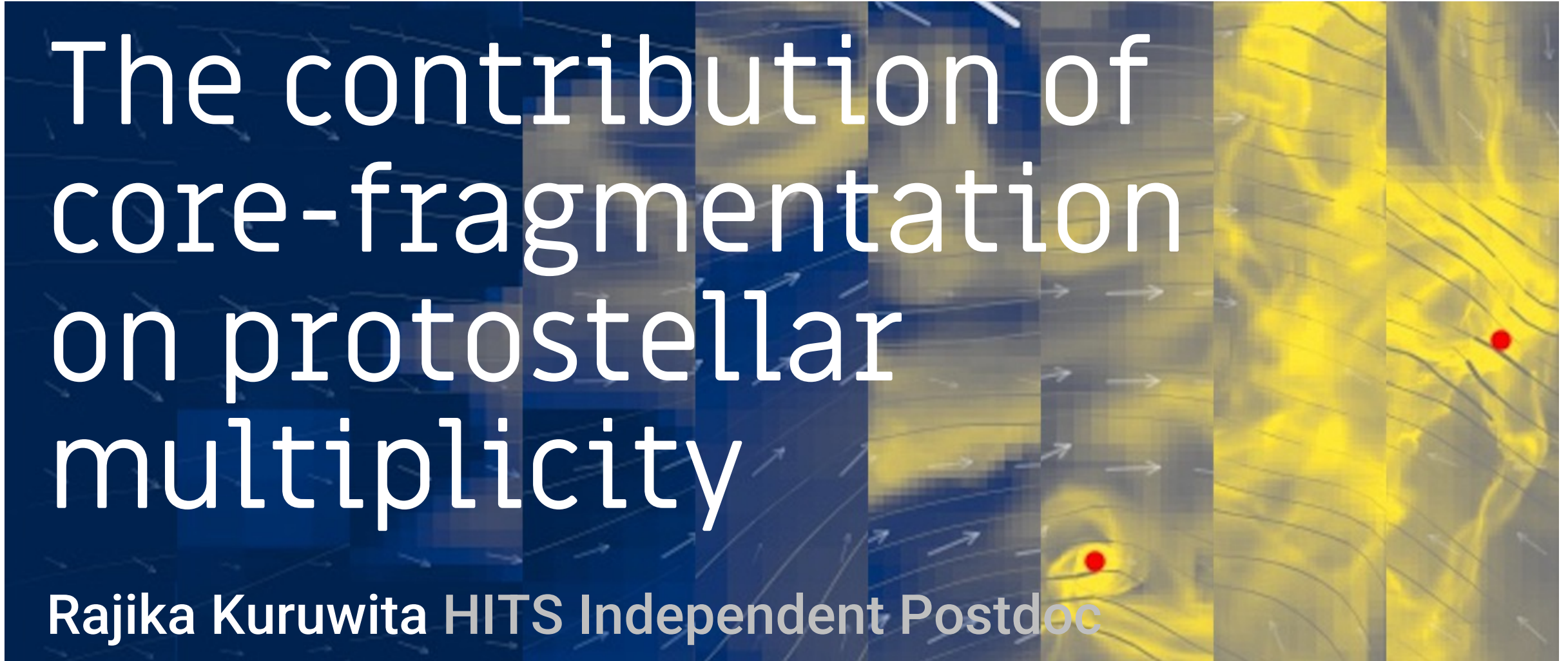


HITS

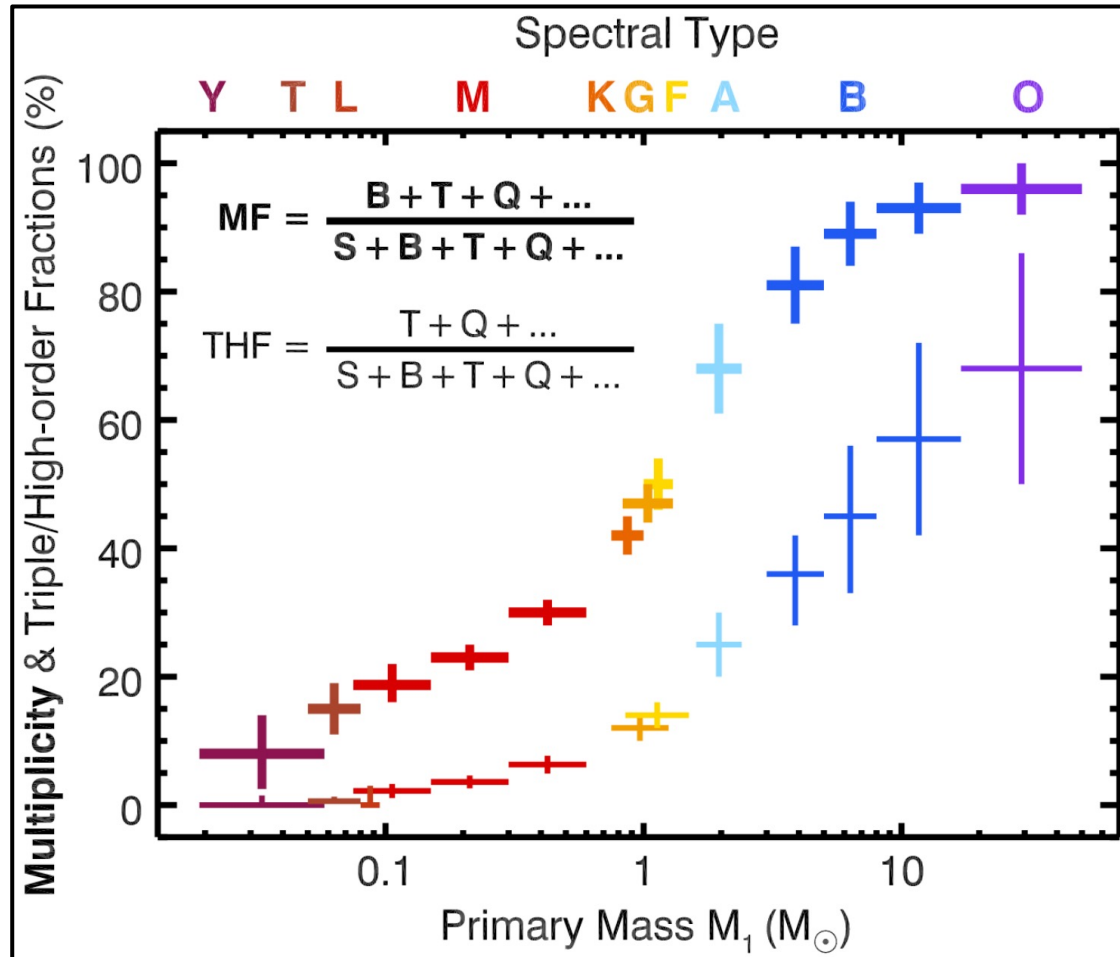
Heidelberg Institute for
Theoretical Studies

The contribution of core-fragmentation on protostellar multiplicity

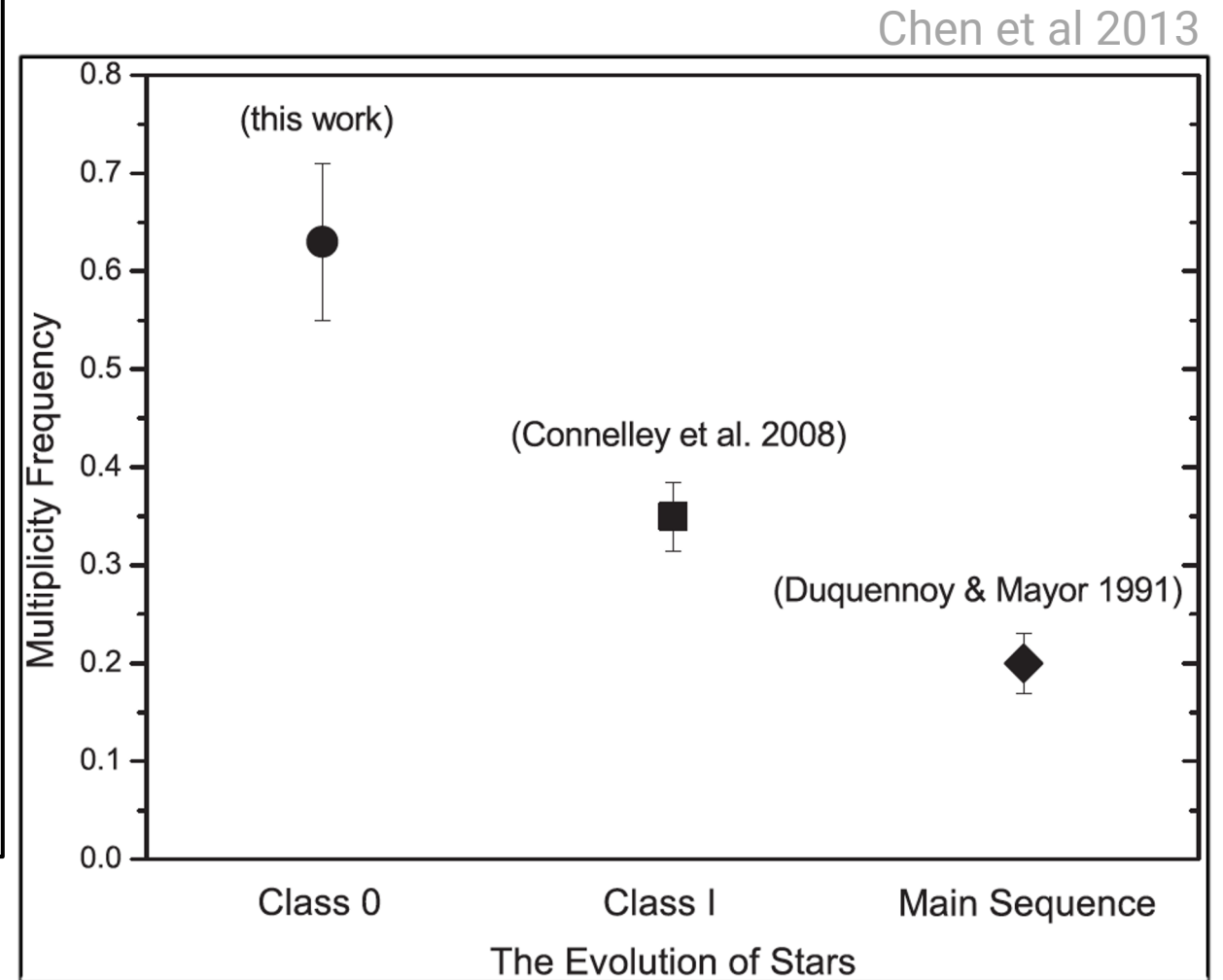
Rajika Kuruwita HITS Independent Postdoc



Multiplicity



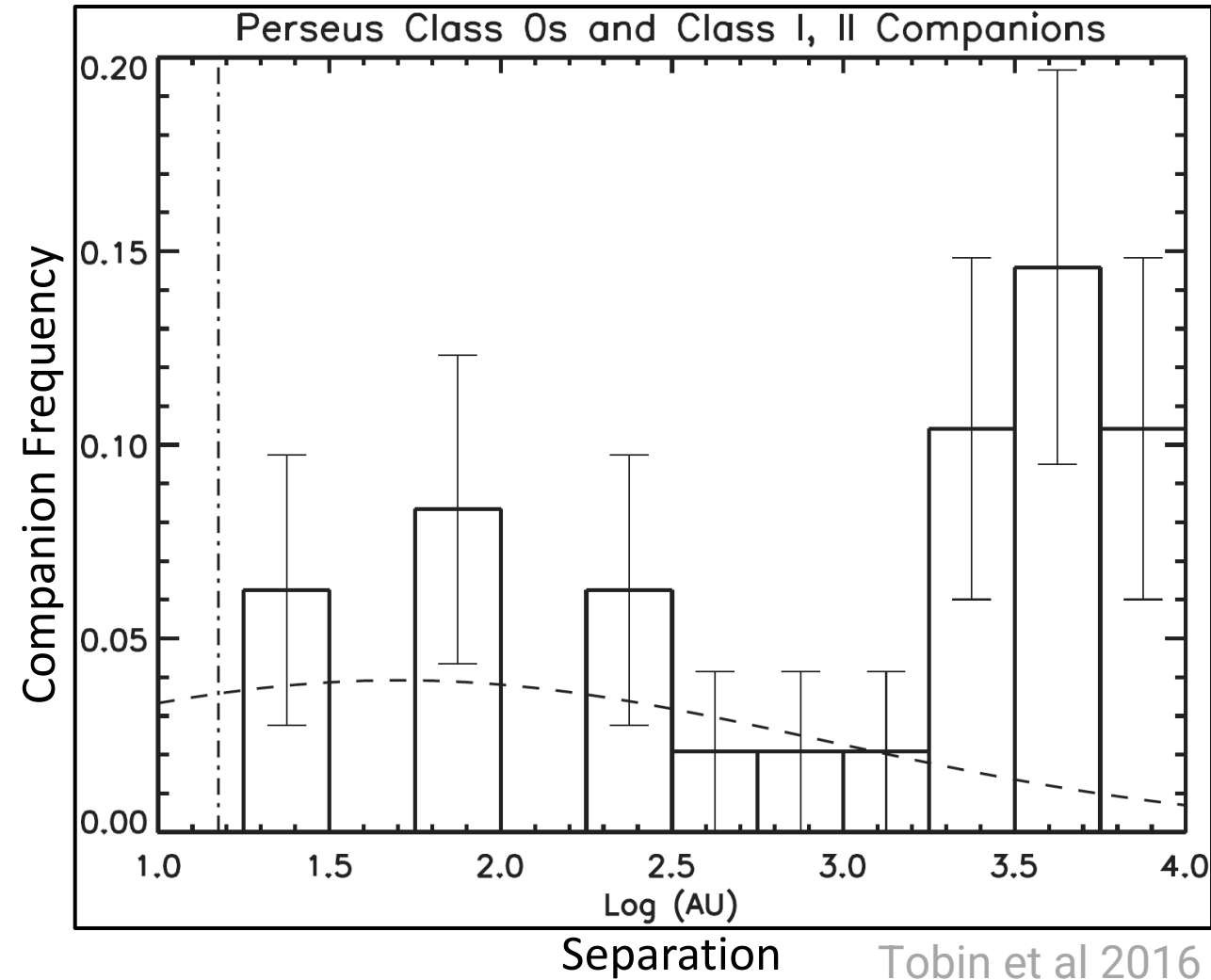
Offner et al 2022



Chen et al 2013

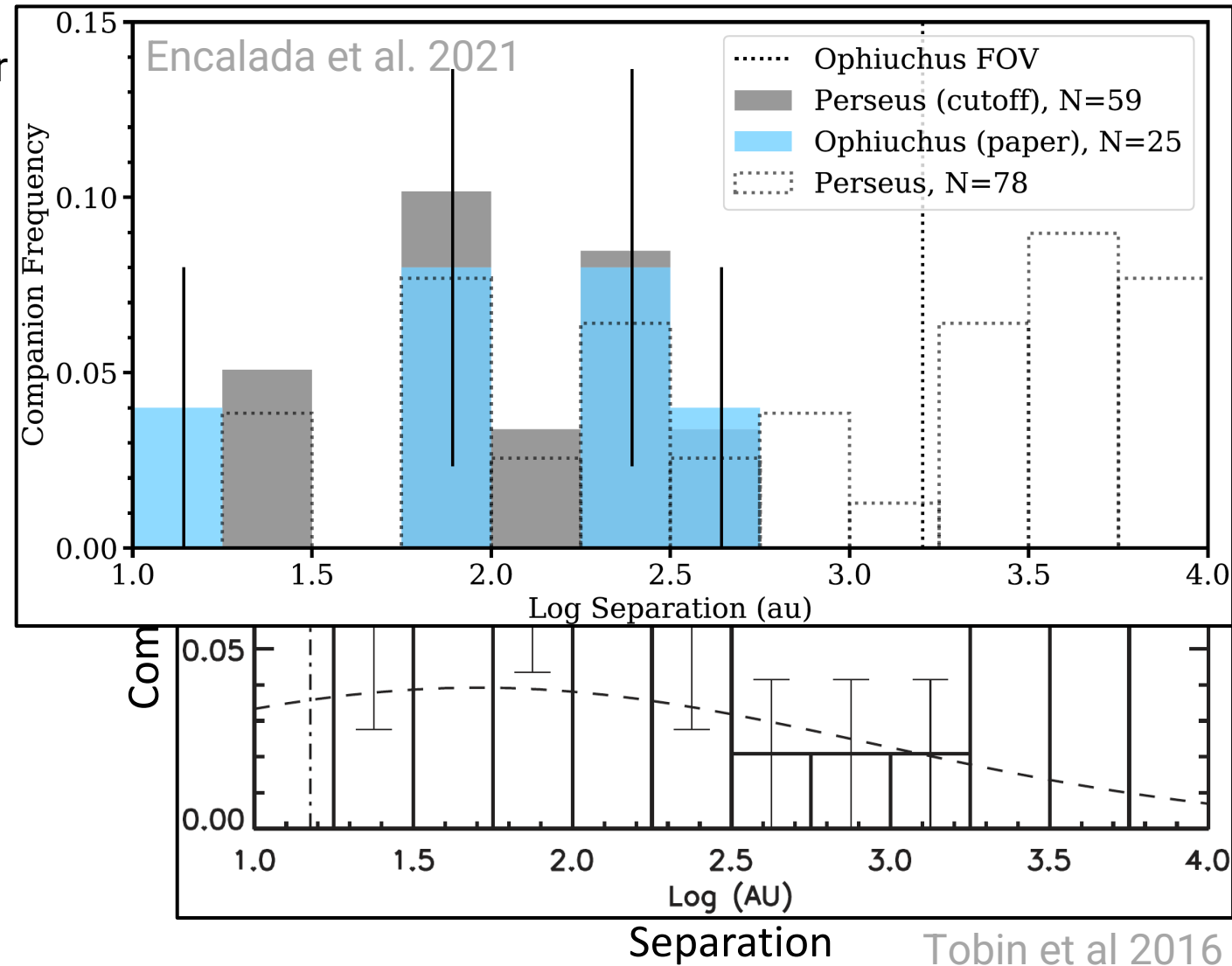
Protostellar Multiplicity

- Observed bimodal distribution in protostar separation



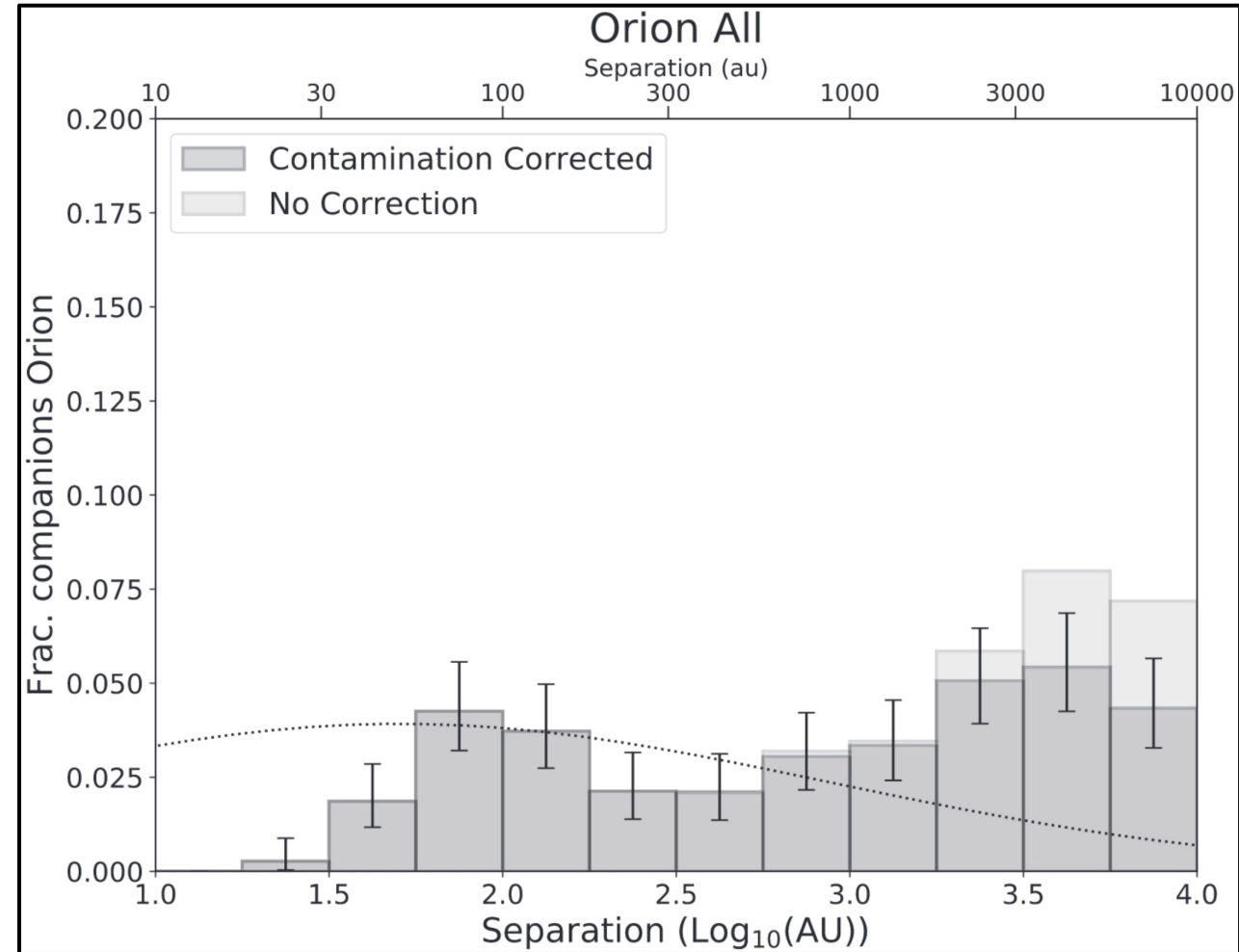
Protostellar Multiplicity

- Observed bimodal distribution in protostar separation



Protostellar Multiplicity

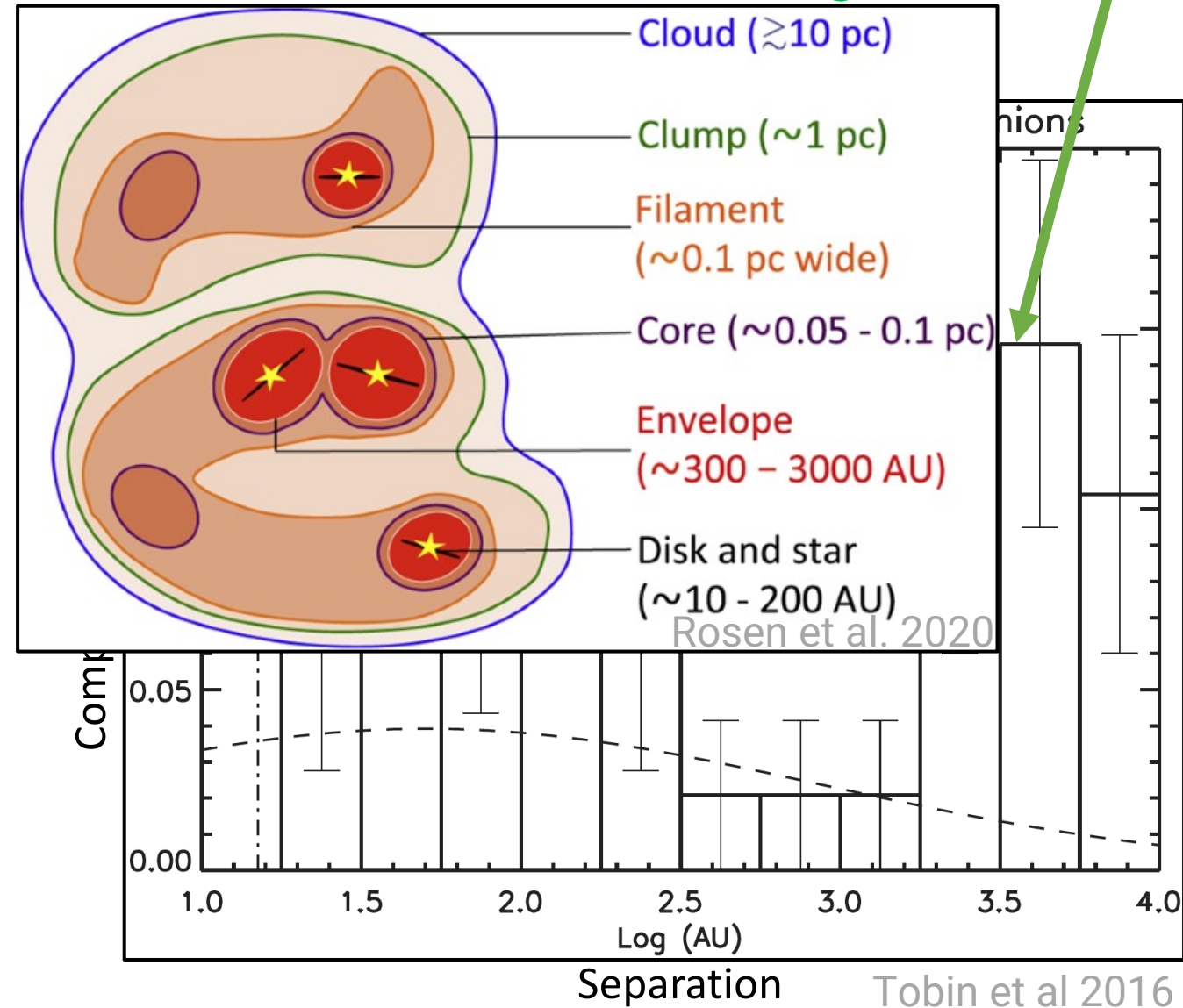
- Observed bimodal distribution in protostar separation



Tobin et al 2021

Protostellar Multiplicity

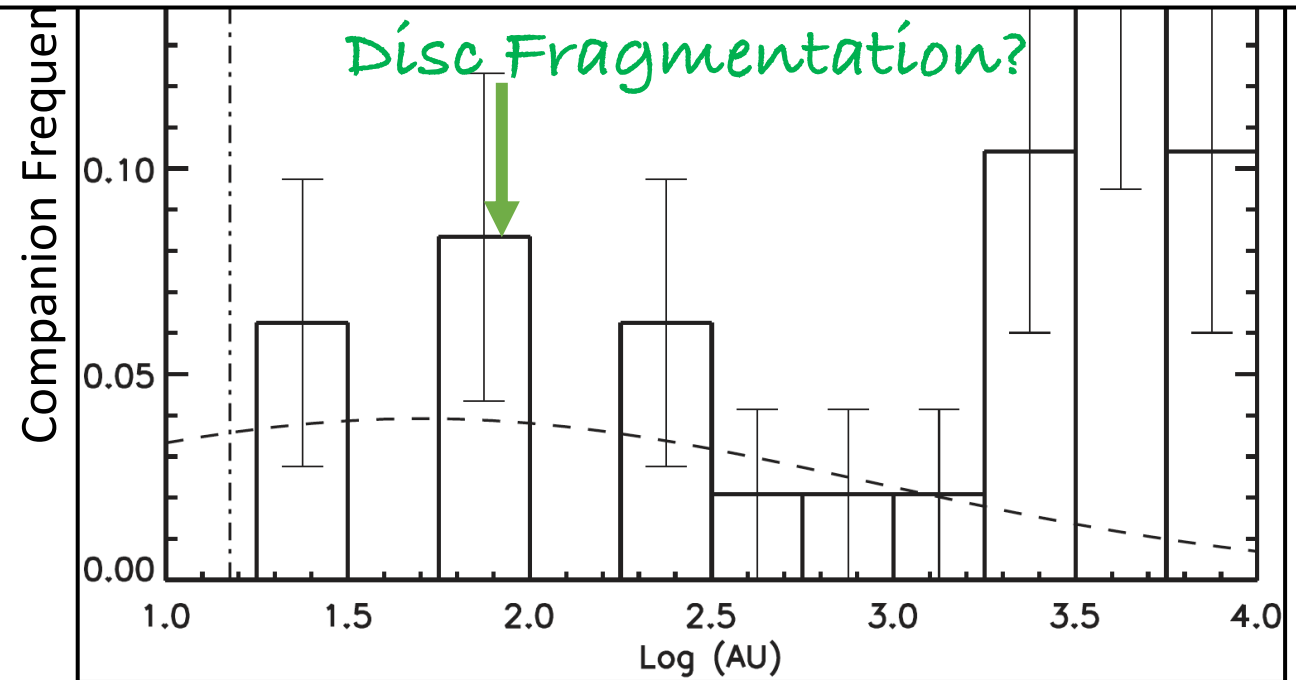
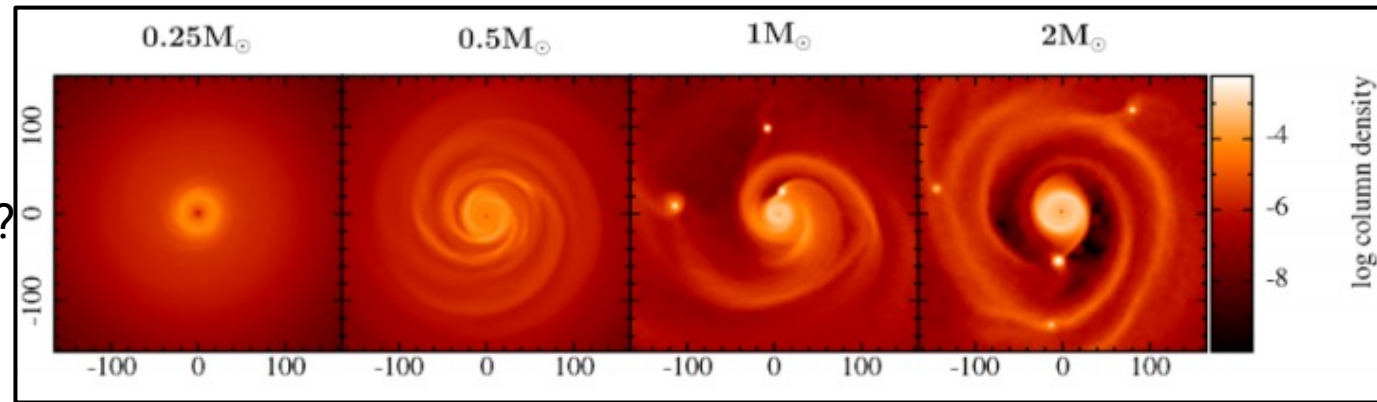
- Observed bimodal distribution in protostar separation
 - Peak at 3000au → Core fragmentation?



Protostellar Multiplicity

Cadman et al. 2021

- Observed bimodal distribution in protostar separation
 - Peak at 3000au → Core fragmentation?
 - Peak at 75au → Disc fragmentation?

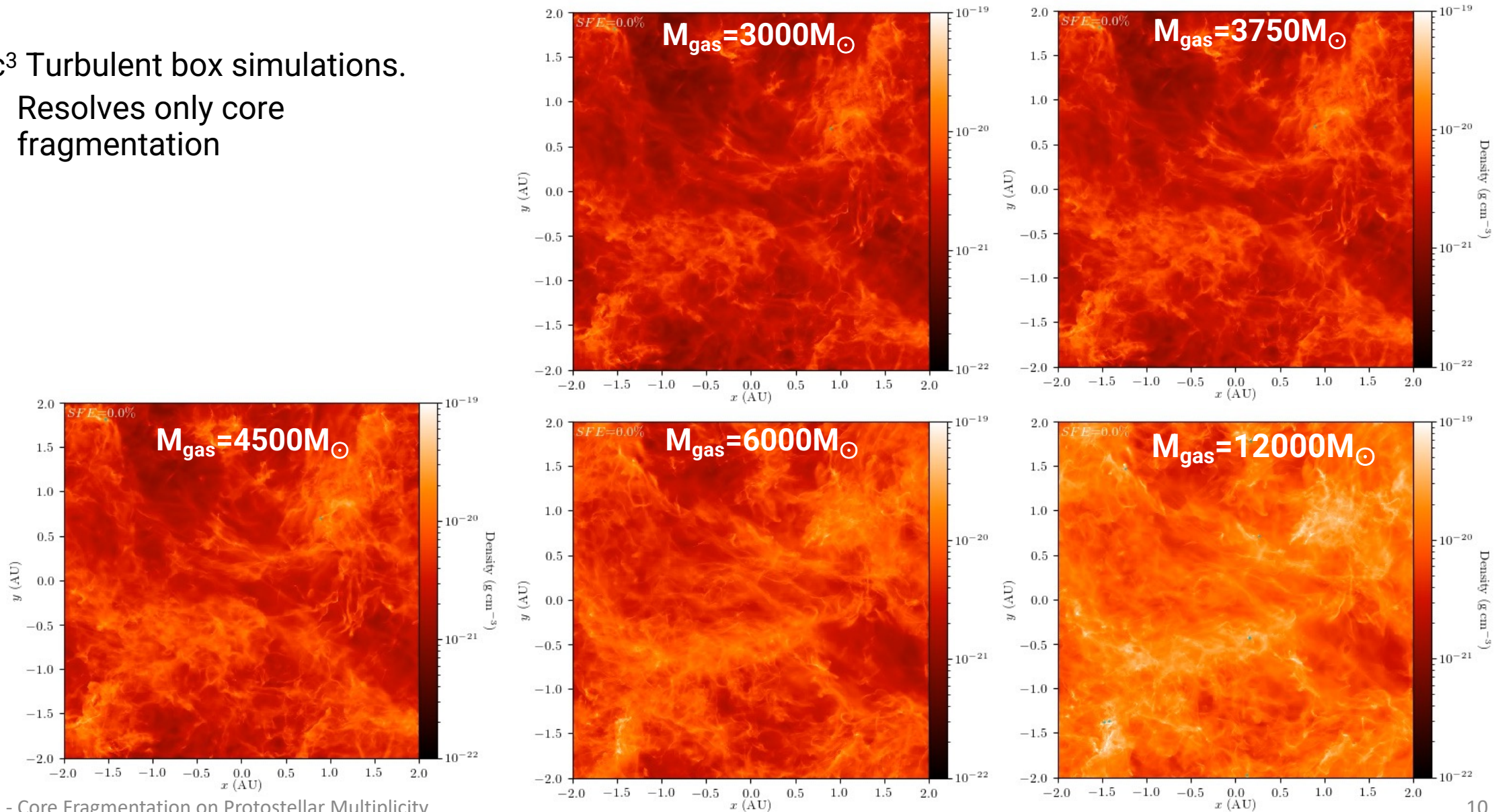


Separation

Tobin et al 2016

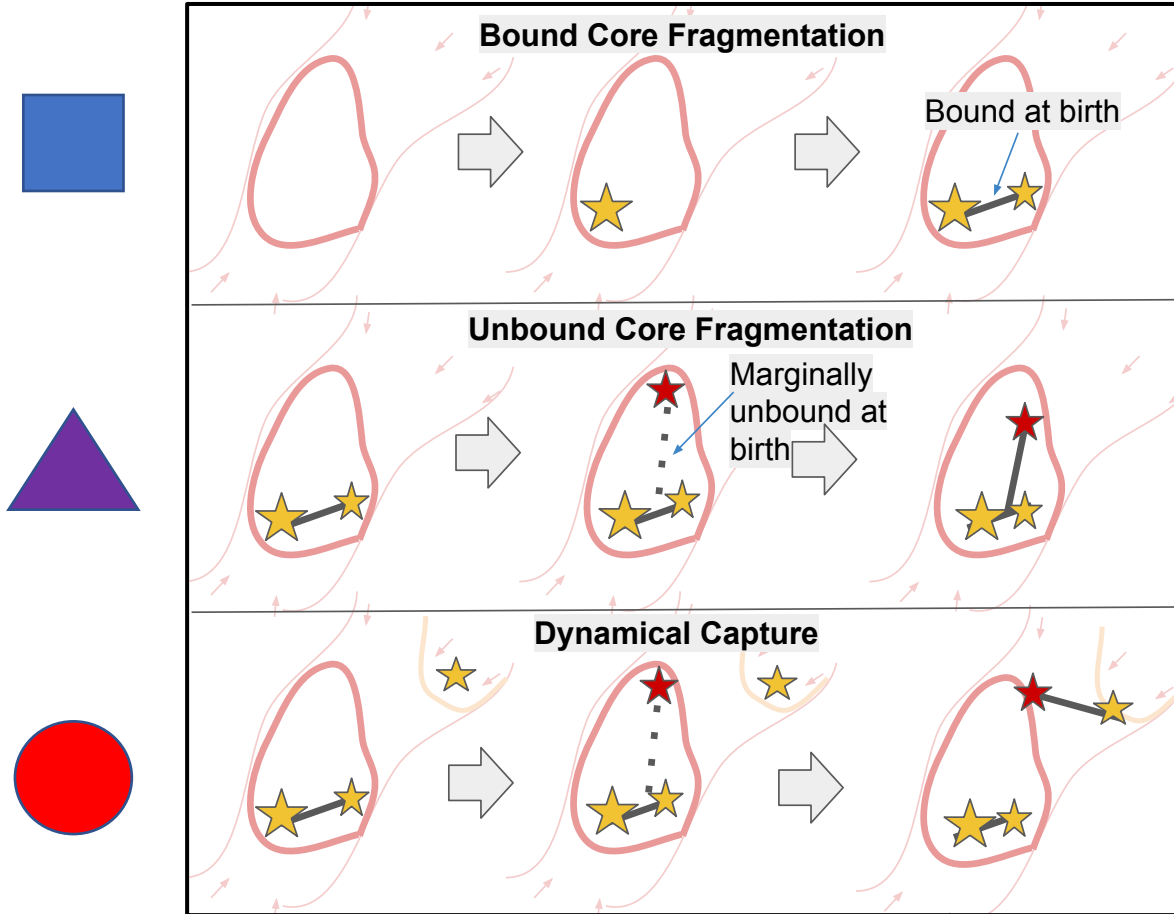
Simulations

- 4pc^3 Turbulent box simulations.
 - Resolves only core fragmentation

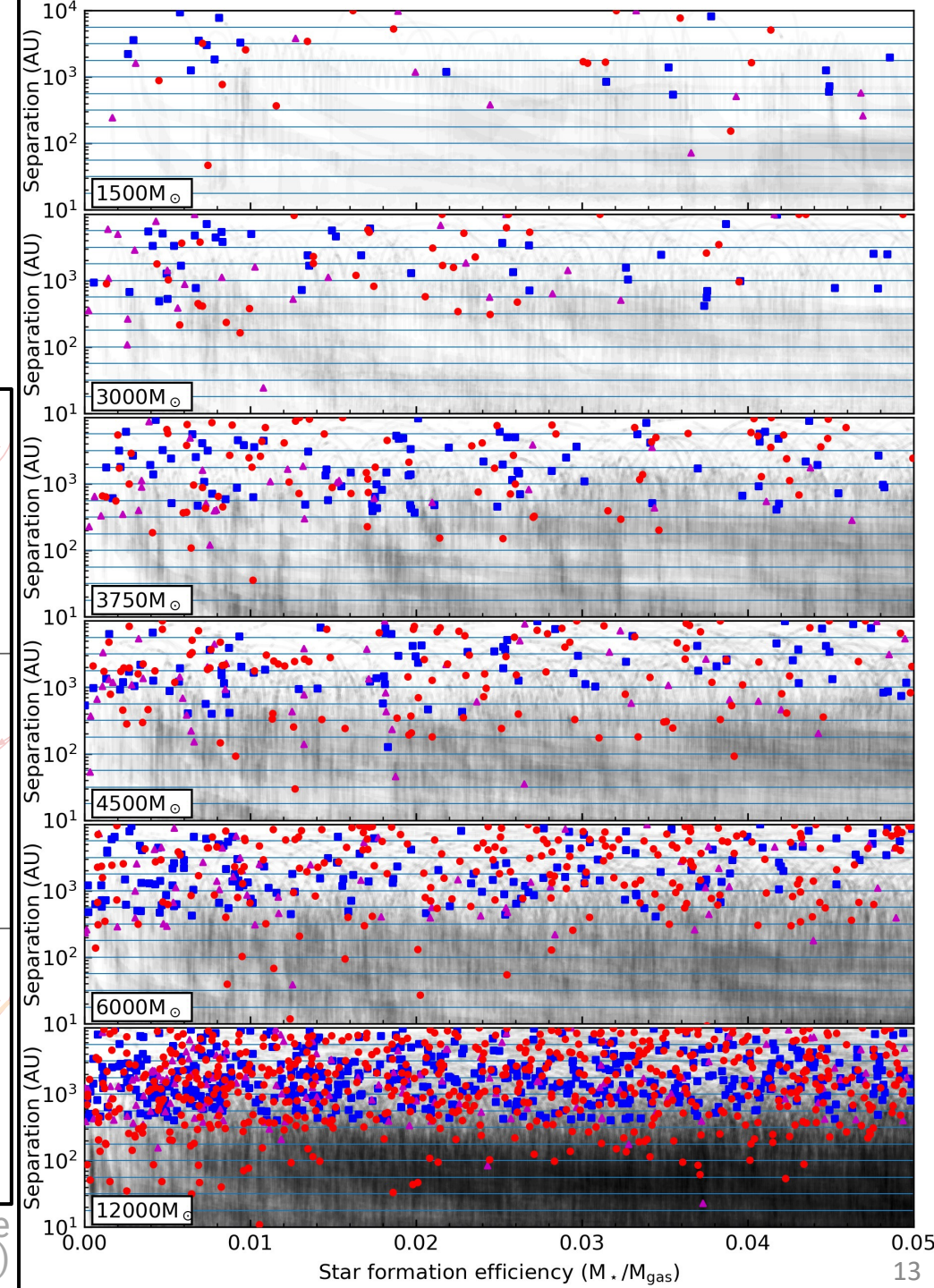


Formation Pathways

- EVERY separation between bound systems.
- Many systems experience significant in-spiral

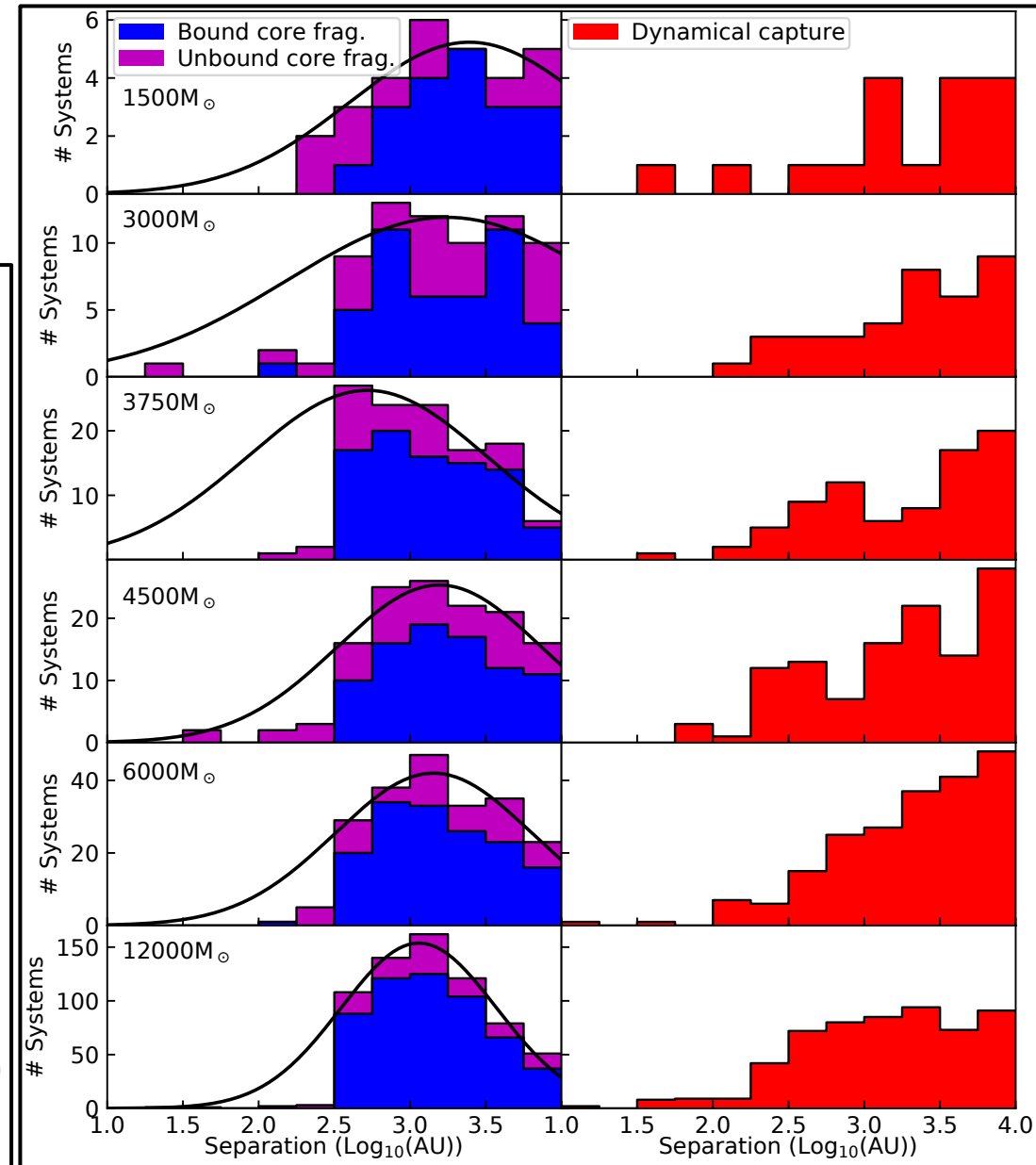
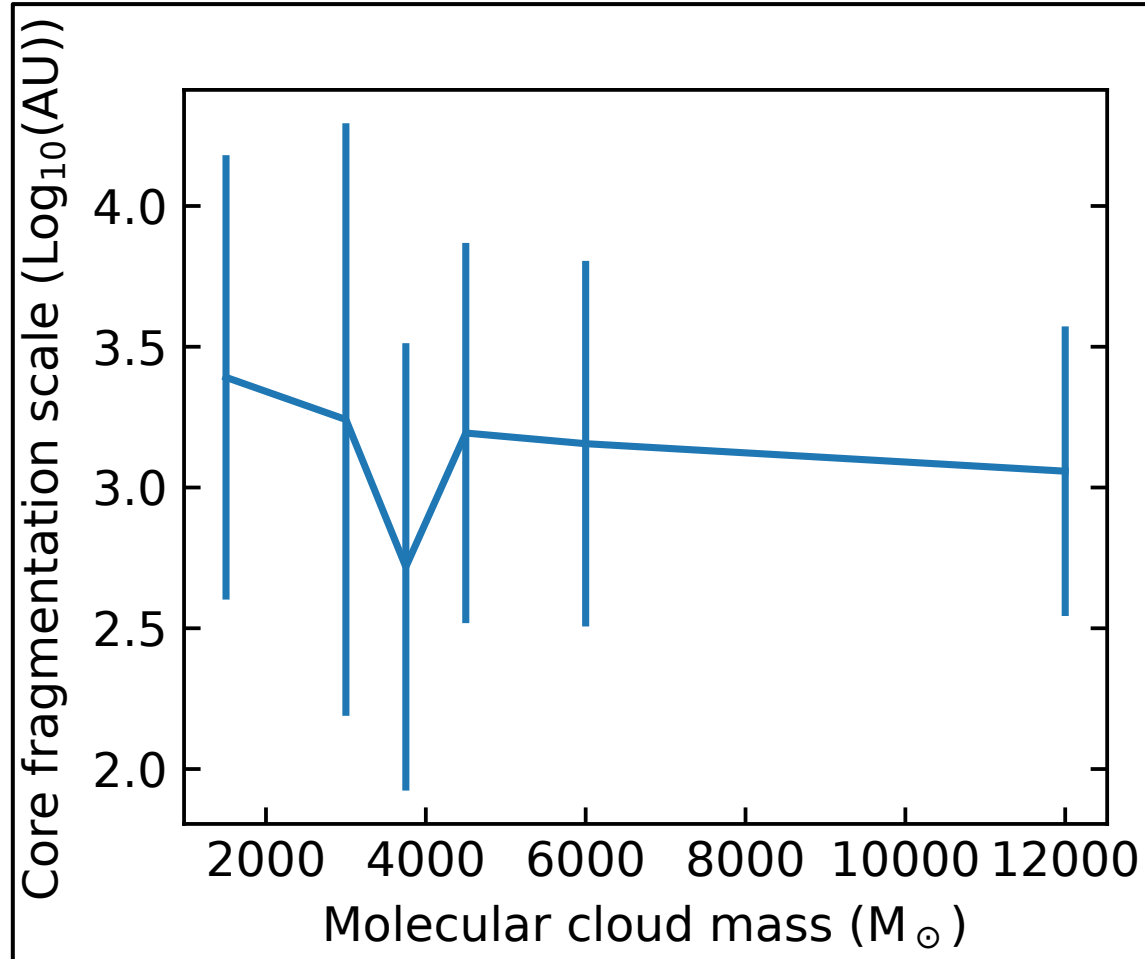


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2023 (accepted)



Formation Pathways

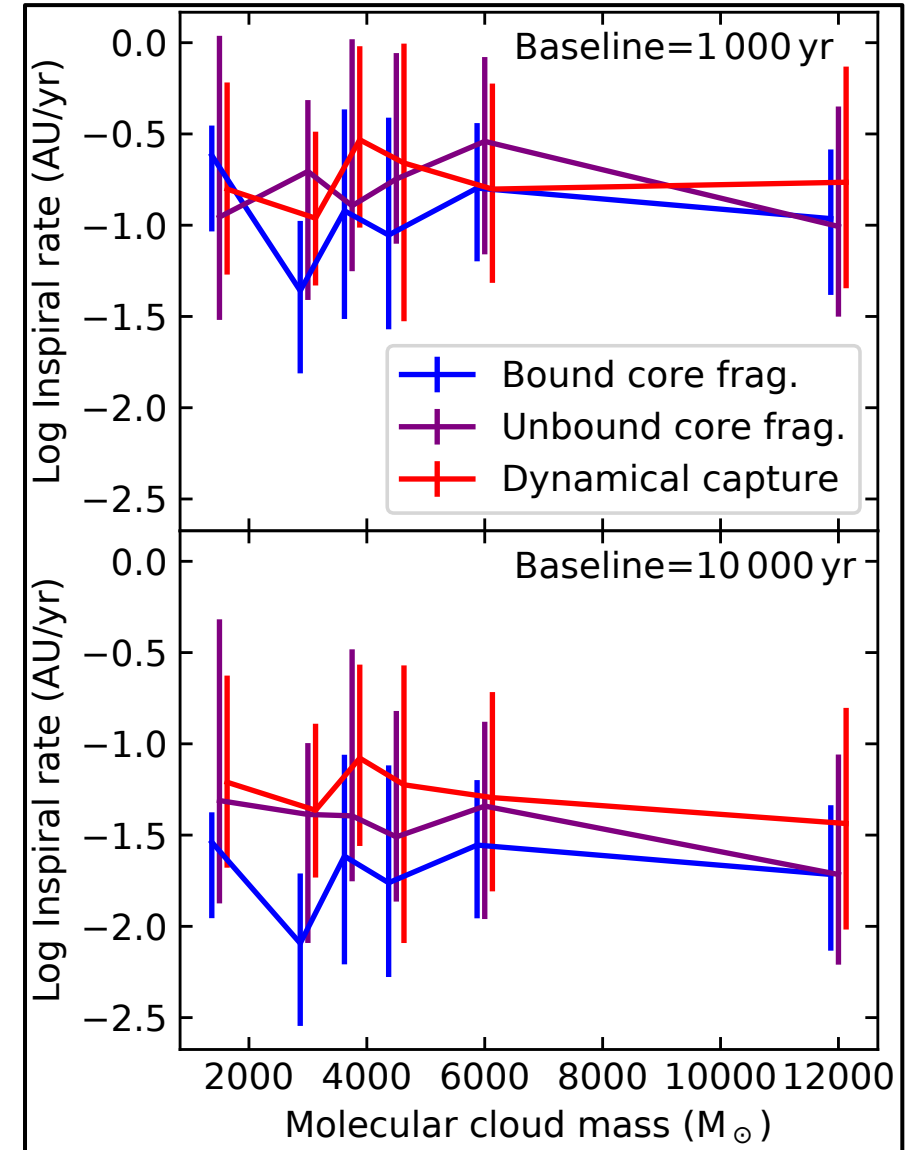
- Maybe a smaller fragmentation scale with higher density?



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Inspiral Rates

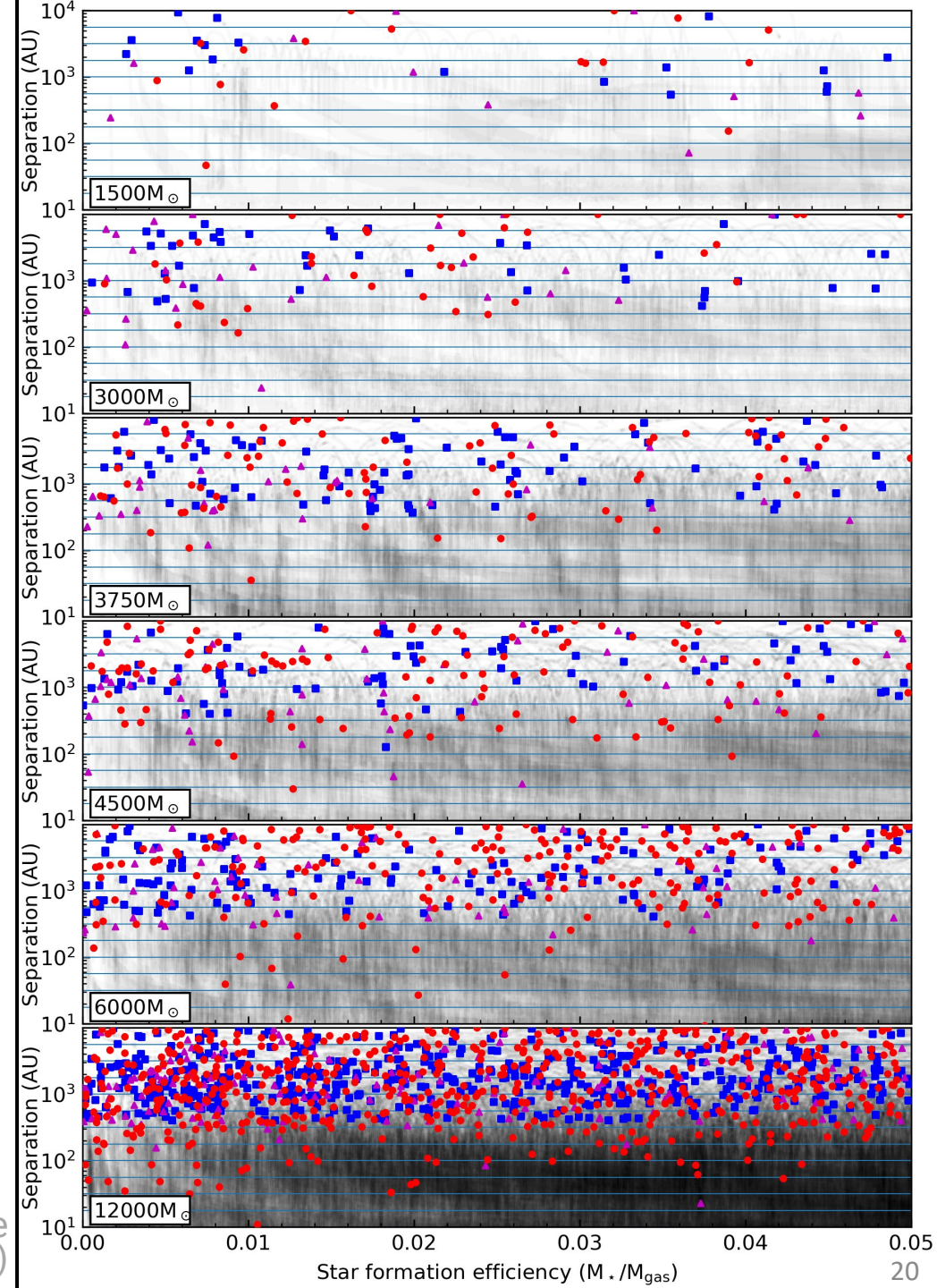
- Measured gradient of semimajor axis after first periastron.
- Environment doesn't affect inspiral rates
- Over first 1000yr all pathways have same rates
- Over first 10 000yr dynamical capture has higher inspiral rates



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Comparison with obs.

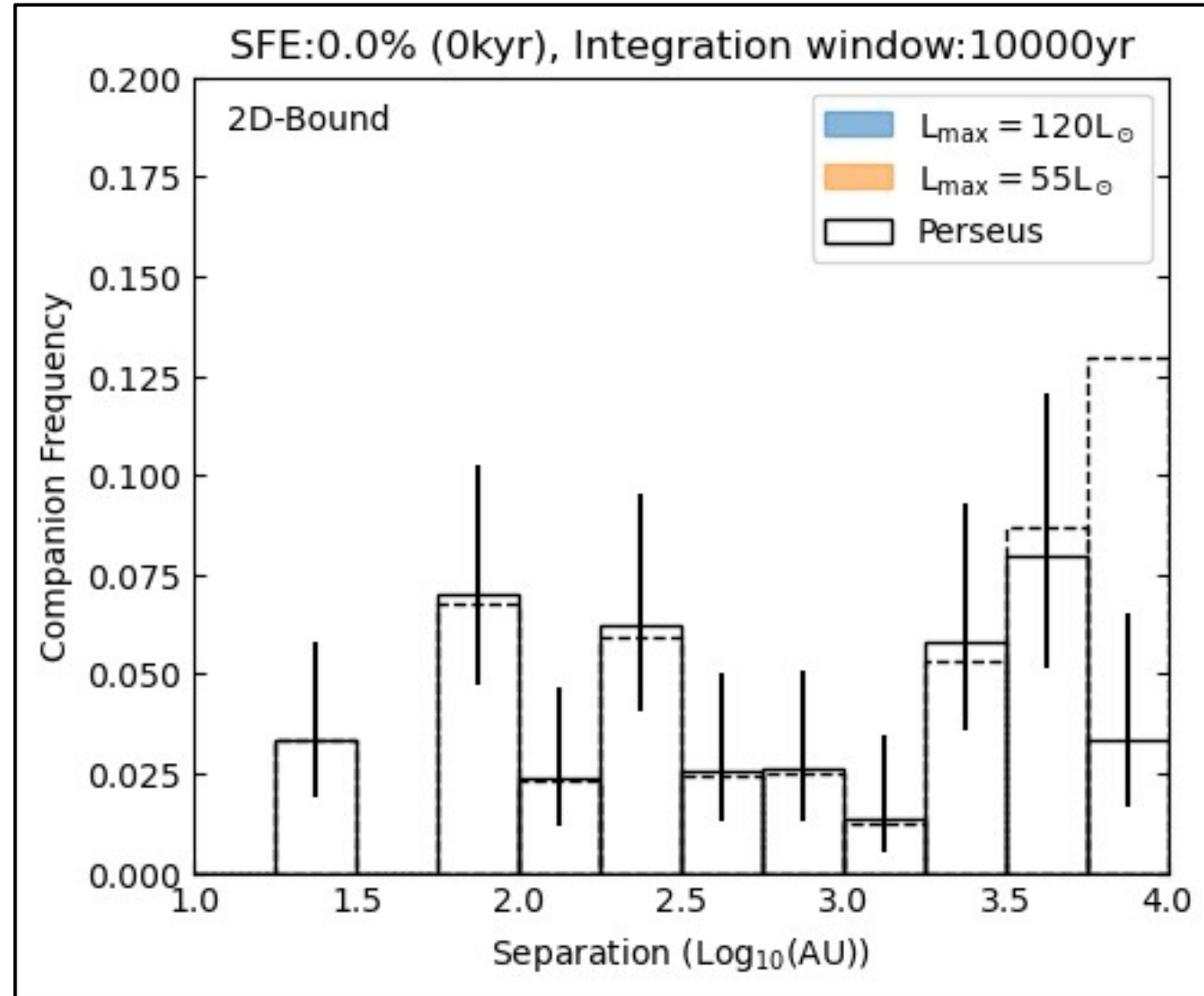
- Simulations evolve over time
- Observations see a snapshot in time.



Kuruwita & Haugbølle
2023 (accepted)

Comparison with observation

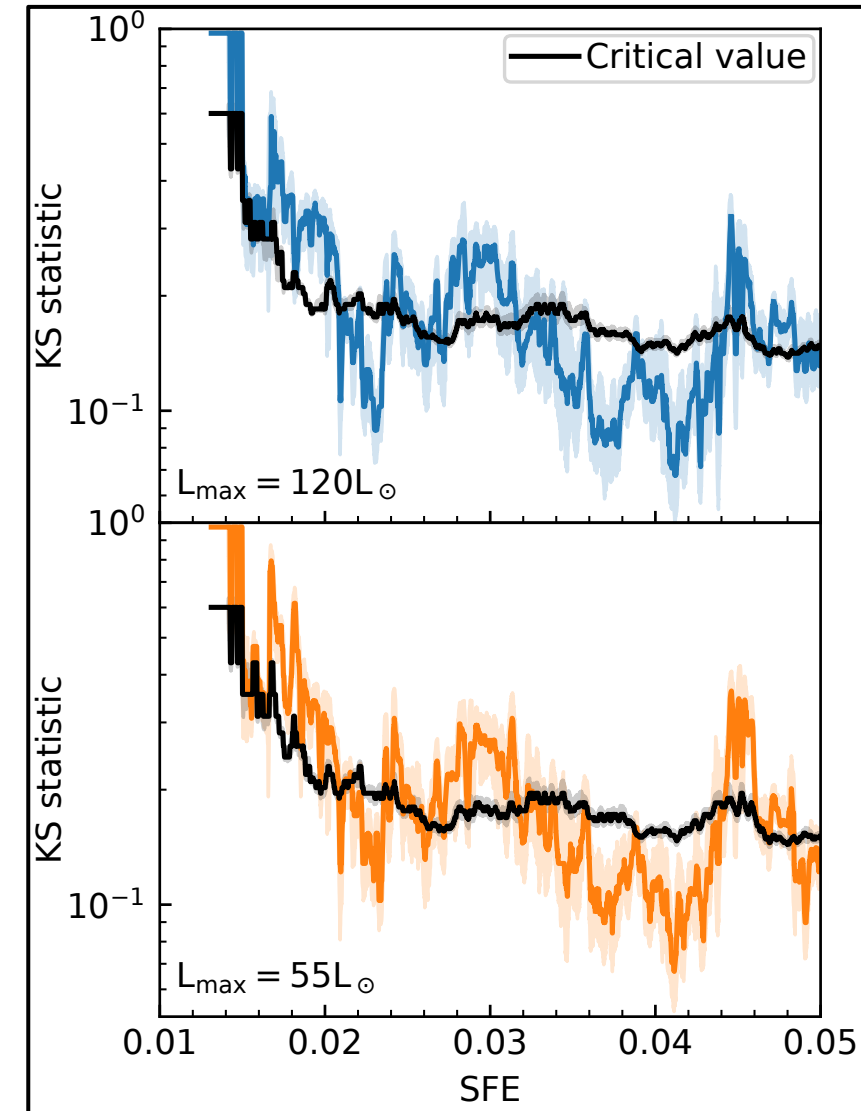
- 3750Msun simulation has similar conditions to Perseus
- Produced similar number of visible stars to observations
- Visible means:
 - $M_{\text{acc}} > 10^{-7} M_{\text{sun}}/\text{yr}$
 - $L_{\text{acc}} > 0.1$ and < 55 or $120 L_{\text{sun}}$.



Kuruwita & Haugbølle 2023 (accepted)

Comparison with observation

- Did KS test to fit shape.
 - Lowest KS-statistic at $\sim 4.1\%$



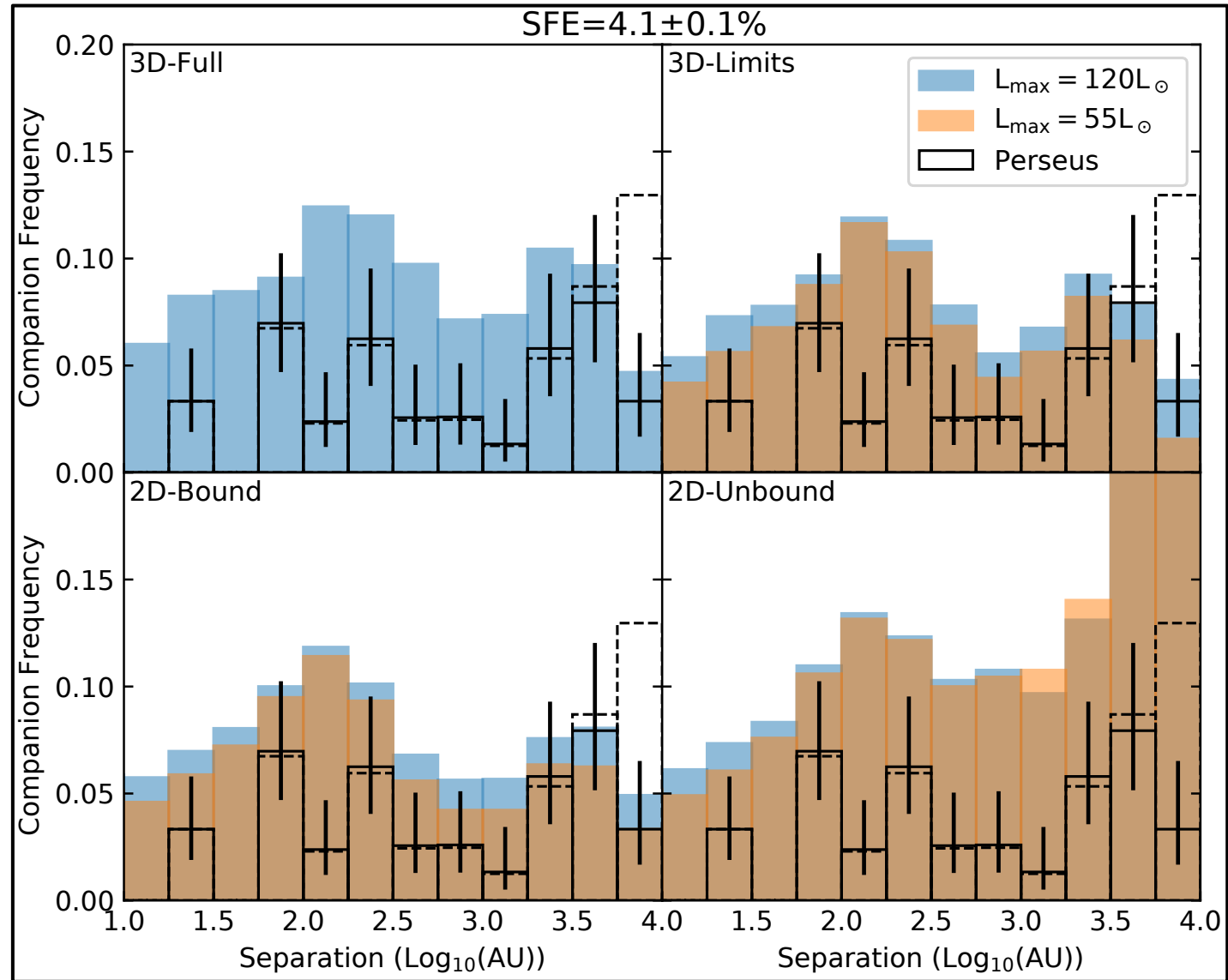
Kuruwita & Haugbølle 2023 (accepted)

Comparison with observation

Name	Projection into 2D	Bound Check	\dot{M} and L_{acc} Limits
3D-Full	False	True	False
3D-LLimits	False	True	True
2D-Bound	True	True	True
2D-Unbound	True	False	True

Kuruwita & Haugbølle 2023 (accepted)

Comparison with observation



Kuruwita & Haugbølle 2023 (accepted)

Conclusions

- Systems form on core-fragmentation scales undergo significant dynamical evolution at early times.
- Able to re-produce observed bimodal distribution, when we impose observational limits
 - Is the bimodal distribution real or an observation effect?
- Core fragmentation can account for a large fraction of close ($<100\text{AU}$) binaries