What Determines the Mass of a Star?

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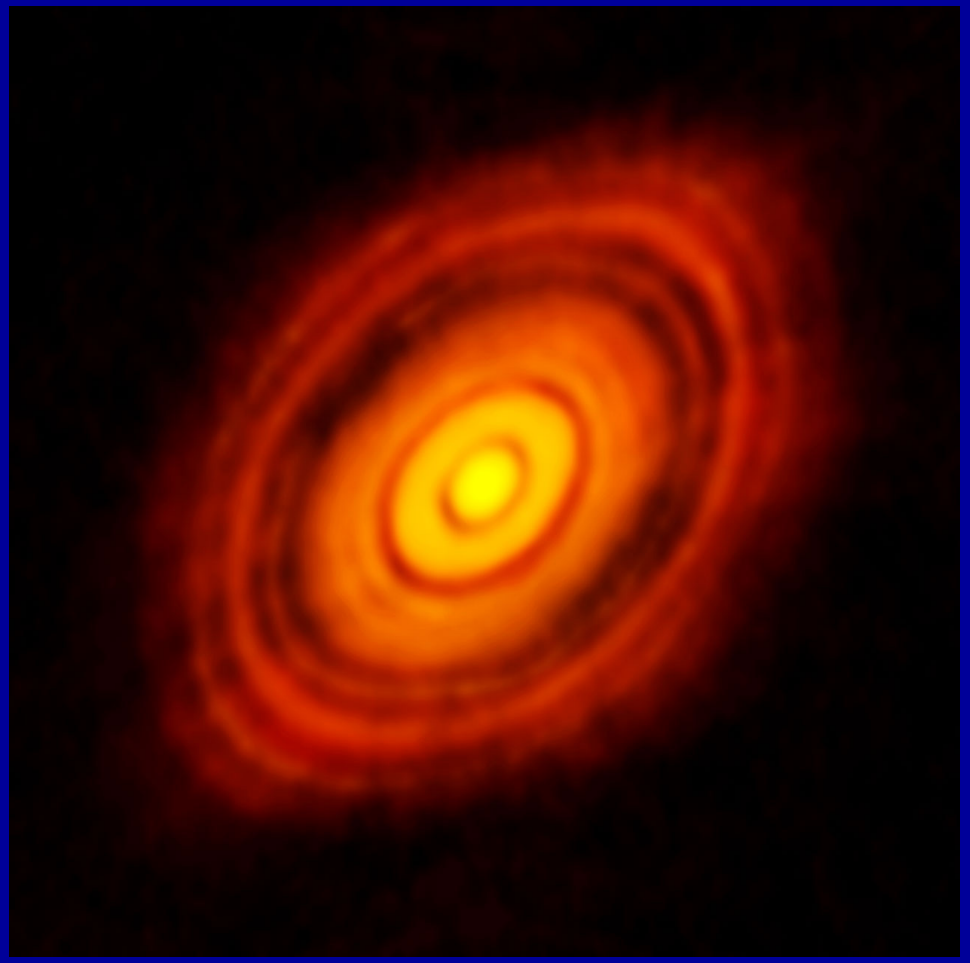
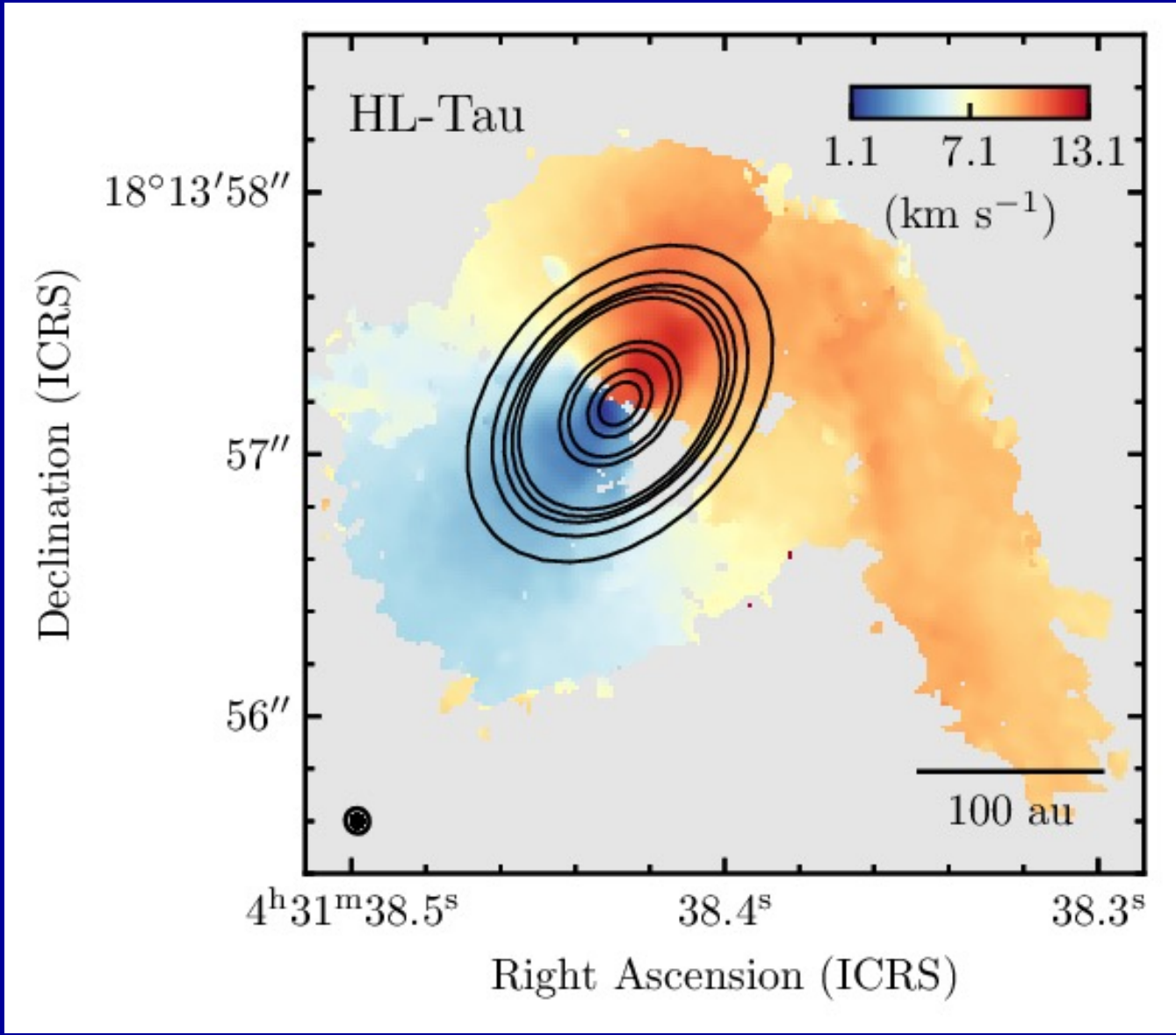
Starting from the end:



A Streamer in HL Tau

HCO^+ (3-2)



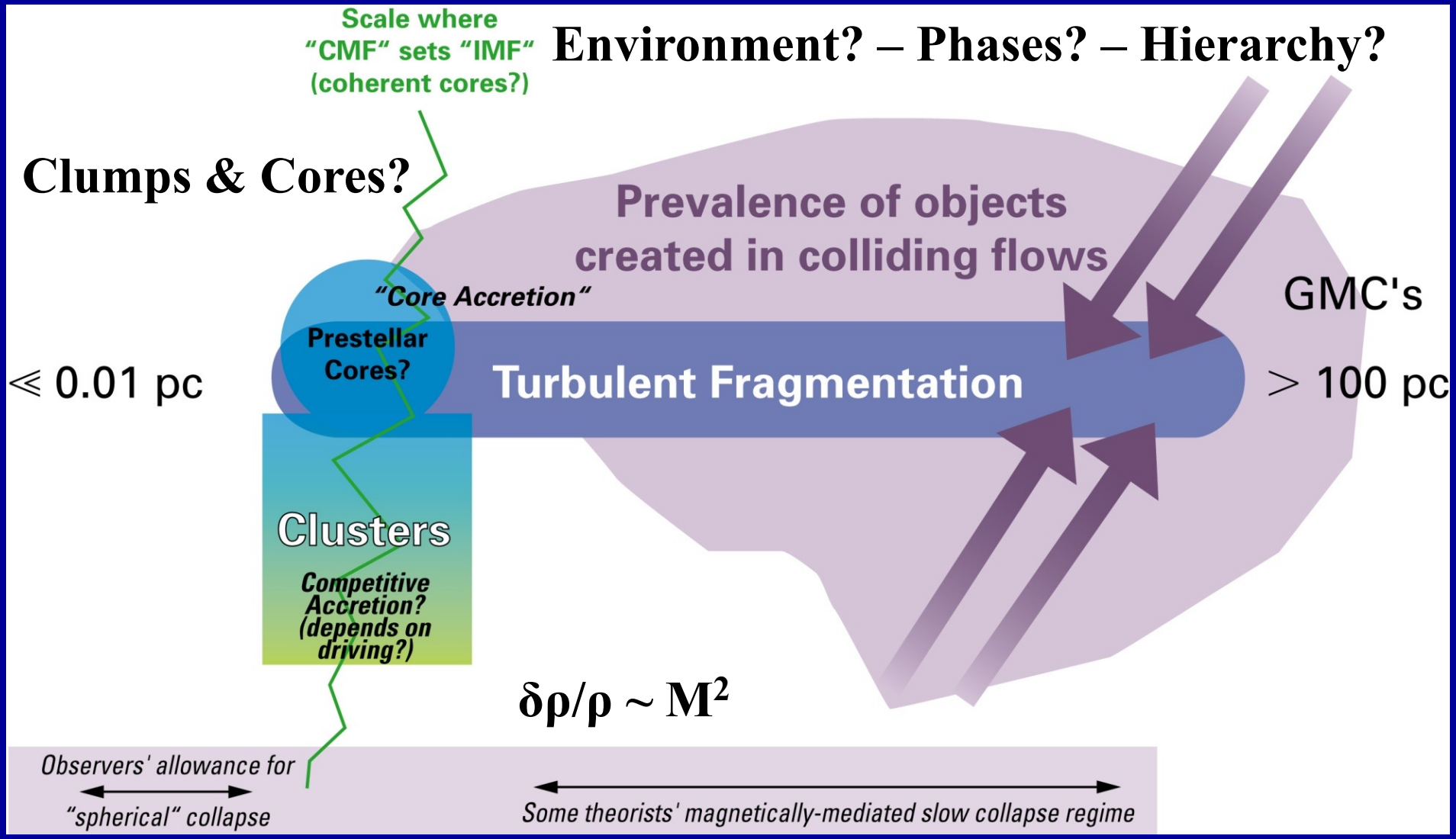
Yen et al. (2017, 2019), see also
NIRCAM inaging: Mullin et al. (2024)

What determines the mass of a star?

- Mass reservoir for star formation (filaments to clumps to cores)
  (e.g. Offner et al. 2022, Redaelli et al. 2022, Nozaki et al. 2025, André et al. 2025)
- Fragmentation on different scales – Magnetic fields?
  (e.g. Chira et al. 2018, Pillsworth et al. 2025, Commercon et al. 2011, Klos et al. 2025, Coletta et al. 2025, Nucara et al. 2025 – yesterday‘s talk)
- What are the accretion timescales (clusters vs. isolated star formation)
  (e.g. Fedele et al. 2010, Sicilia-Aguilar et al. 2005, Rogers, C. et al. 2025)
- Are streamers important?
  (Pineda et al. 2023, Prodige Survey – e.g. Valdivia-Mena et al. 2022, Gieser et al. 2024, 2025)
- Stellar feedback (outflows, winds, radiation)

Accretion process: Different scales, not axisymmetric, time dependent.

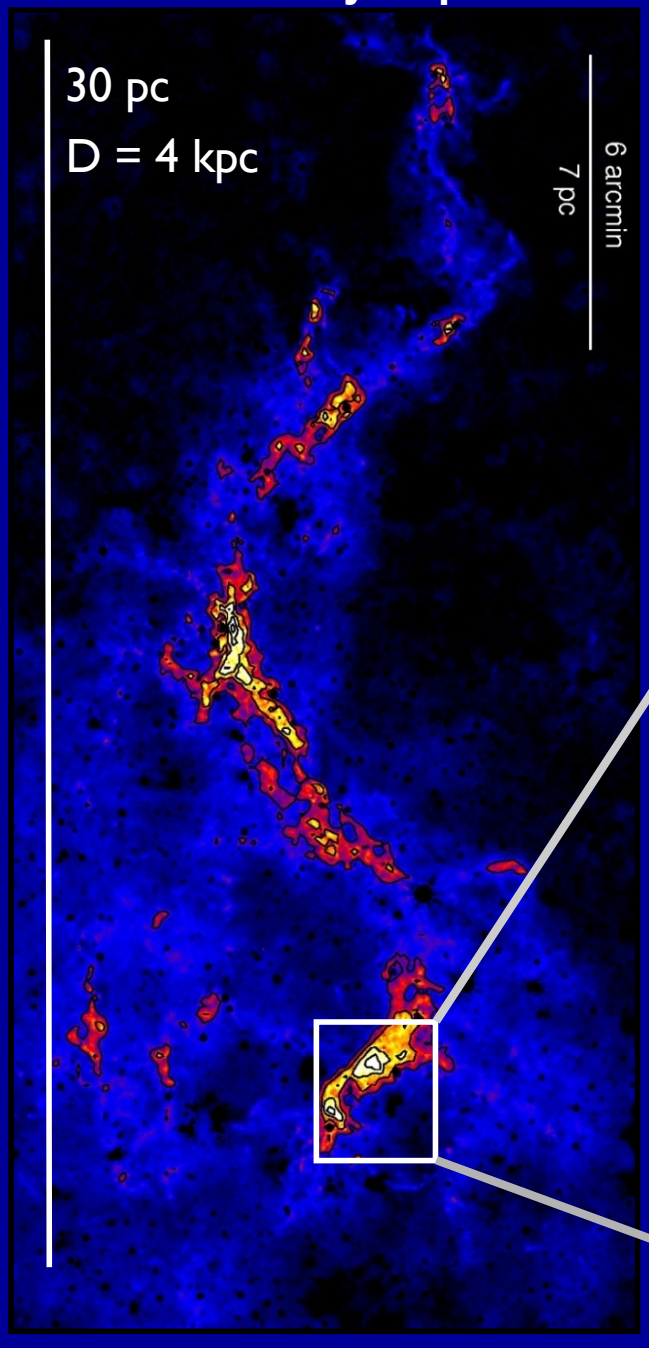
Important Steps towards Star Formation …



"The fault, dear Brutus, is not in our stars, but in ourselves" - Statistics

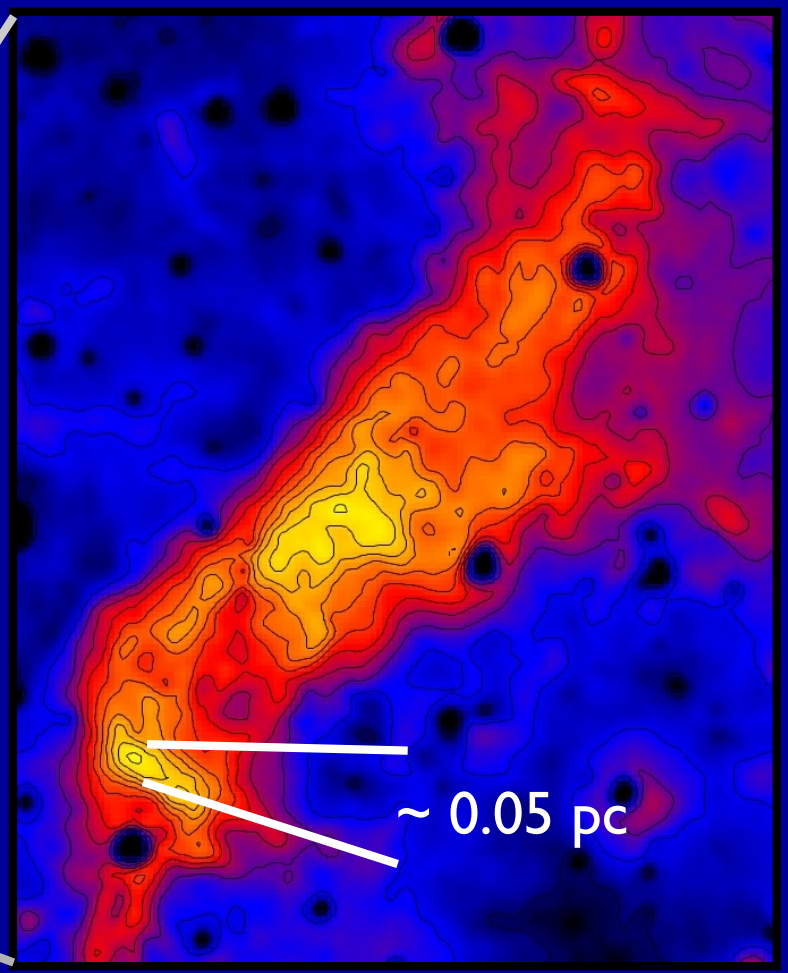
W. Shakespeare

Hidden Mass Reservoir of Molecular Clouds



High-dynamic-range dust extinction mapping (Kainulainen ea. 13, Kainulainen & Tan 13): UKIDSS + Spitzer (2”, 1 - 100x10^{21} cm^{-2}); Filaments are not isolated: Heitsch 2012

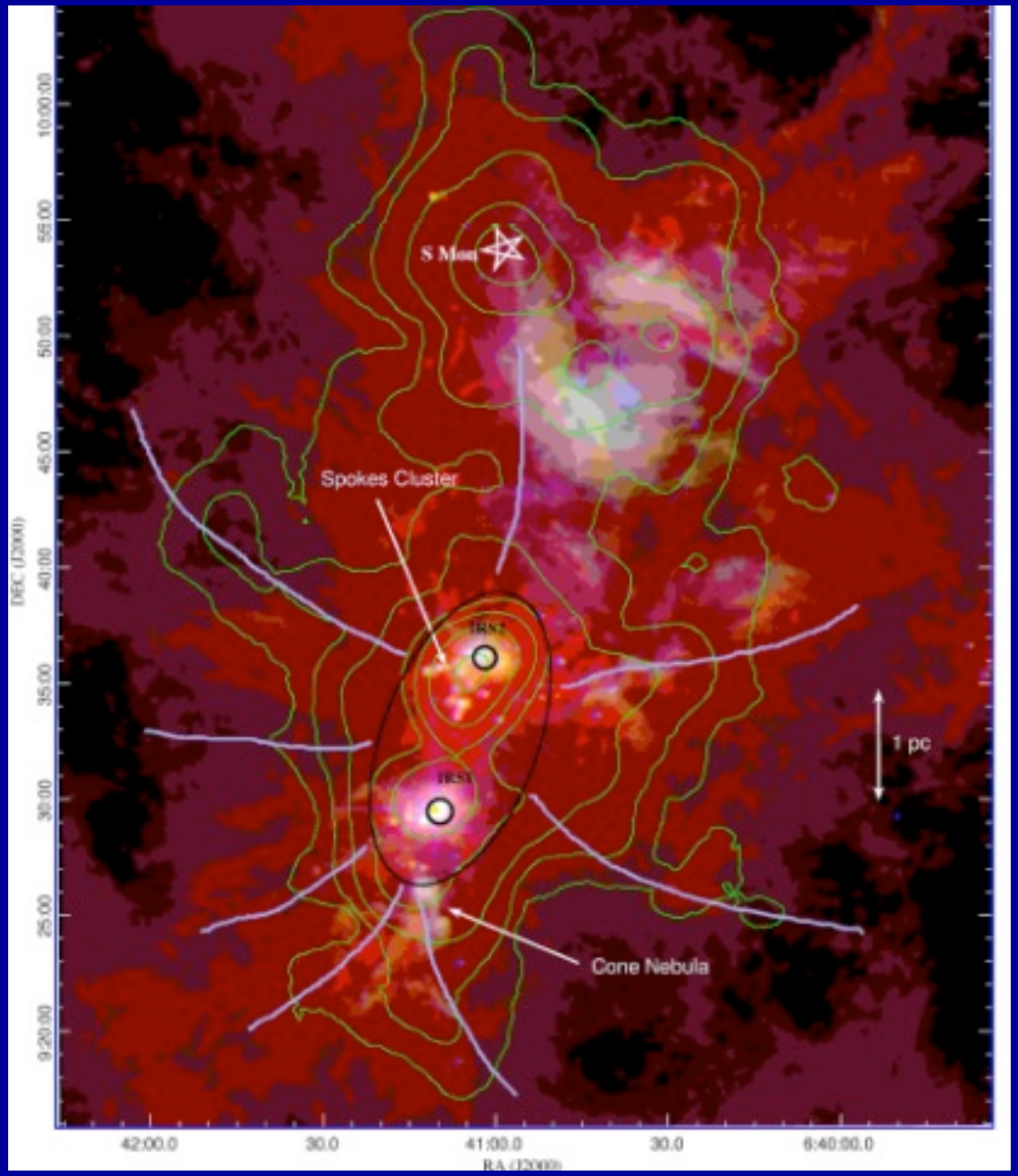
10x more mass as probed by submm emission



Unification of Low- & High-Mass Star Formation?

Filaments & Hubs in NGC 2264 –

What about 100 M_{sun}?



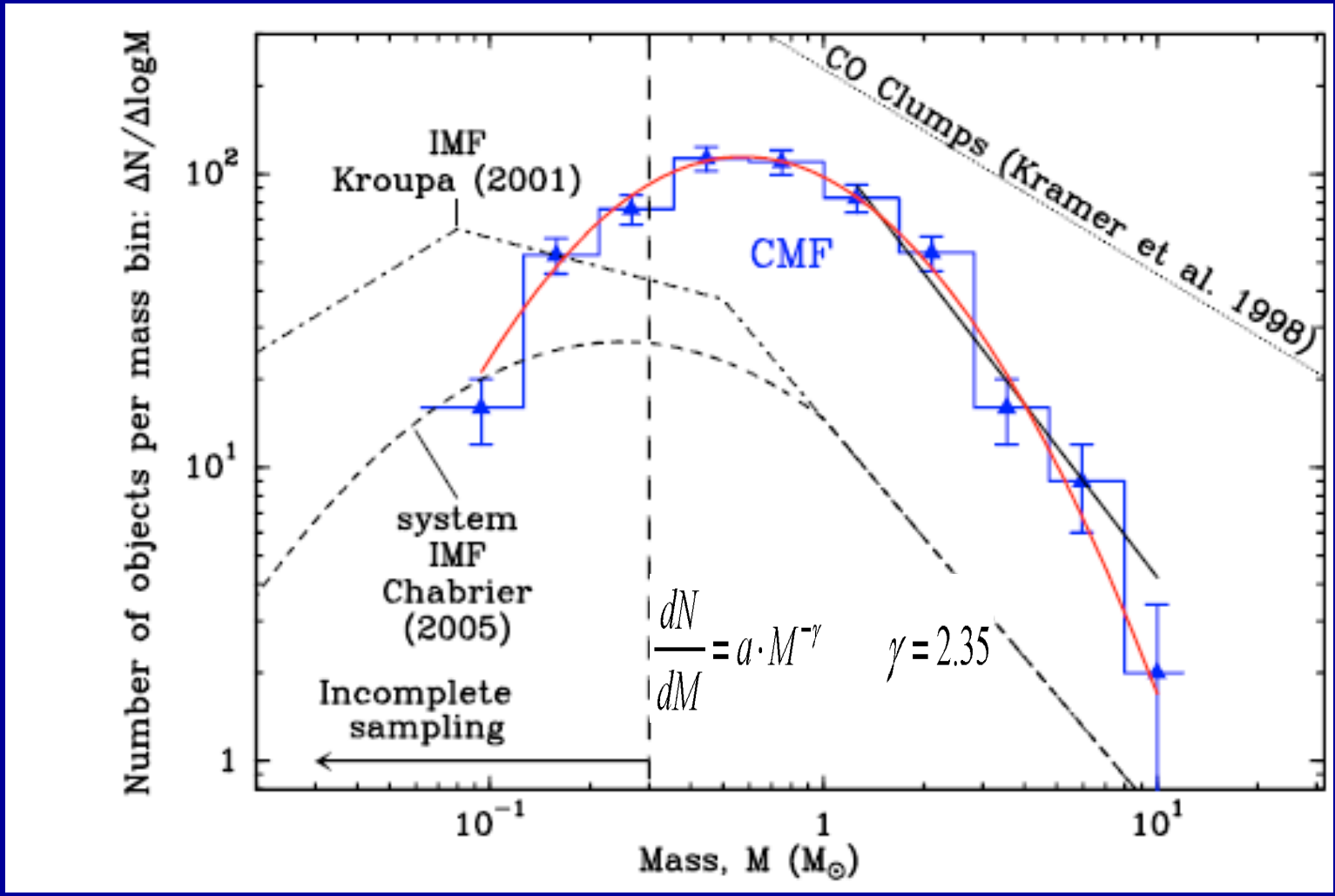
SPIRE (red, 500 μm)
PACS (green, 70 μm)
MIPS (blue, 24 μm)

Kumar et al. (2020)

The Origin of the Initial Mass Function

Core formation is time dependent and core masses change with time

(About 1.000 massive ALMAGAL clumps with different L/M - Coletta ea. 2025)

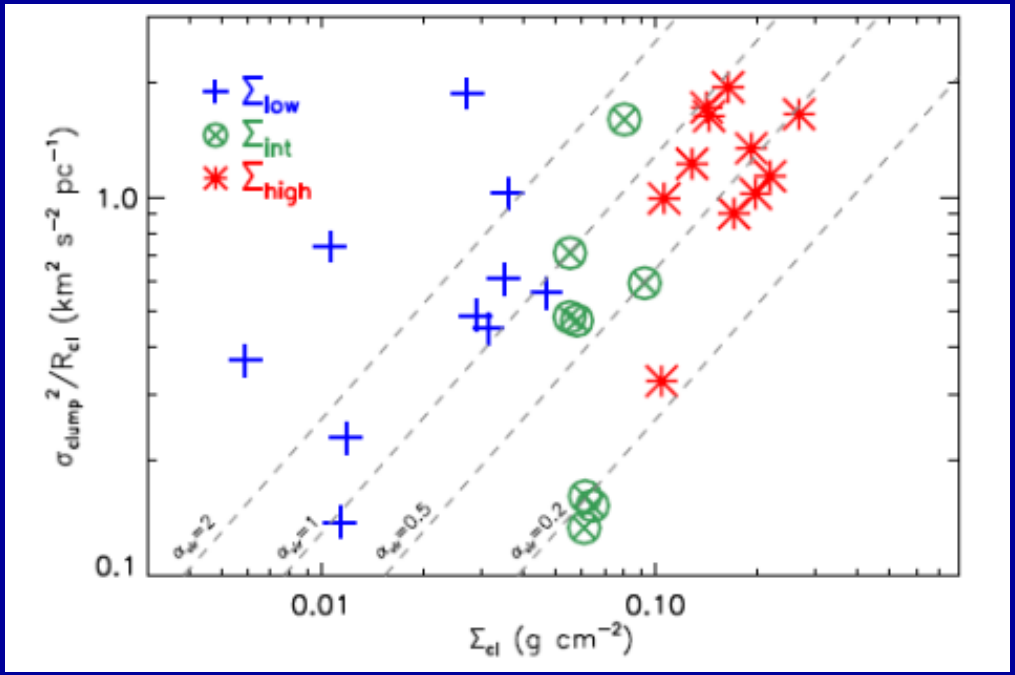


Herschel SPIRE/PACS: 541 candidate pre-stellar cores in Aquila (Andre et al. 2010)

Mapping between CMF and IMF: Offner et al. (2014, PPVI)

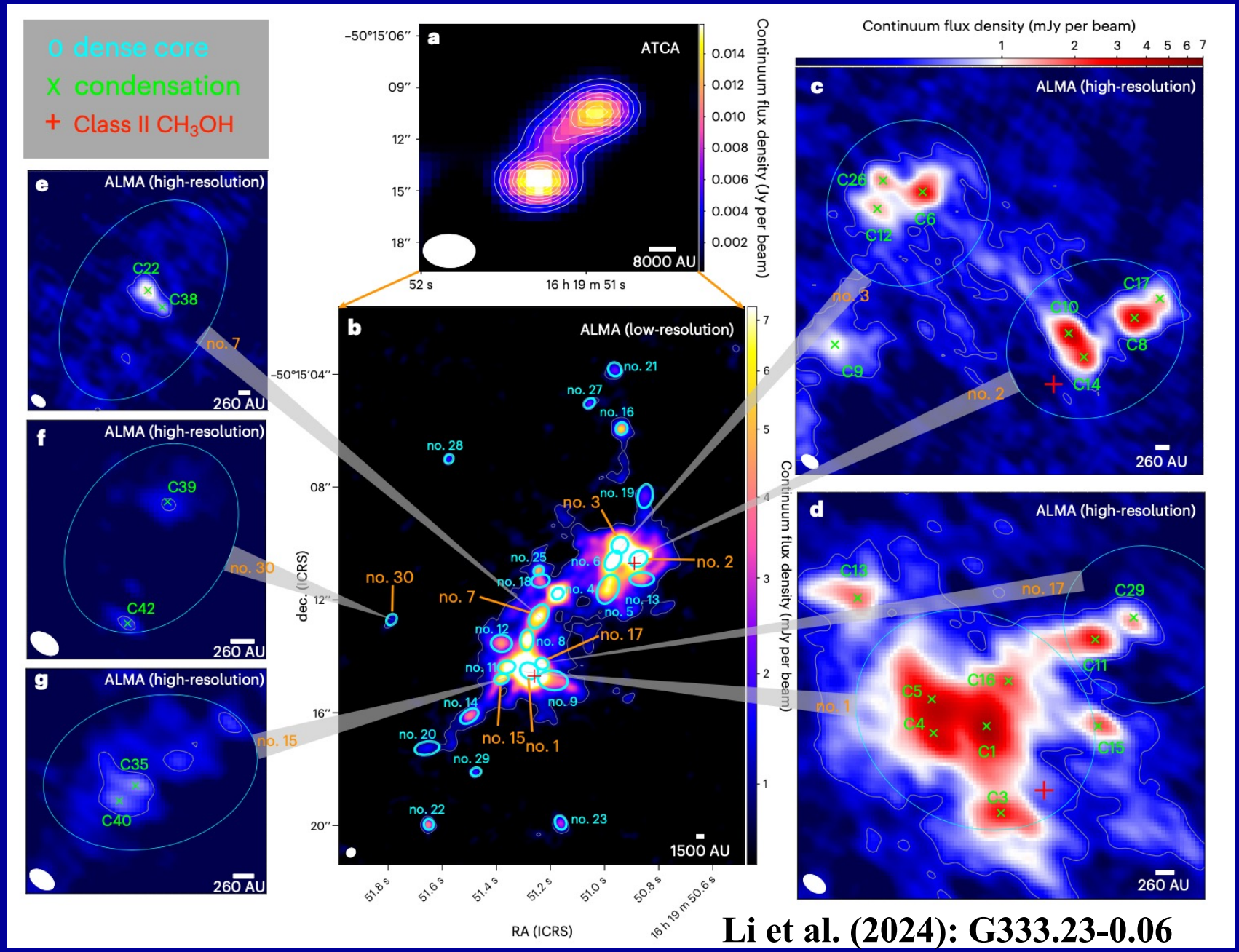
New Observational Constraints, but Small Samples

- Mass of most massive core correlated with clump mass at early stage
  (Anderson et al. 2021)
- Clumps (pc-scale overdensities) dynamicall decouple from their parent molecular cloud at $\Sigma \backsim 0.1$ g/cm^{-2}
  (Traficante et al. 2020, Peretto et al. 2023)



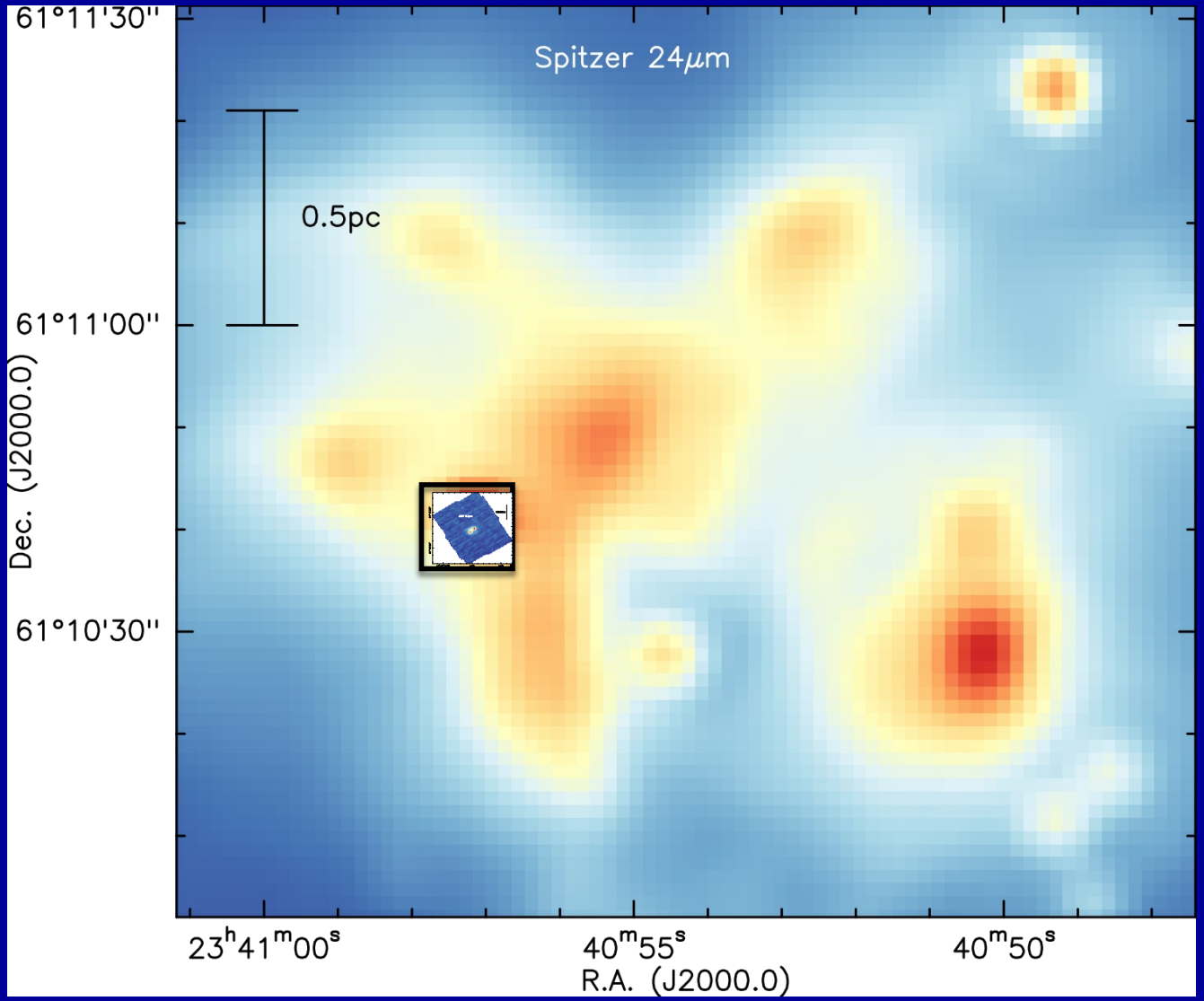
Generalized Larson relation (gravity dominates): $\Sigma \propto \sigma^2/r$
(e.g. Heyer et al. 2009, Ballesteros-Paredos et al. 2011)

Multiplicity in High-mass Star Formation



Li et al. (2024): G333.23-0.06

Spitzer : Massive Protostar IRAS 23385+6053



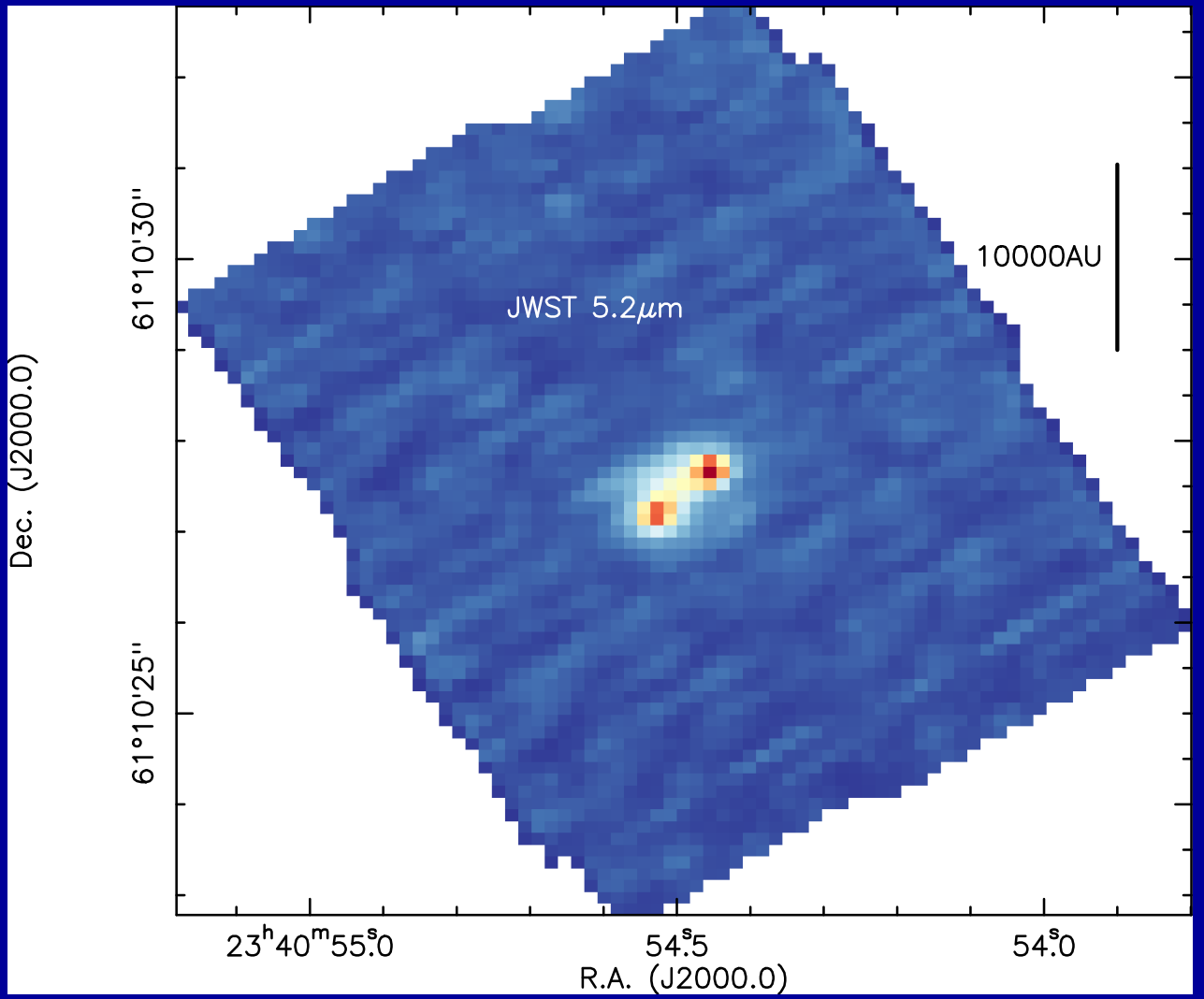
Beuther et al. (2023):
JOYS MIRI
GTO Team

JWST: Massive Protostar Binary IRAS23385+6053

Spatial resolution
0.19′′ at 5 μm

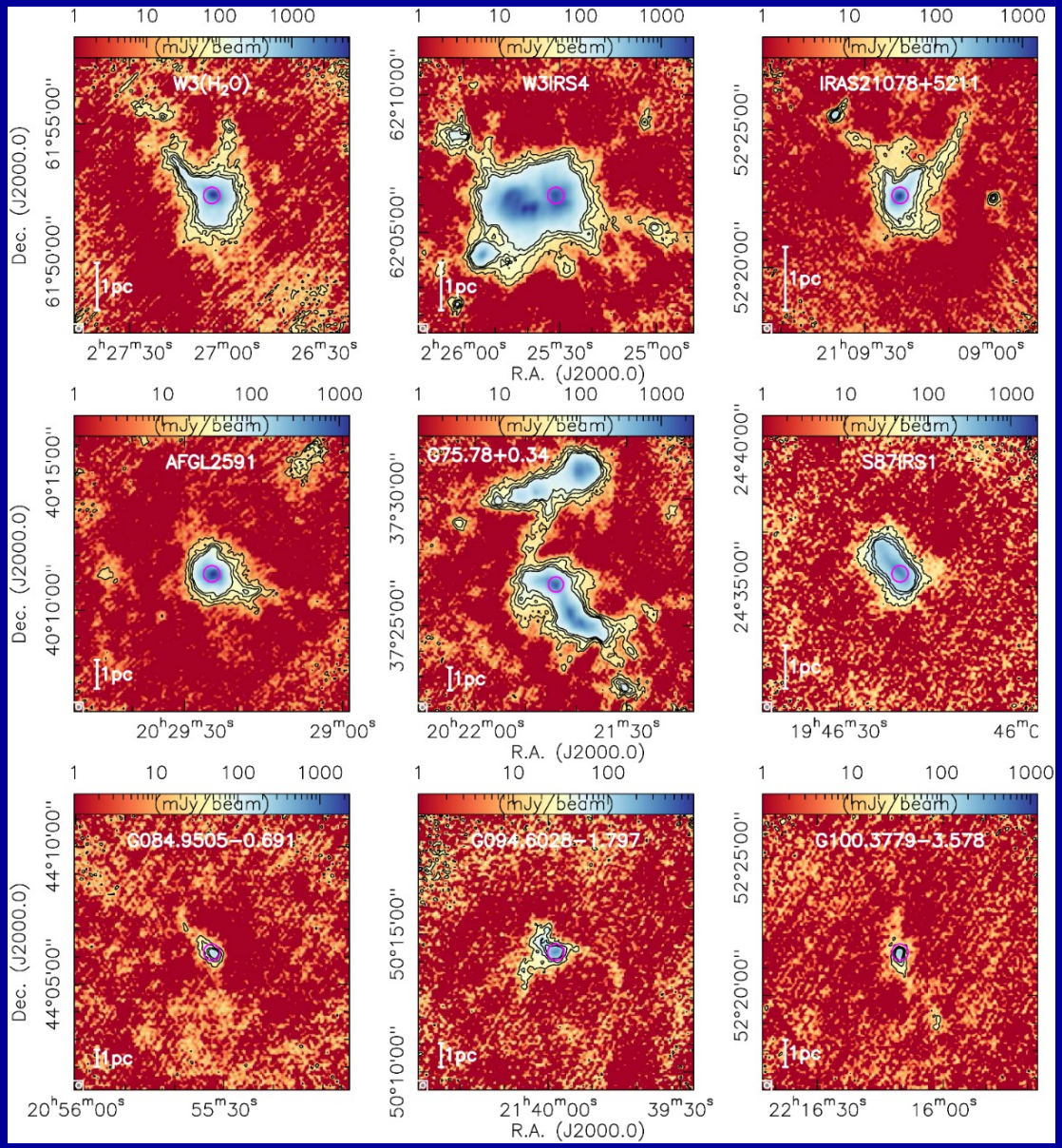
Linear resolution
570 au @ 3kpc

Sources at 4.9 kpc



Fragmentation and Magnetic Fields?

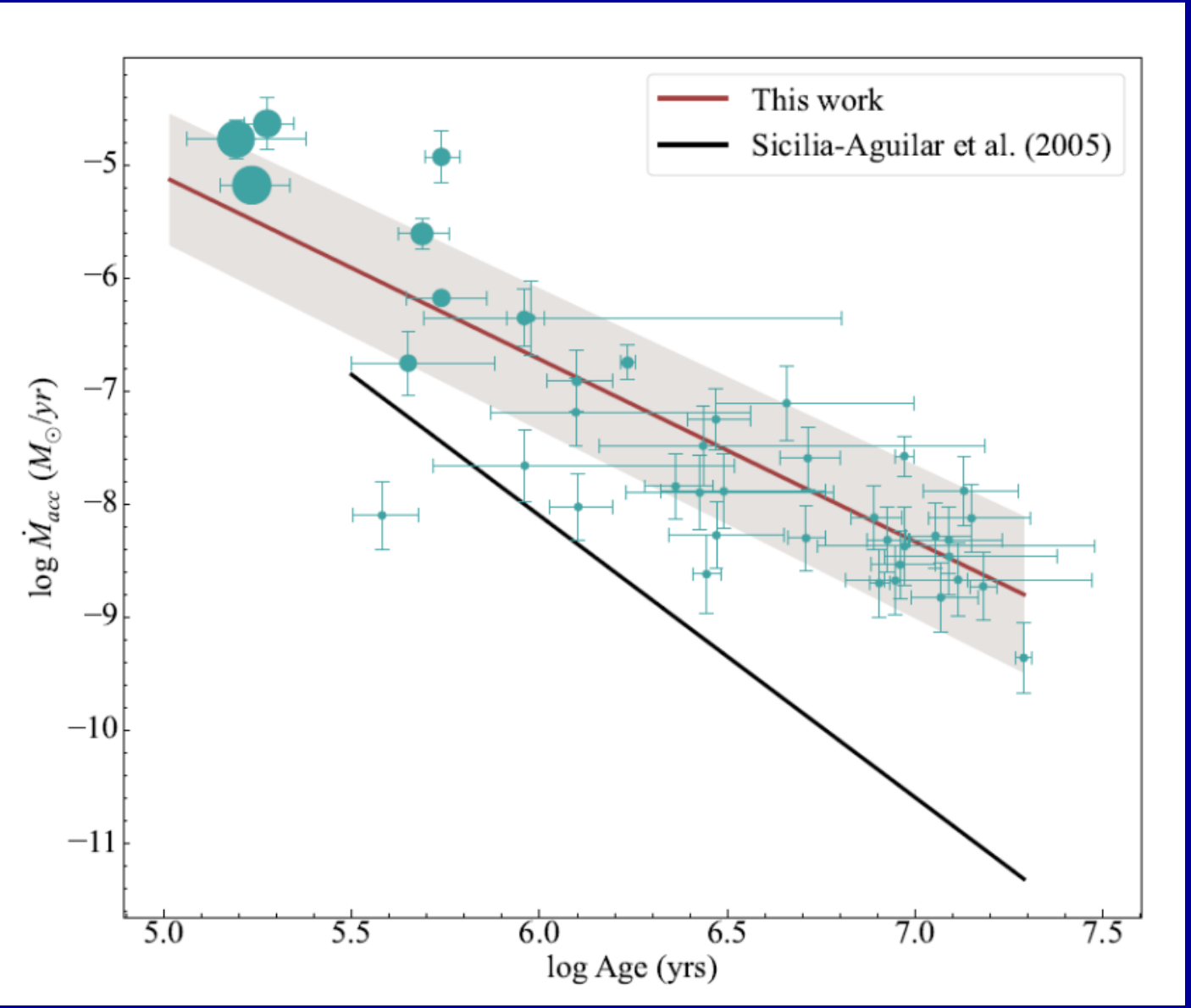
Recent Simulation: Klos et al. (2025)



Beuther et al. (2024)

No correlation between magnetic field strength and fragmentation level

Accretion in Clusters – NGC 3603



Rogers et al. (2025)


Thank you!