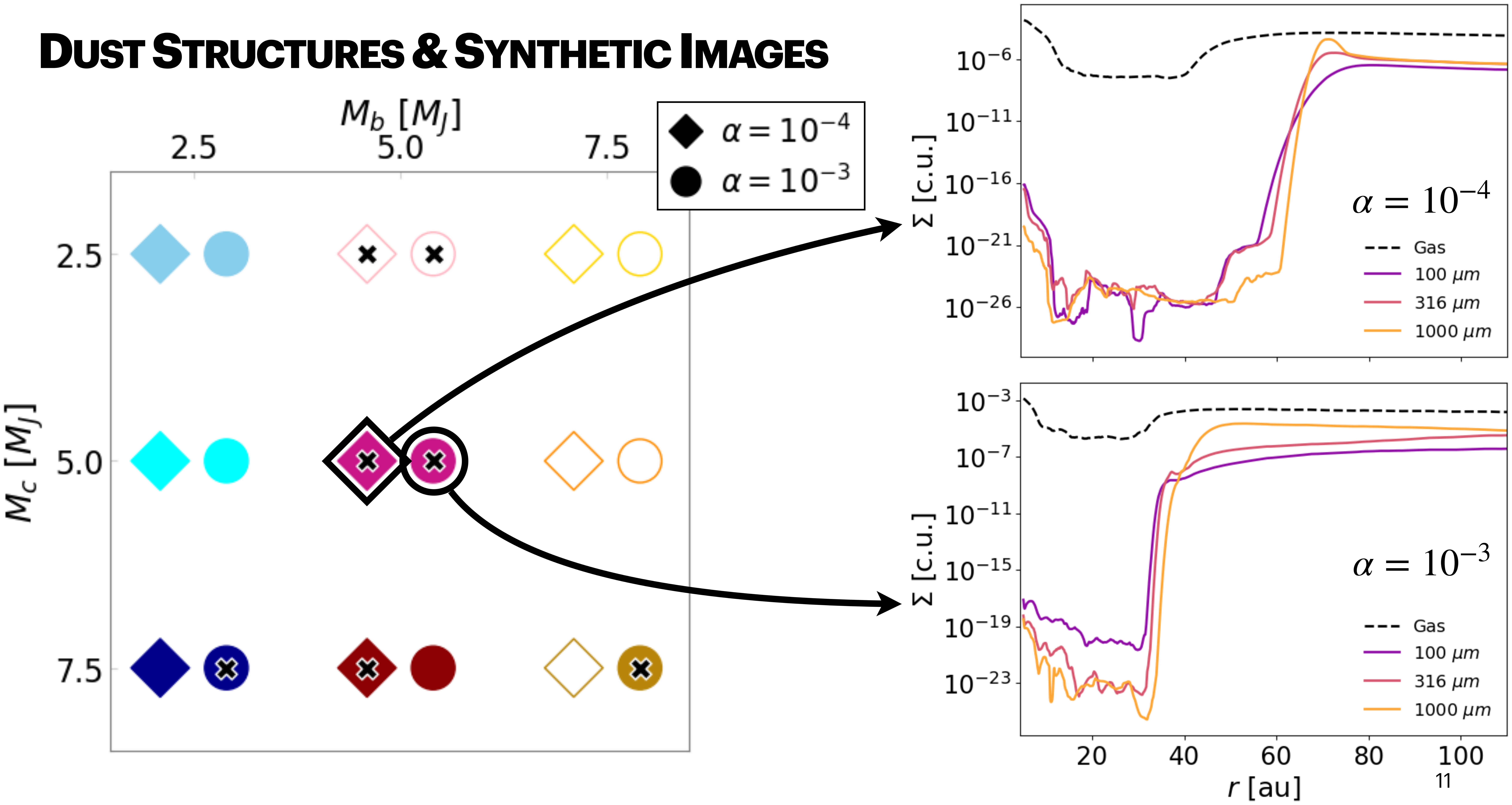


# DUST STRUCTURES & SYNTHETIC IMAGES



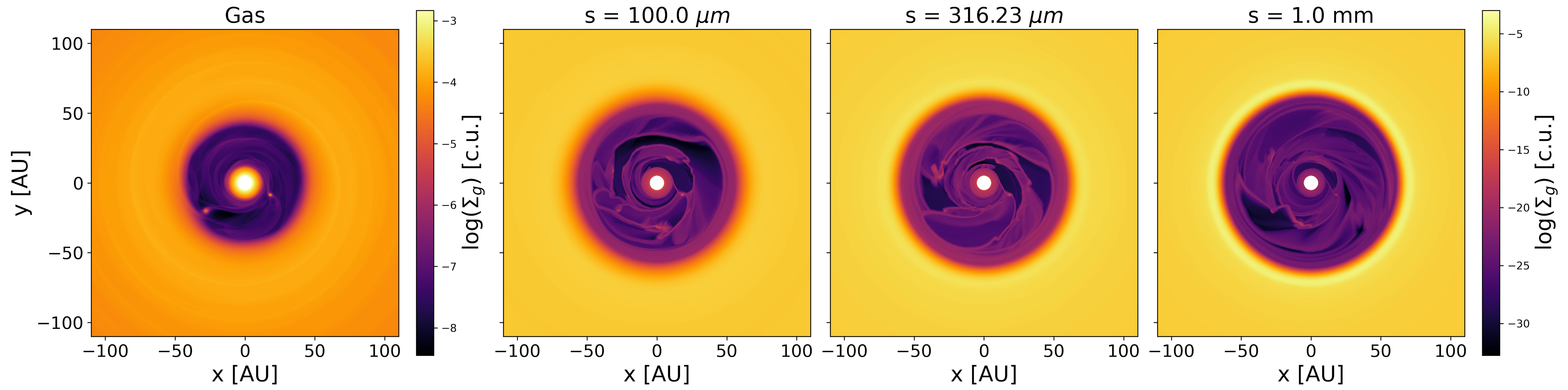
# Dust Structures & Synthetic Images



Dullemond+2012; using fargo2radmc3d (by C. Baruteau)

# Radiative Transfer with Radmc-3d

$\alpha = 10^{-4}$

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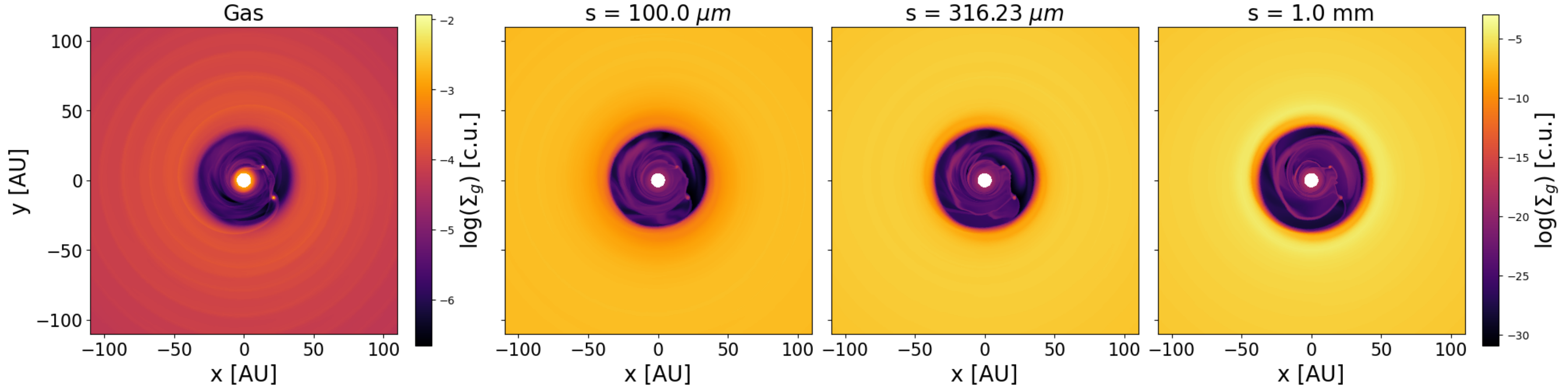

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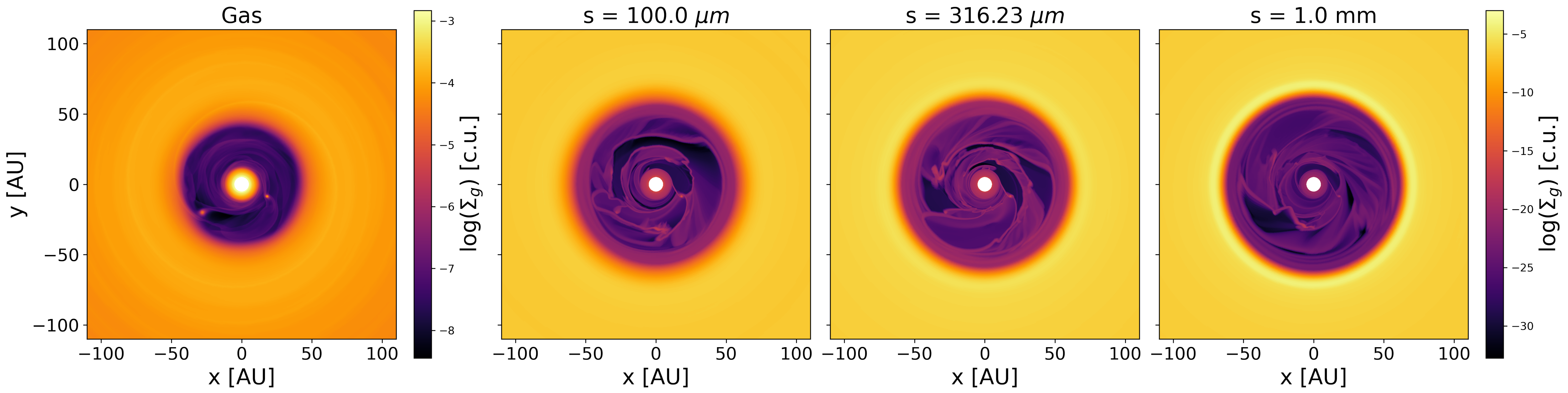


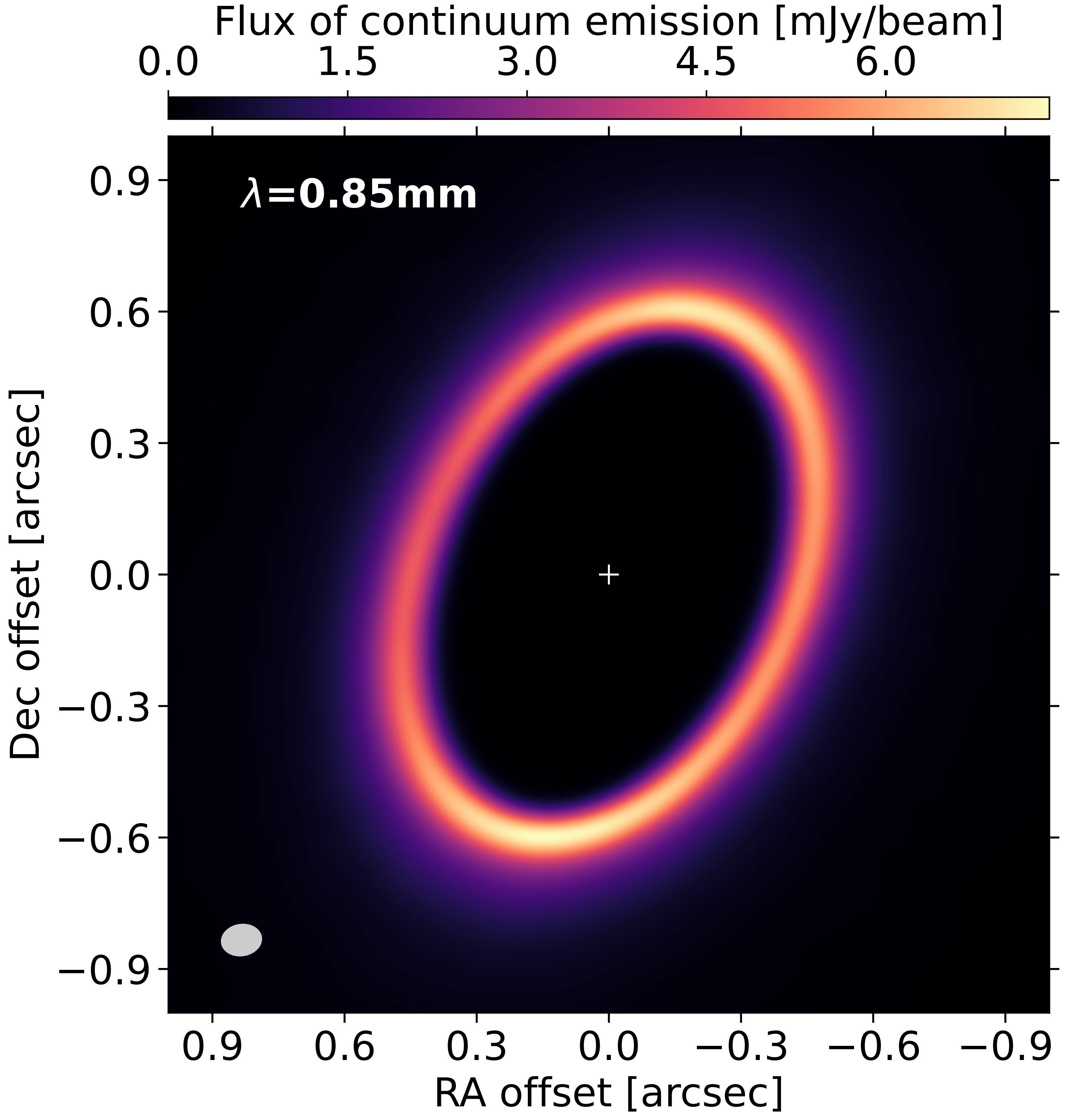


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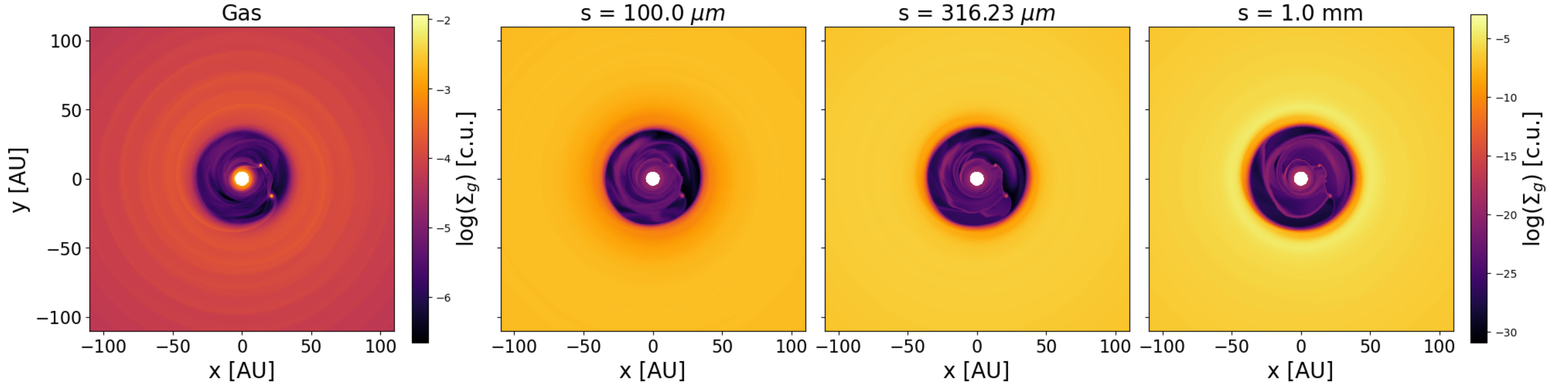


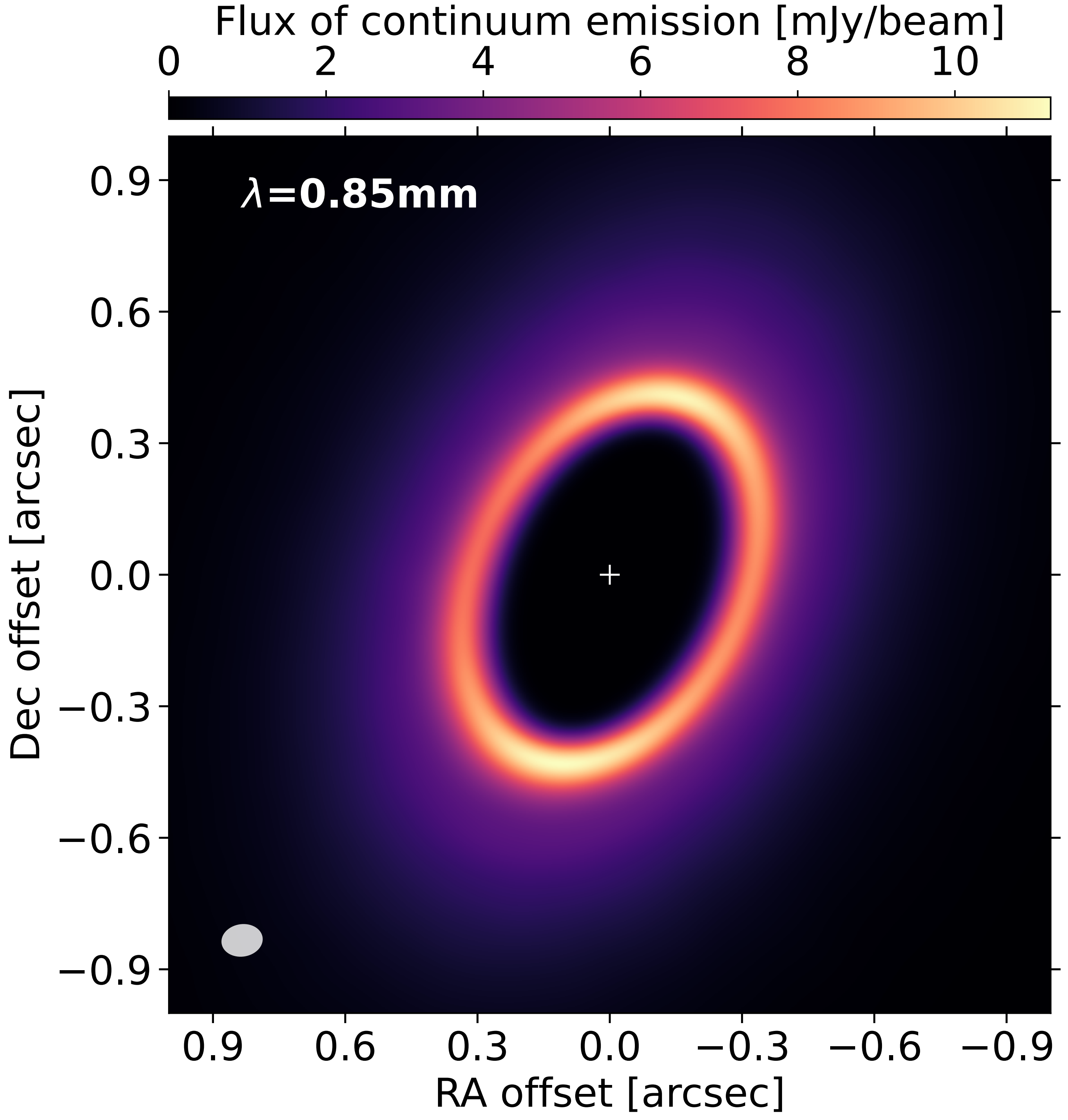

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# Radiative Transfer with Radmc-3d

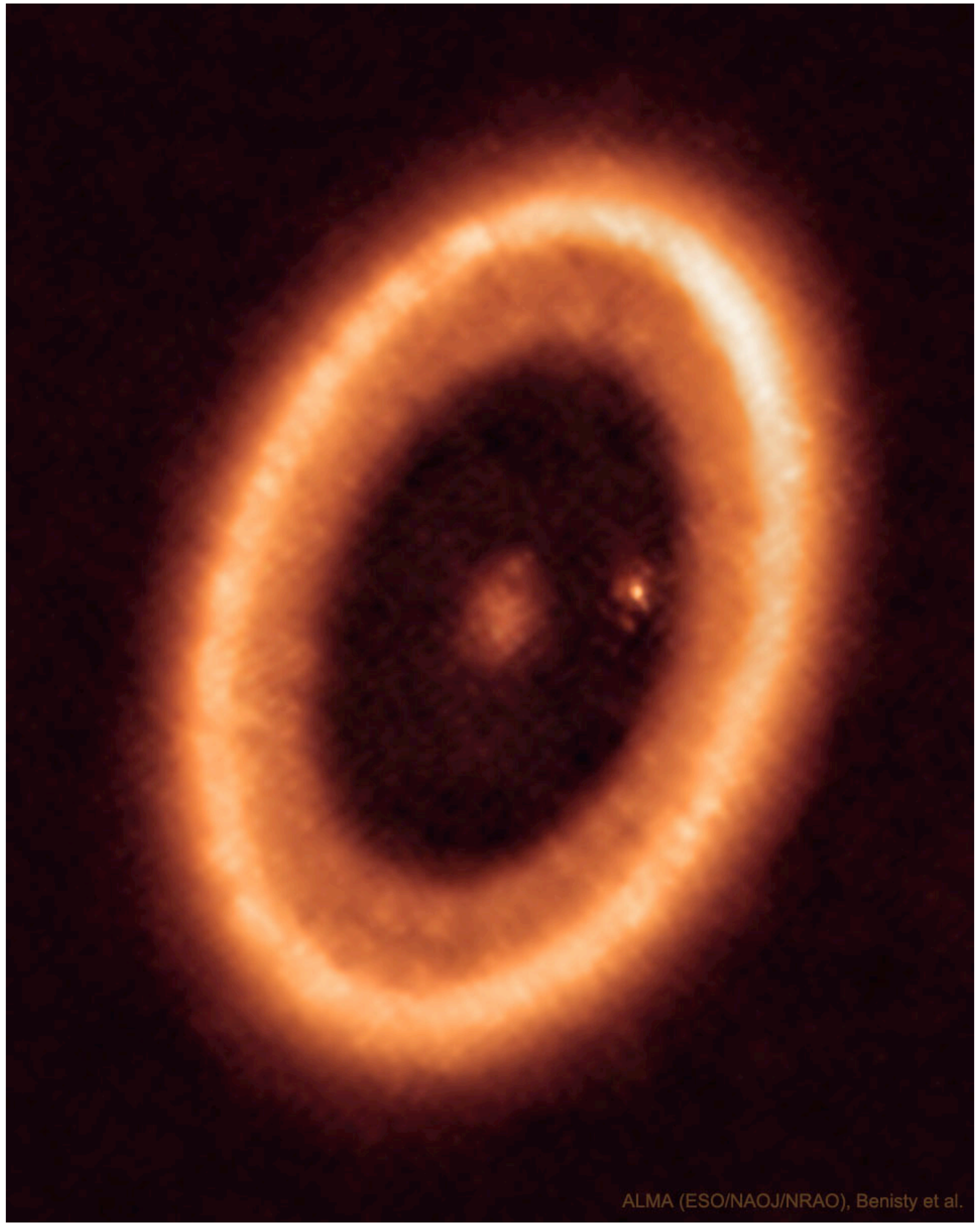
# SUMMARY — PRELIMINARY CONCLUSIONS

## ORBITAL DYNAMICS

- Dynamical configuration favors $M_c \geq M_b$ ; with better match for $M_b, M_c \geq 5M_J$
- No clear distinction between viscosities.

## DUST STRUCTURES — PRELIMINARY

- Seems to favor low viscosity for a wider cavity & stronger dust trap.



# Summary — Preliminary Conclusions

## Orbital Dynamics

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## Dust Structures — Preliminary

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## More to come

- Degeneracy between viscosity and planetary masses?
- Quantifying dust & gas flow through the cavity
- Radmc3d: multi wavelength synthetic observations