Which is responsible for driving disc evolution? Viscosity or magnetised winds?

Simin Tong

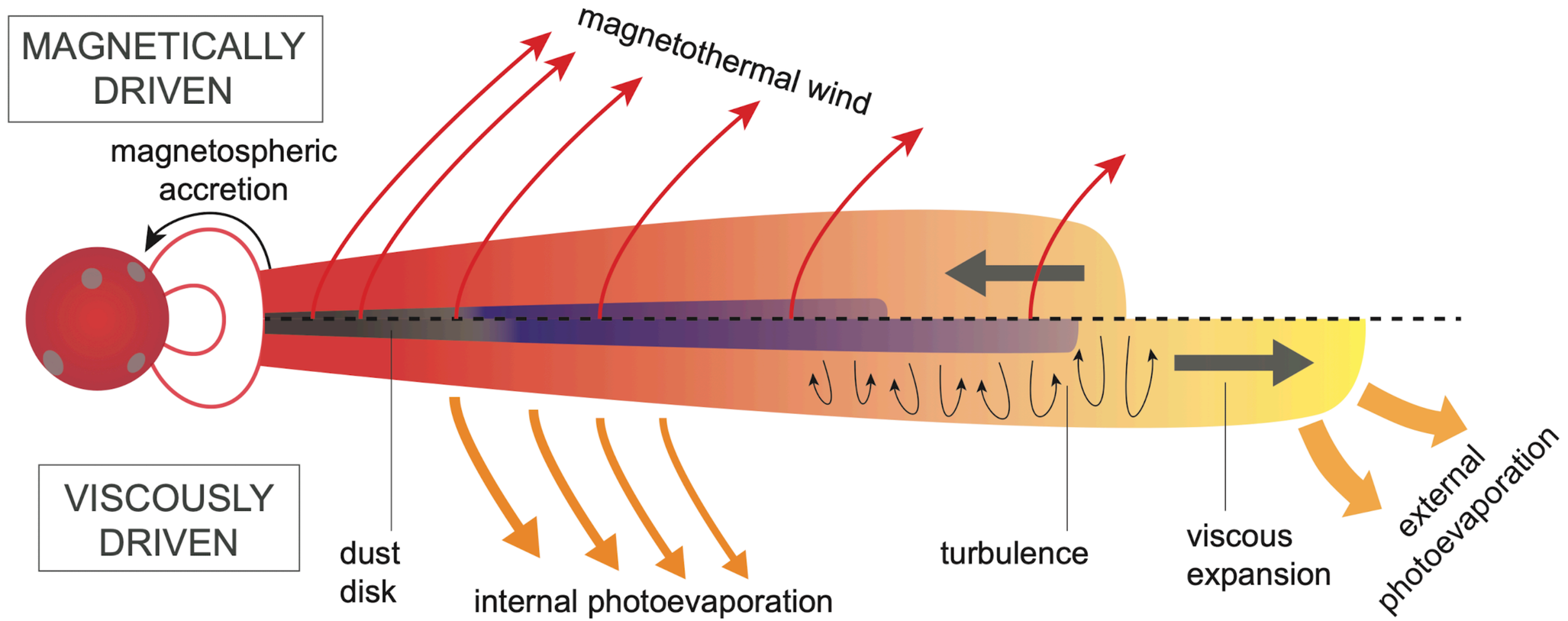
University of Leicester

Collaborators: Richard Alexander, Giovanni Rosotti

9th July @ Toruń

@simintong

Background



Manara+2022, Lynden-Bell&Pringle 1974, Bai&Stone 2013

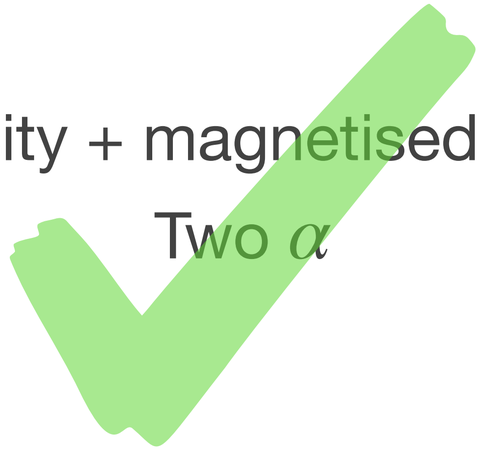
Gas disc sizes

angular momentum transport?

Najita&Bergin 2018, Long+2019

Models: transition profiles

Only viscosity



viscosity + magnetised winds

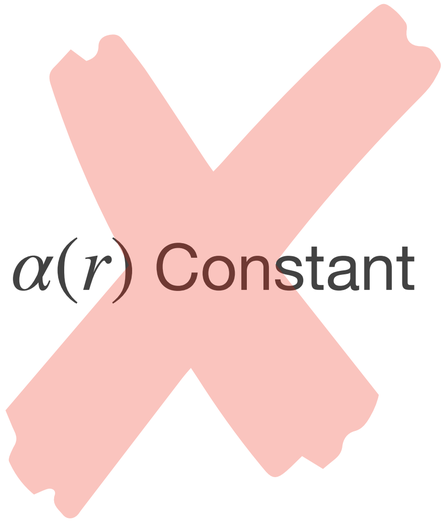
Two α

"Hybrid" discs driven by **viscosity** and **winds** together.
Their strengths are described by α.

Tabone+2022

Models: transition profiles

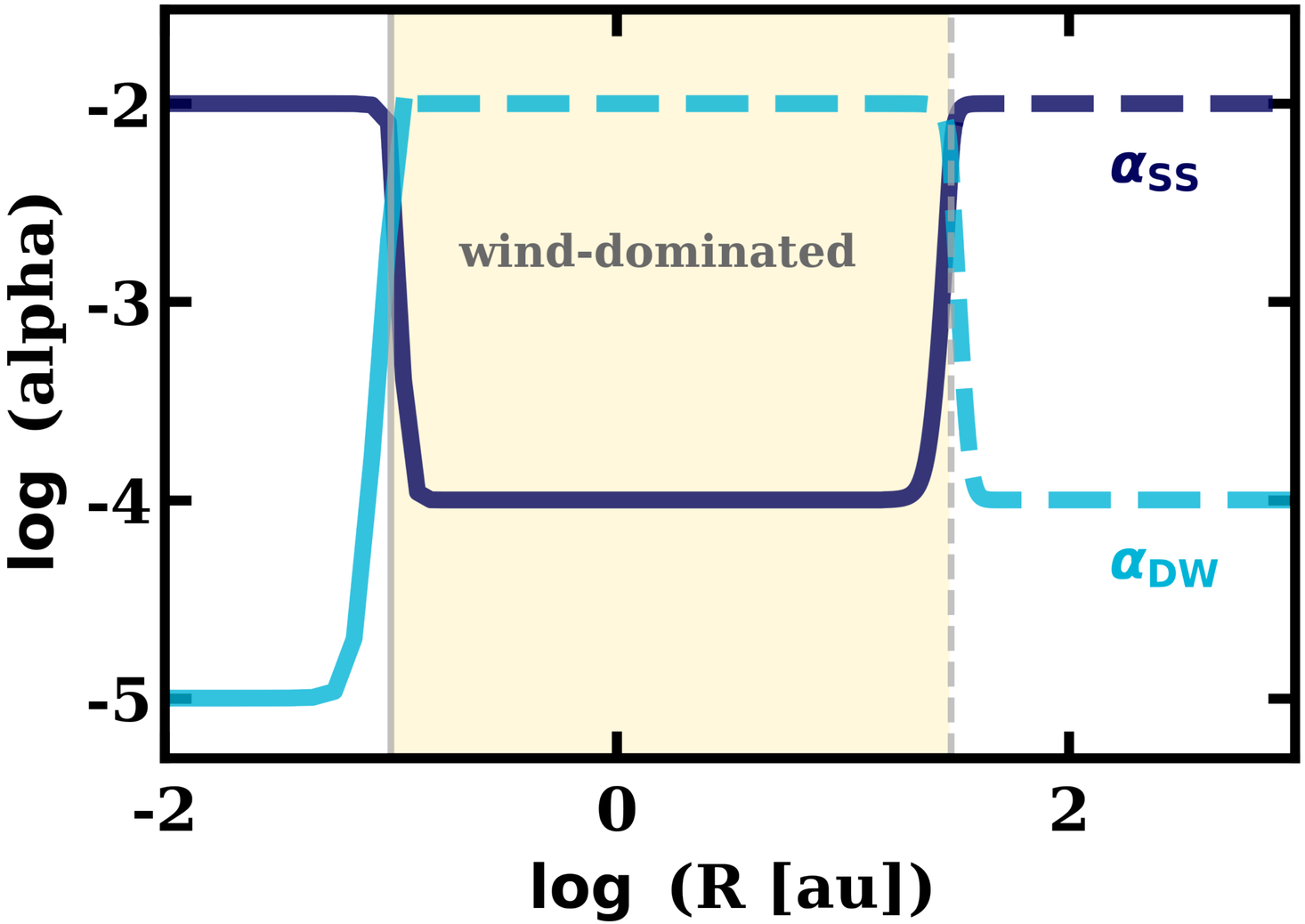
$\alpha(r)$ Constant



$\alpha(r)$ change with radii

Morishima 2012, Gárate+2021

Models: transition profiles



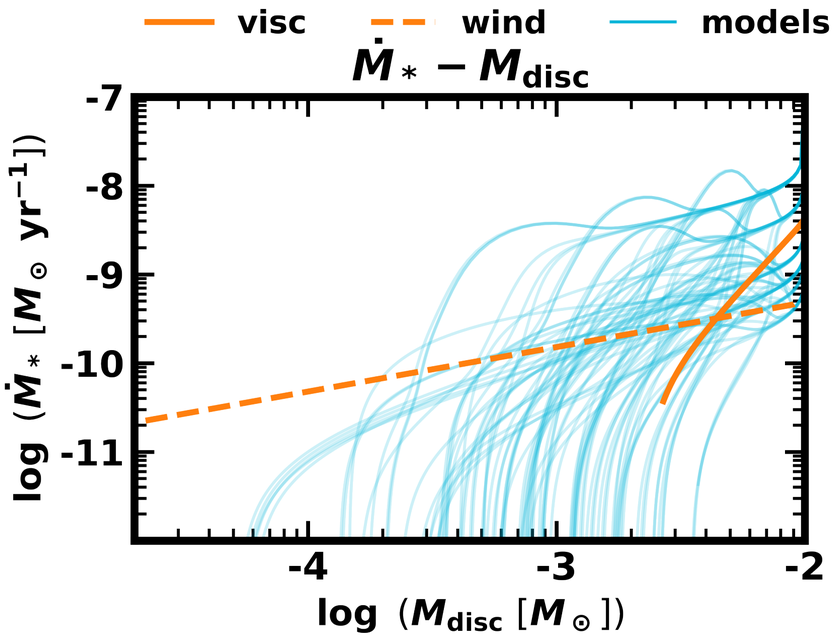
Viscosity dominates inner and outer discs.

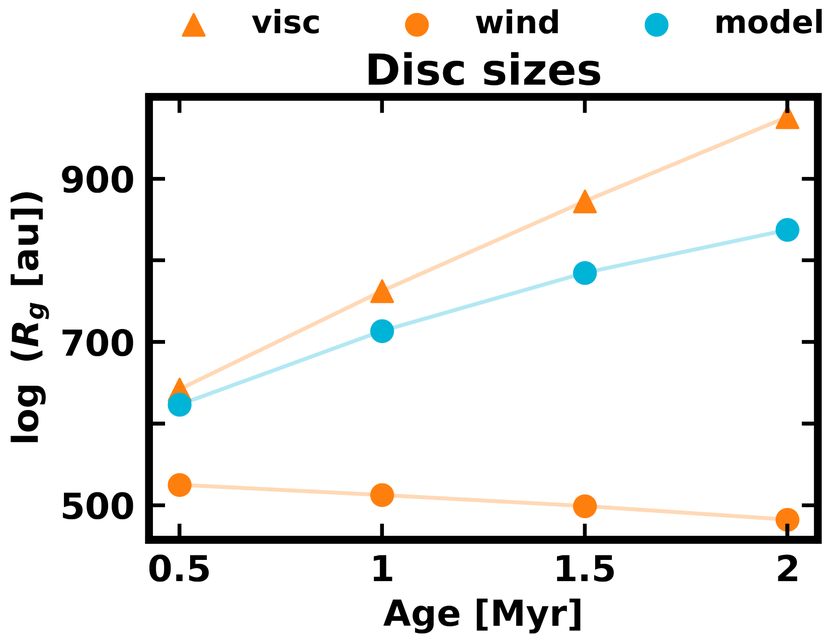
Winds dominate intermediate discs.

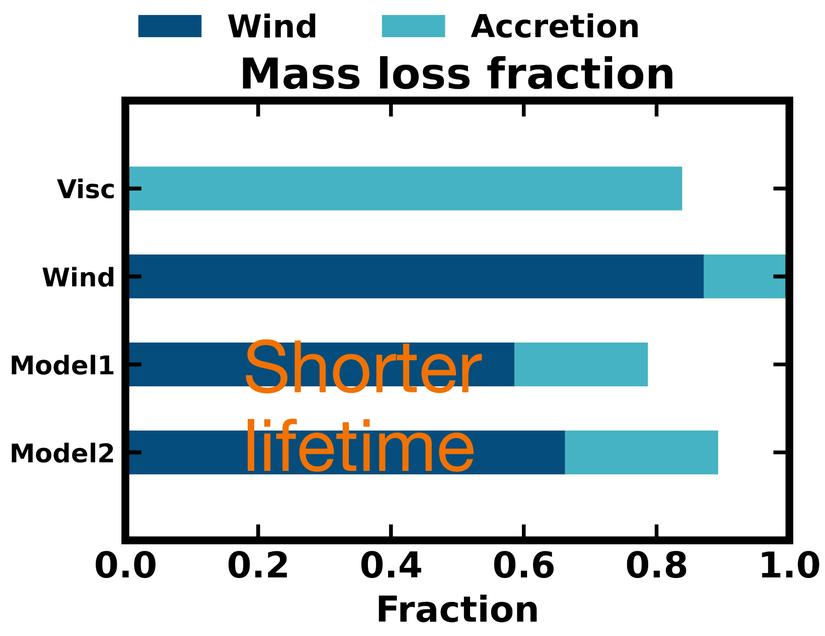
Outer transition radius: free parameter

Bai 2013

Hybrid discs: Accreting and expanding like viscous discs,
and losing mass like wind-driven discs.







Stellar accretion rates & gas disc sizes are *local* indicators.

Individual discs

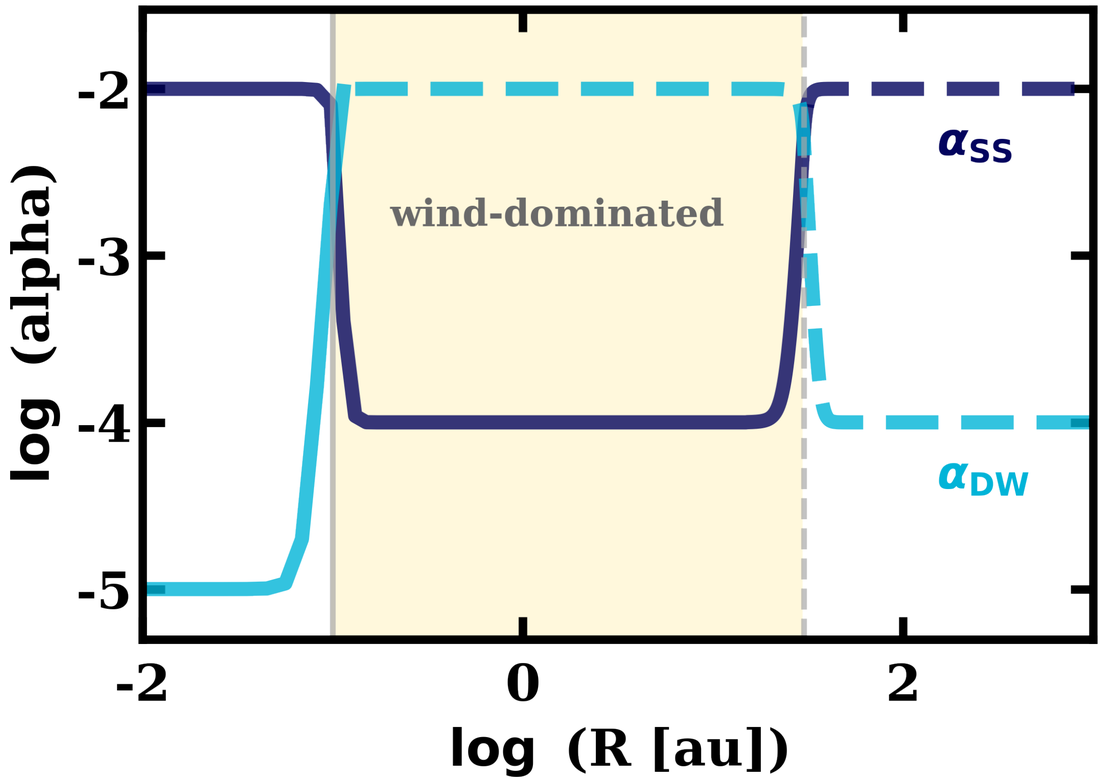
disc spreads when viscosity dominates the outer disc

Disc demographics

Disc personalities: different initial properties

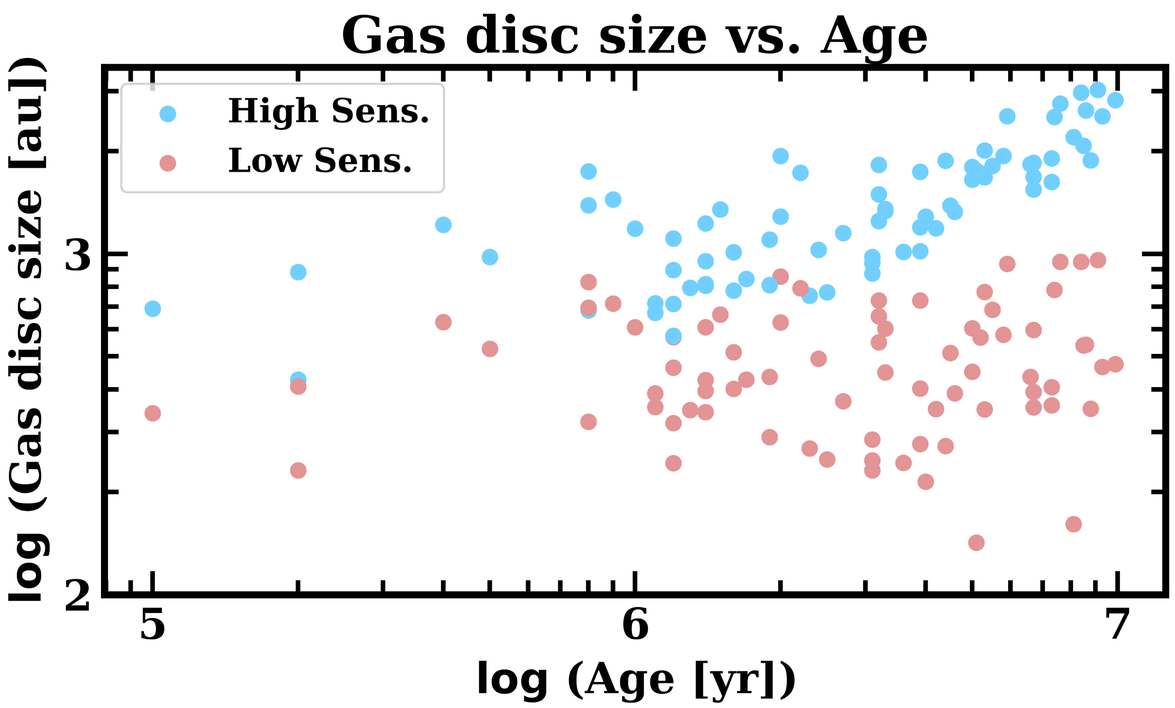
Population Synthesis

- 1st population: disc masses, disc sizes, wind-dominated region sizes
- 2nd population: also $\alpha_{\rm SS}$ & $\alpha_{\rm DW}$ combinations

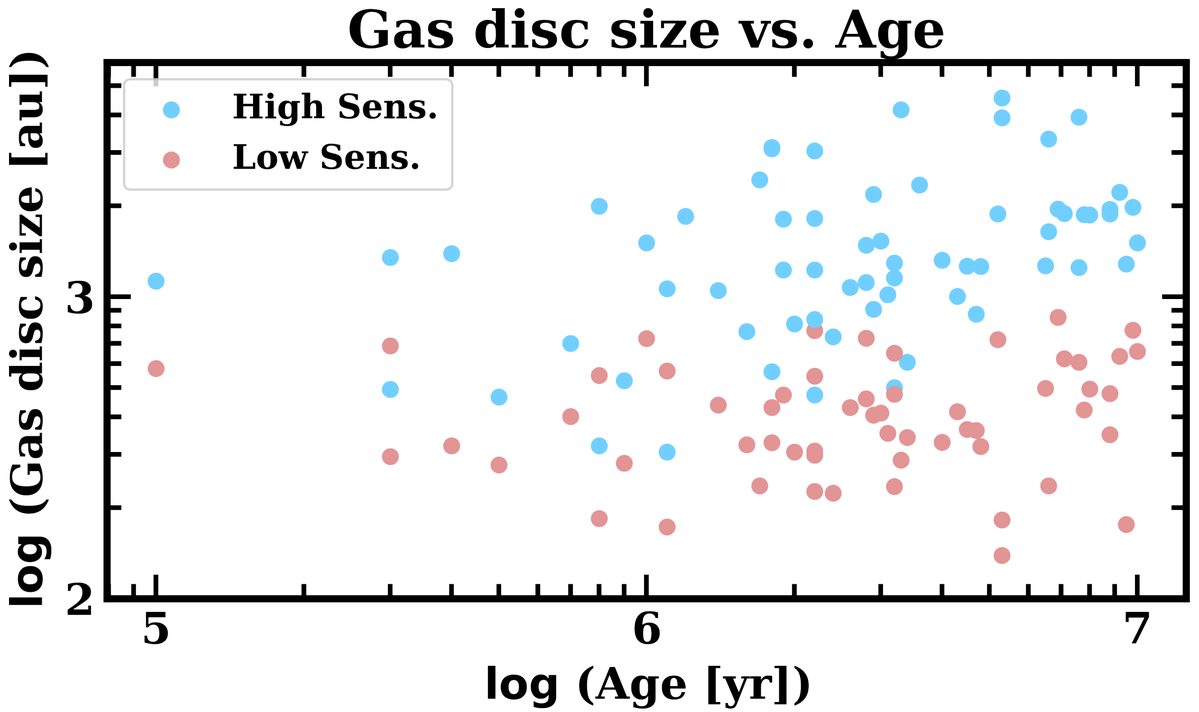


Population Synthesis

- Randomly draw 100 samples at 0.1–1 Myr.
- Measure sizes with surface density thresholds $\Sigma_{\rm thres} = 10^{-2}$ (low)/ 10^{-4} (high) g cm^{-2}
- First pop:



- Second pop:



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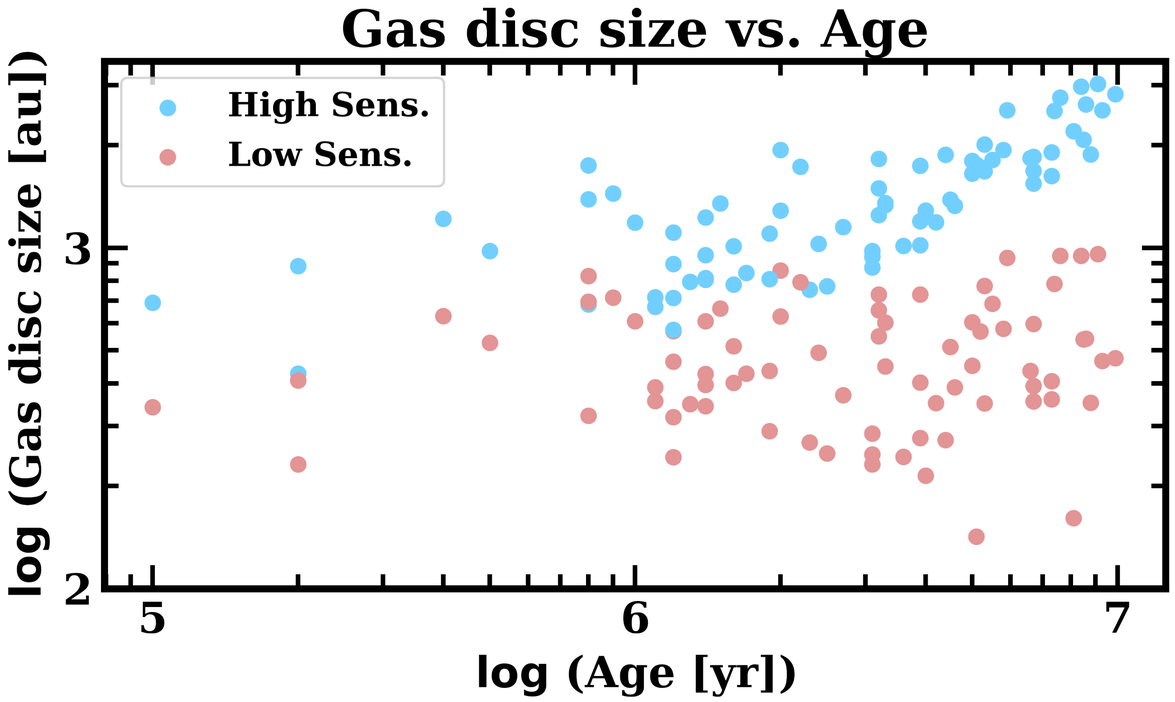
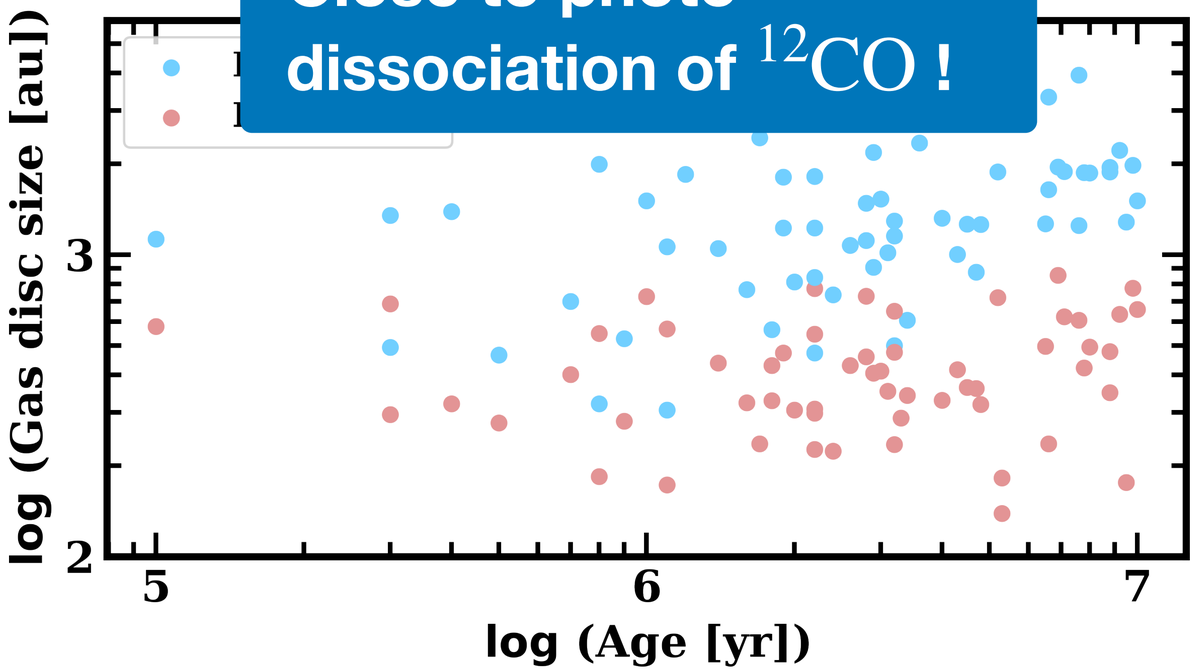


- Second pop:

Close to photo-dissociation of ^{12}CO !



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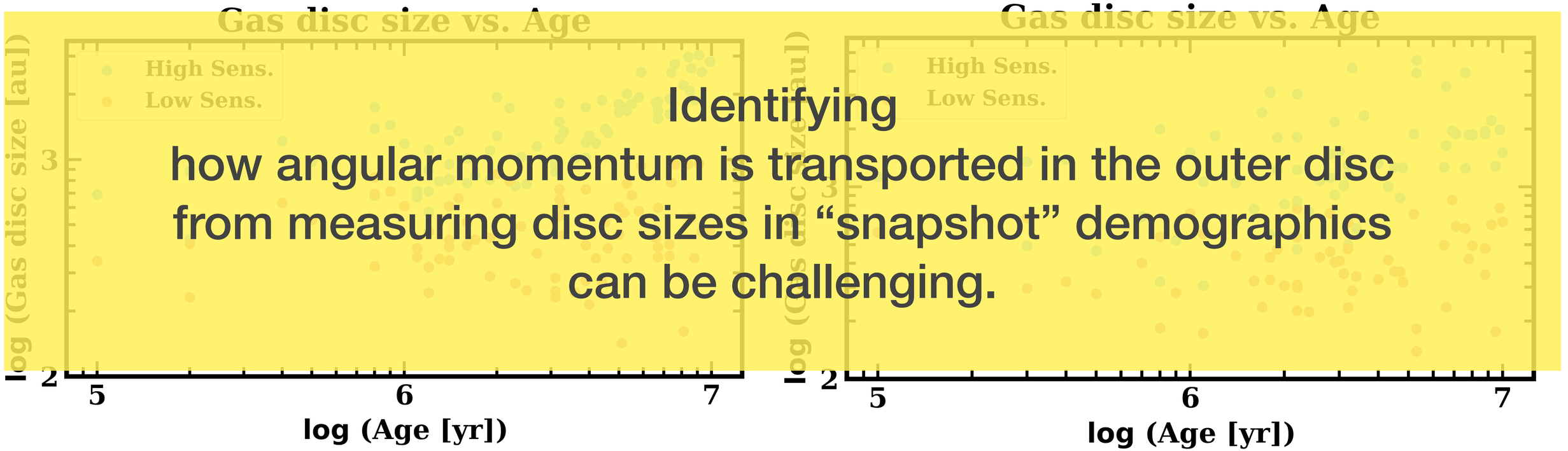

Identifying how angular momentum is transported in the outer disc from measuring disc sizes in "snapshot" demographics can be challenging.

Take-home messages

- We study 1-D gas disc models simultaneously **driven by viscosity and magnetised winds** (“hybrid discs”). We assume their efficiency of transporting angular momentum varies with radii.
- These hybrid discs accrete and spread like viscous discs, but lose mass and are short-lived as wind-driven discs.
- Discs sizes and stellar accretion rates can only tell how the angular momentum is transported **locally.** Other observables are required to jointly determine how the angular momentum is transported **globally.**
- Even individual disc spreads, this trend is **challenging to be observed in demographics**.