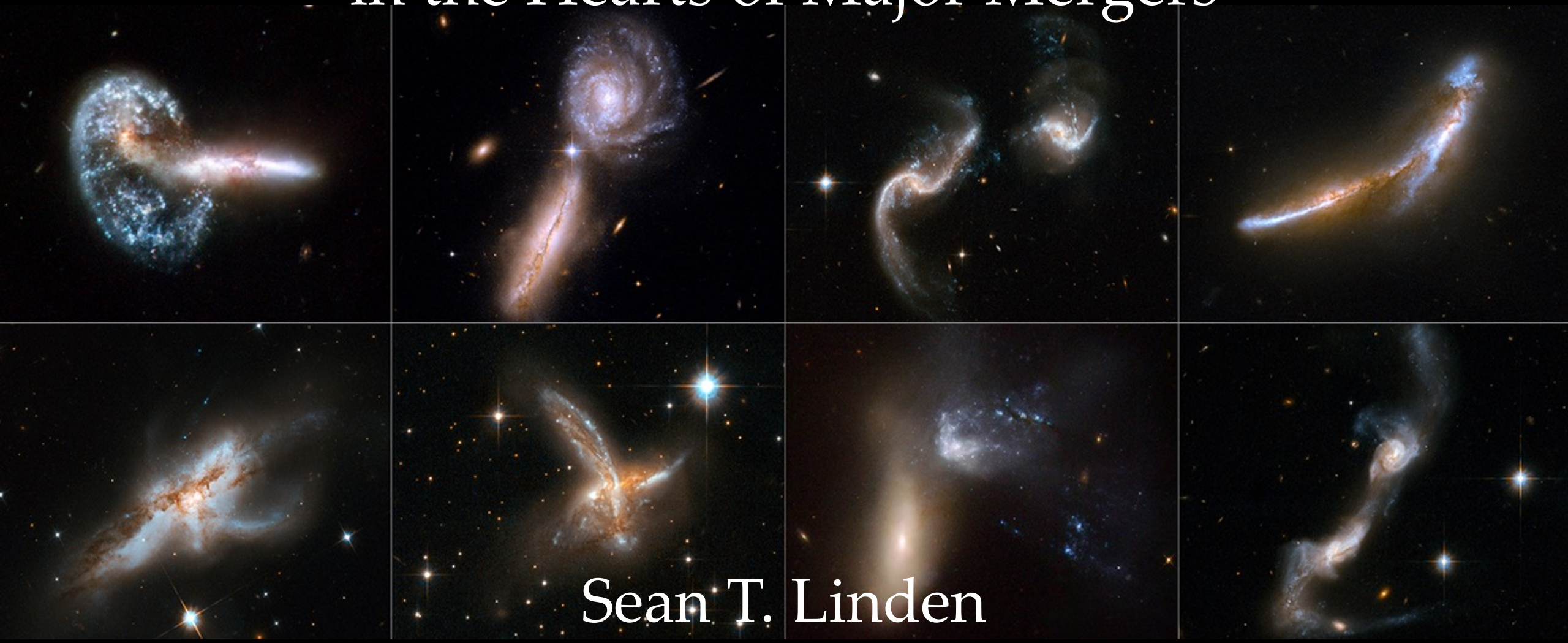
In the Belly of the Beast: Massive Clump Formation in the Hearts of Major Mergers



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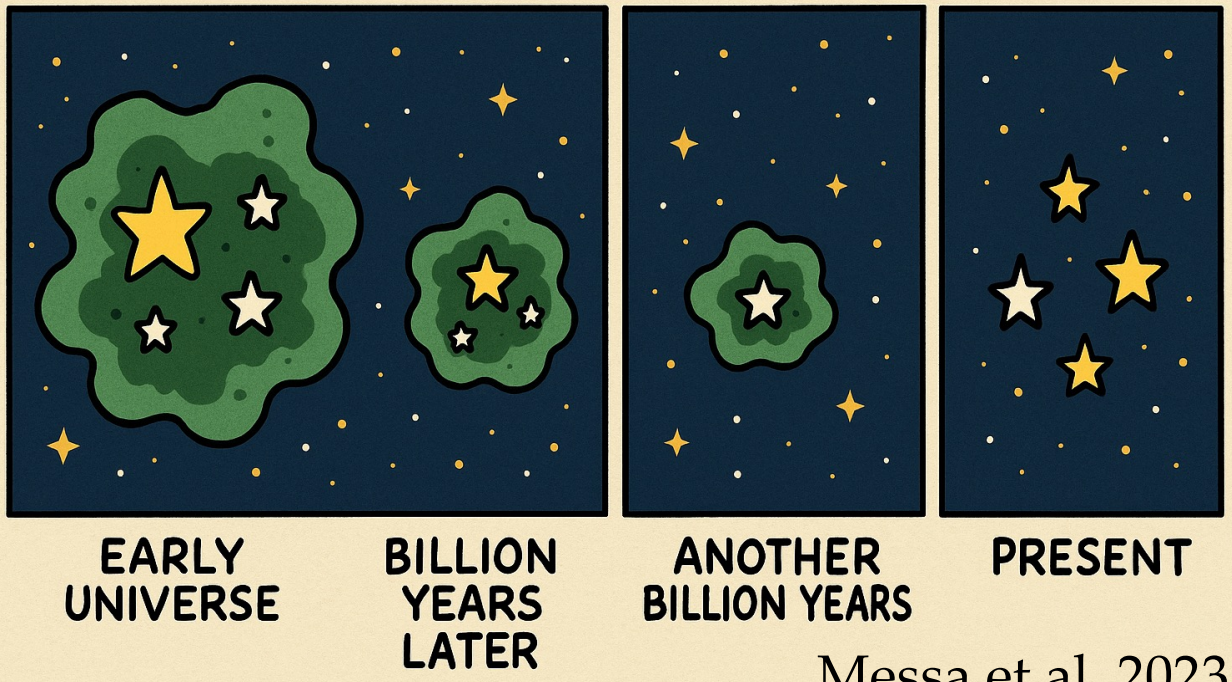
Evolution of Galaxy Structure Across Cosmic Time

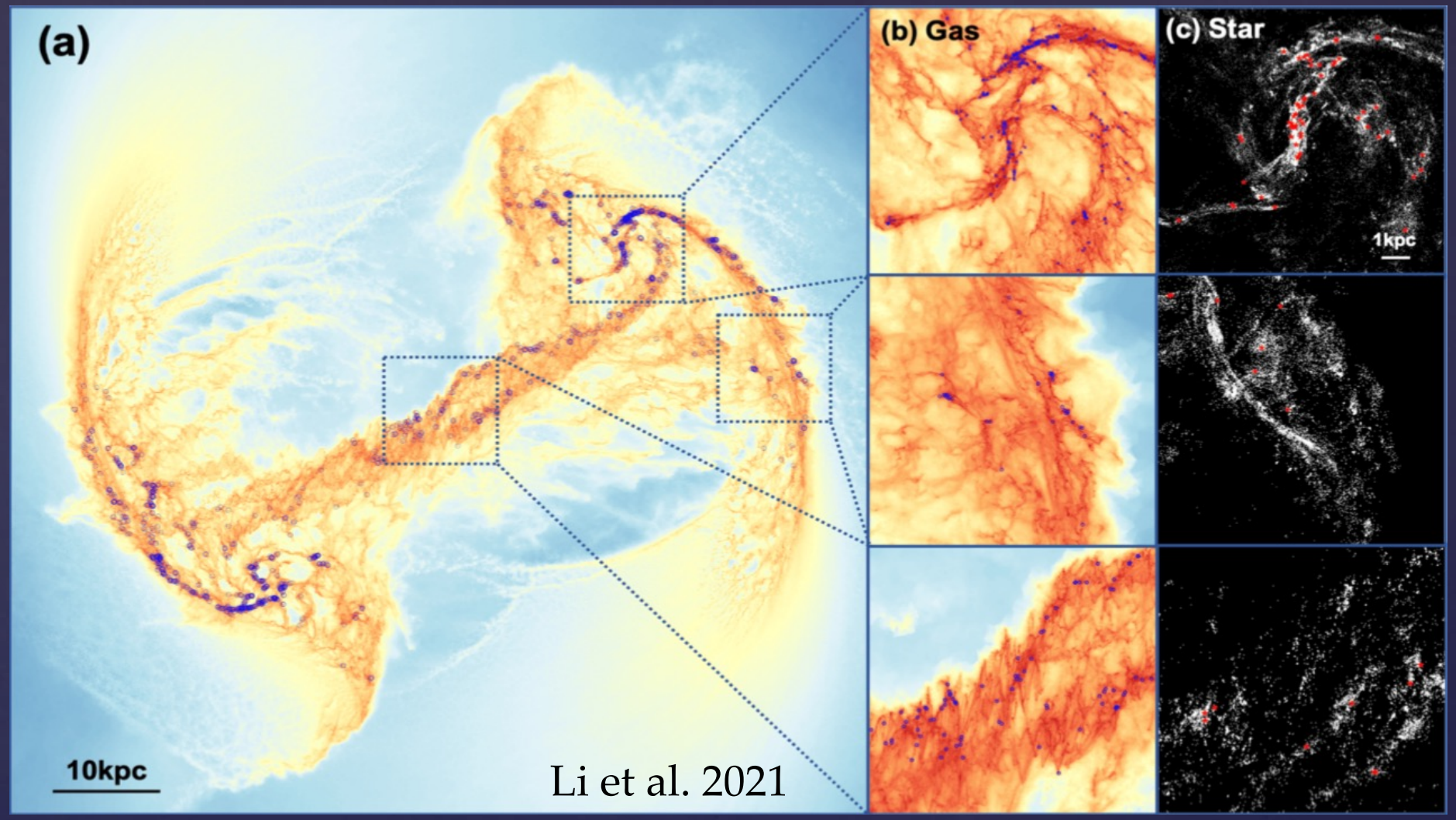


Messa et al. 2023

Le Bail et al. 2024

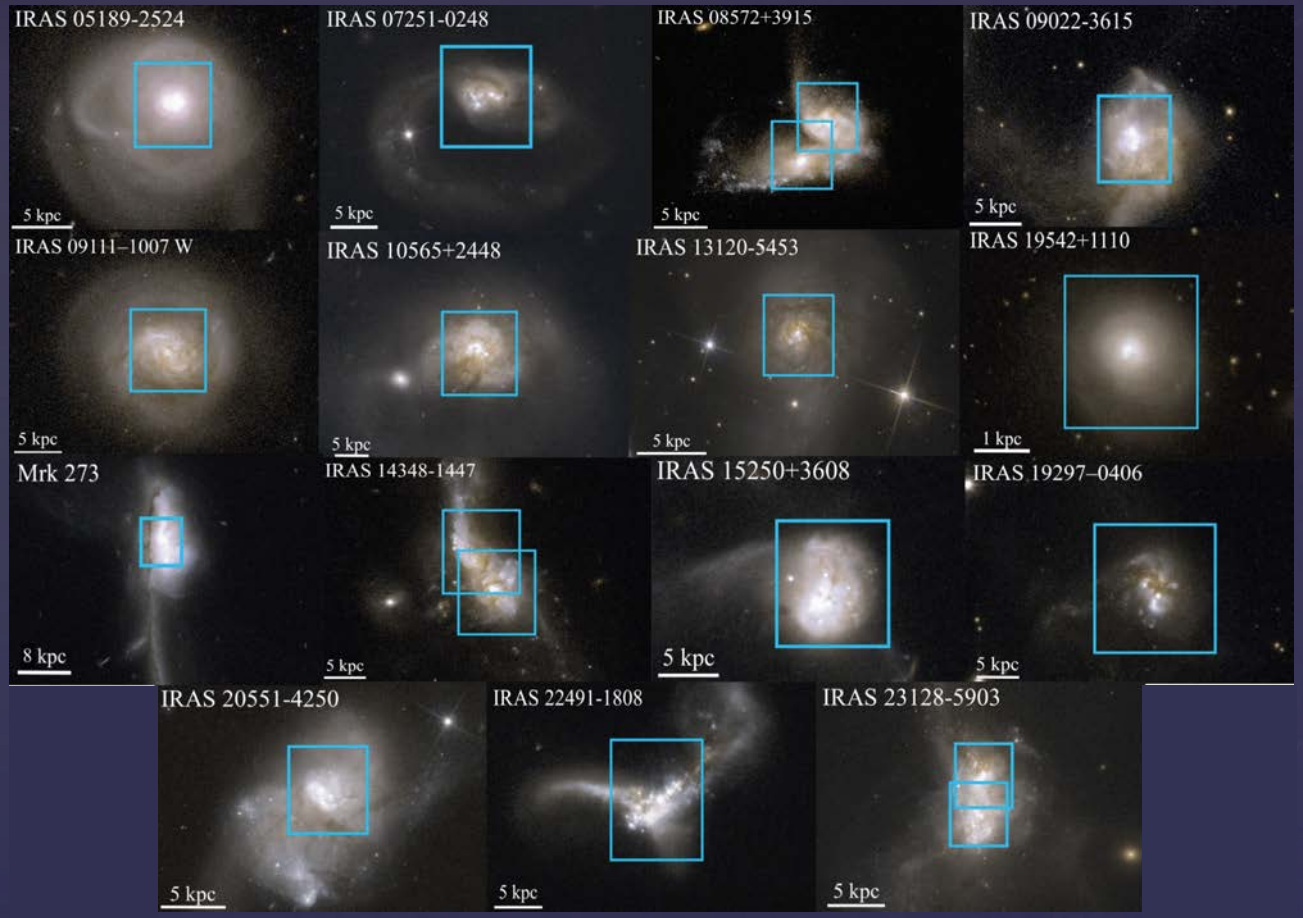
- Analysis of clump brightness as a function of redshift reveals a steady decrease in clump density since a redshift of ~5 (Messa et al. 2023).
- Major Mergers tend to drive massive clump formation in the early universe (Le Bail et al. 2024)

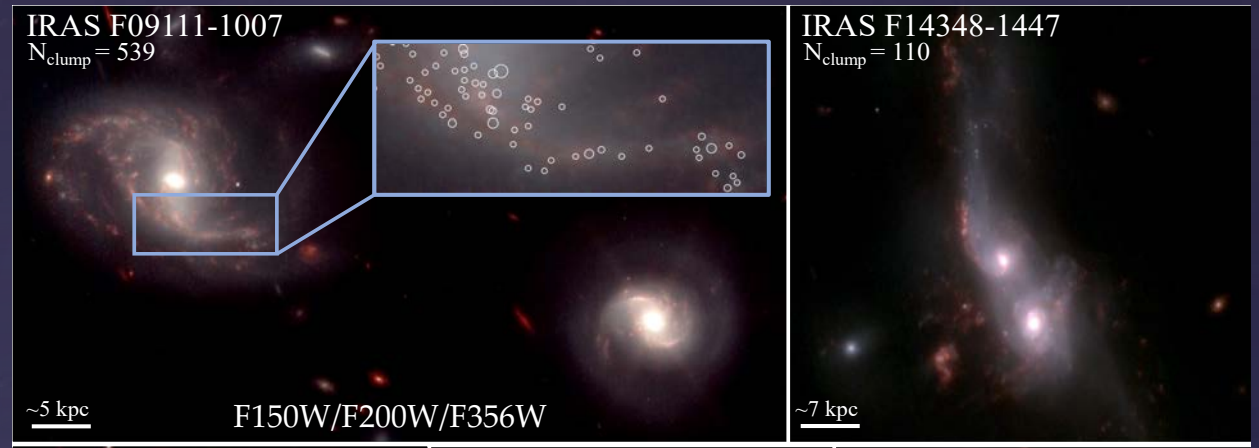
Hydrodynamic Simulations of Galaxy Mergers

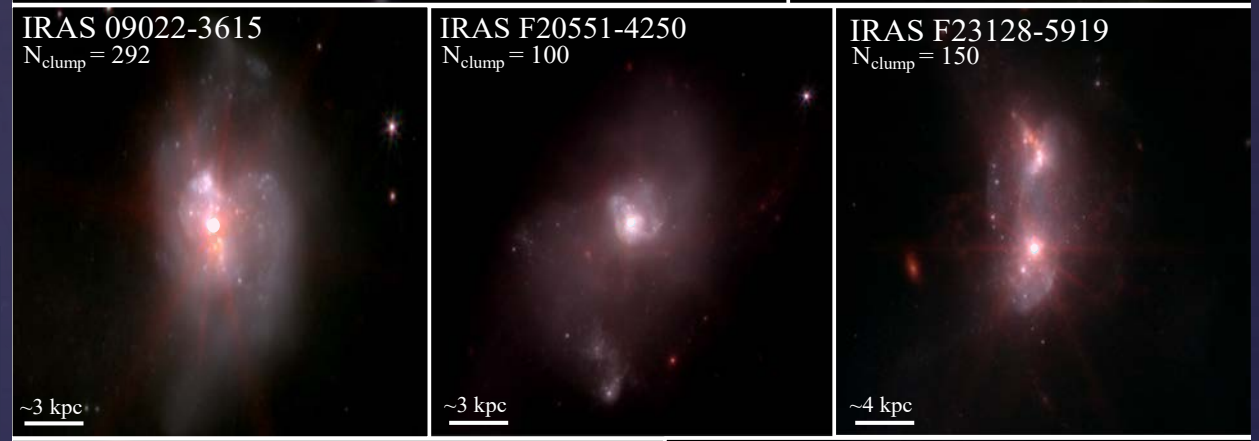


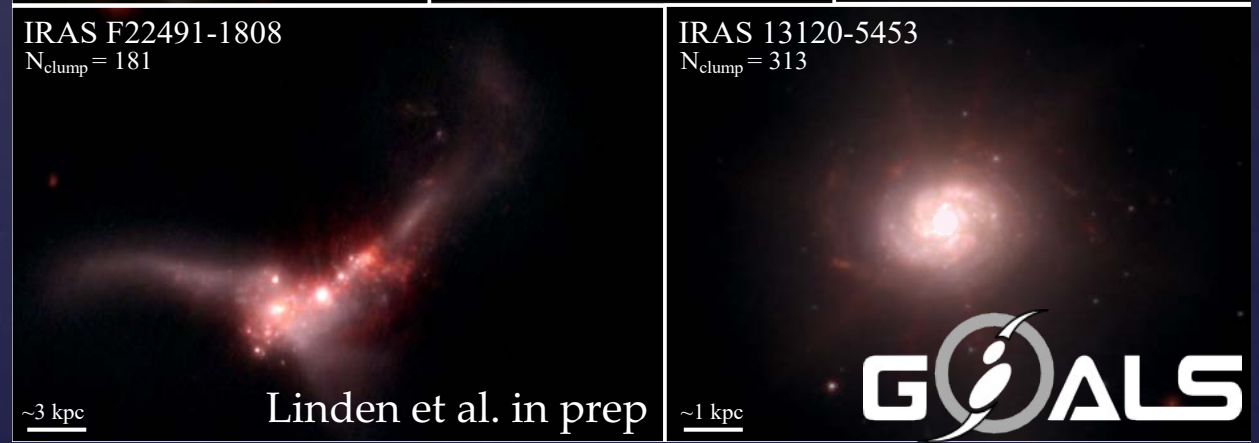
- SMUGGLE zoom-in simulations of merging systems show that the most massive clumps form in the densest (and highest pressure) regions in the interstellar medium.

The Great Observatories All-Sky LIRG Survey (GOALS)



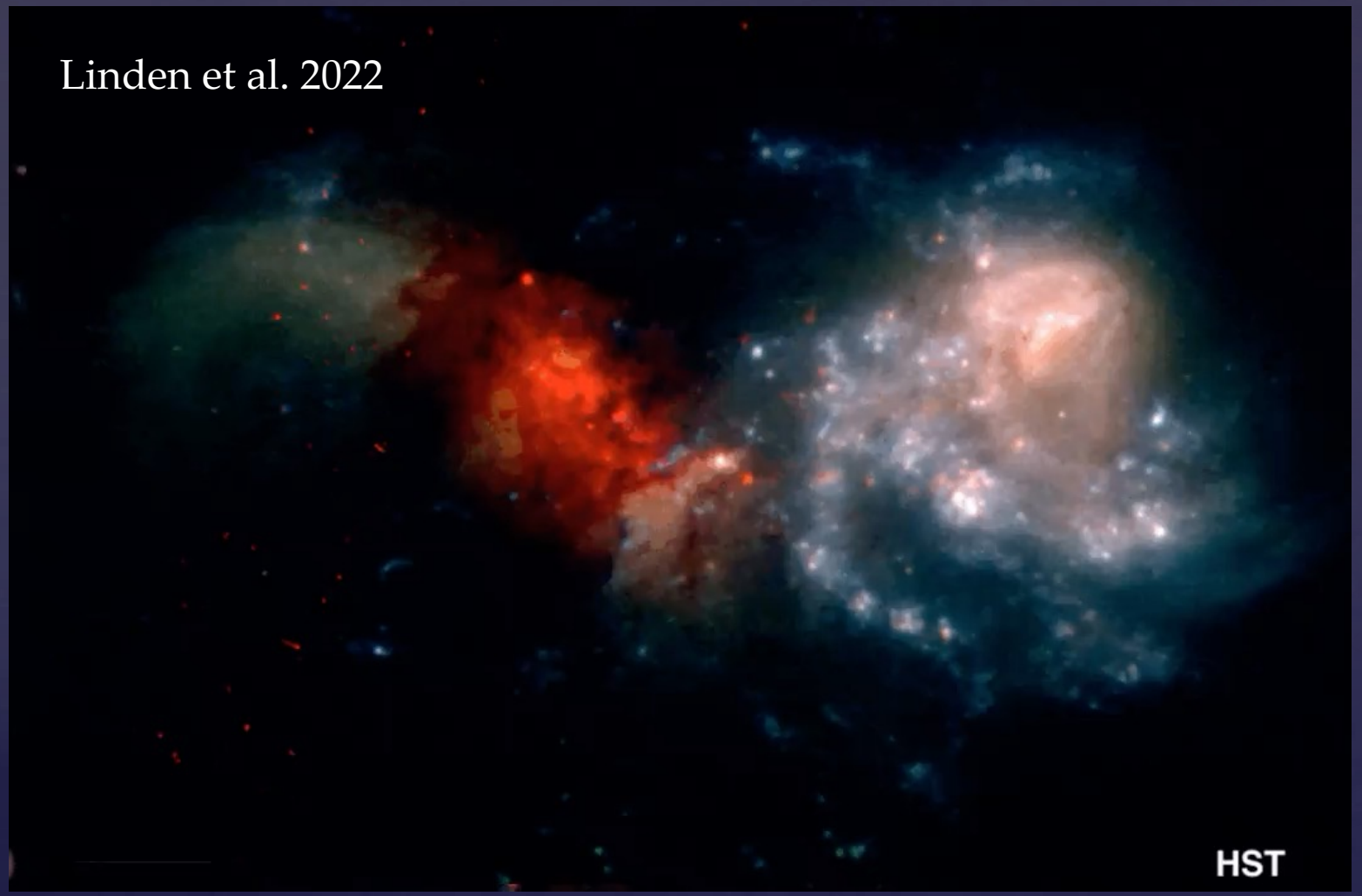






- JWST Cycle 2 program for 14 ULIRGs with 4-band NIRCam imaging and NIRSpec + MRS spectroscopy (see talk 117.05 by Laura Lenkic!)
- This survey represents ~ 50% of all NIRCam observations taken to date of LIRGs in the local Universe.

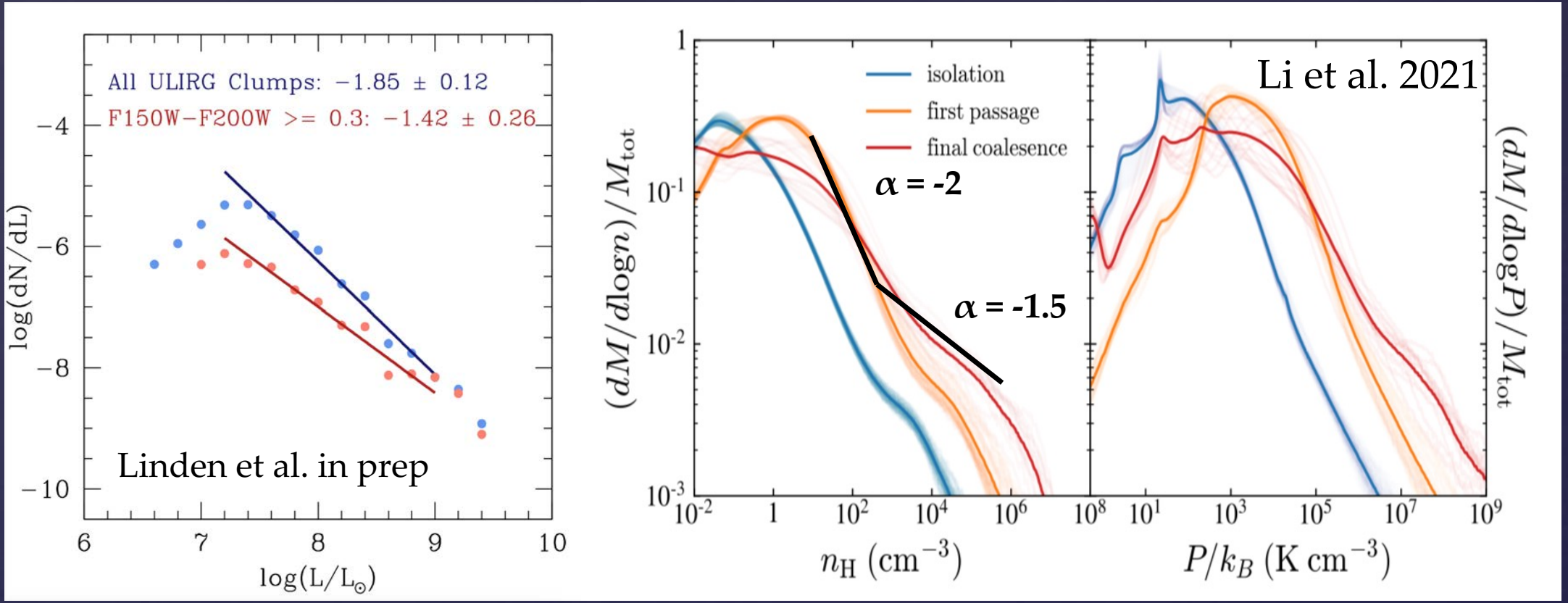
Clump Formation and Evolution in the Centers of local ULIRGs with JWST



- With multi-band NIRCam observations in combination with the NIRSpec IFU for 14 ULIRGs as part of the Great Observatories All-Sky LIRG Survey we dust-embedded massive clumps for the first time!

- **At least 20% of these sources appear to be undetected at optical wavelengths!**

Clump Formation and Evolution in the Centers of local ULIRGs with JWST



- Selecting clumps with red NIR colors indicating they are young/dusty (t < 5 Myr – Linden et al. 2023, 2024) produces a much flatter slope, and verify the predictions of the SMUGGLE simulations!

Summary

- Local U/LIRGs contain resolved clumps of comparable SFR and size to high-redshift clumps at z ~ 6 - 10.

- With multi-band NIRCam observations in combination with the NIRSpec IFU for 14 ULIRGs as part of the Great Observatories All-Sky LIRG Survey we identify young and dust-buried massive clumps for the first time!

- Our observations verify in detail the results of simulations of MW-MW like merging systems and demonstrate that more massive clumps form when the density and pressure in the ISM increases in ULIRGs.

- This study represents a major step towards understanding clump formation and evolution across cosmic time.