



Durham
University



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Confirming SMGs at $z > 4$

THE SEARCH FOR SMGS AT HIGH REDSHIFT IN THE UDS

Elizabeth Cooke

In collaboration with: Stuart Stach, Ian Smail, Mark Swinbank,
Omar Almaini, ALESS and UDS collaborations

Outline

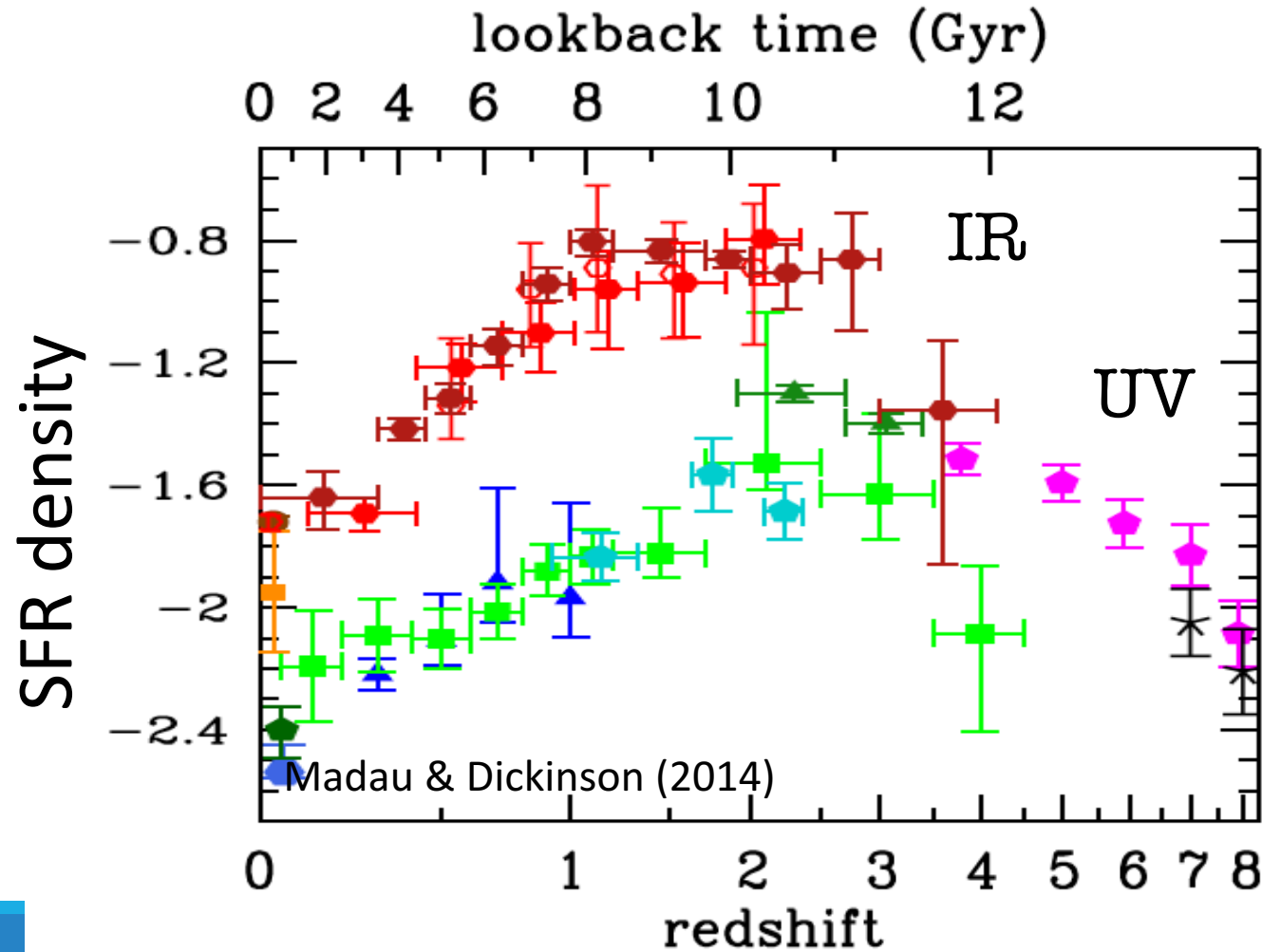
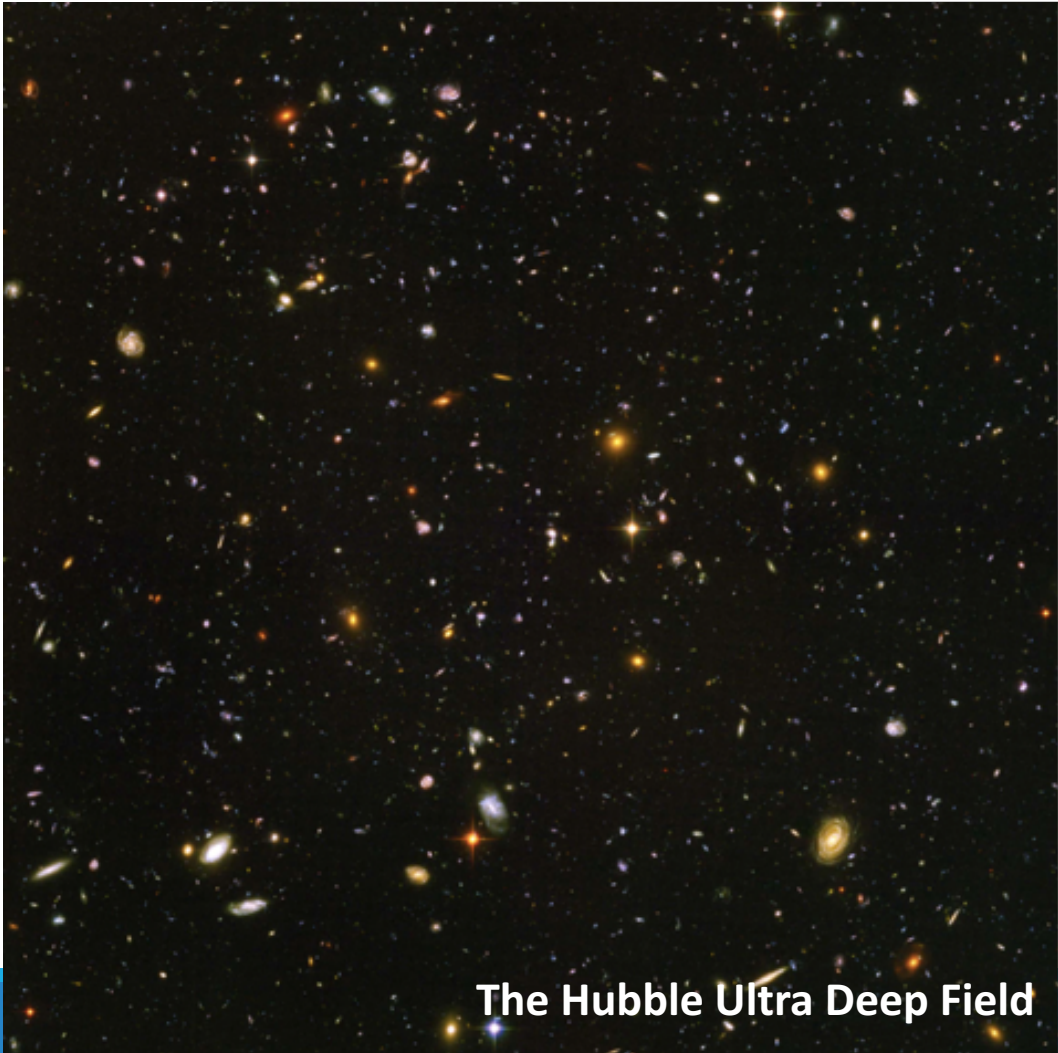
- Why you should care about submillimeter galaxies (SMGs)
- How to find SMGs
- The largest sample of SMGs to date

Why should we care about sub-mm?

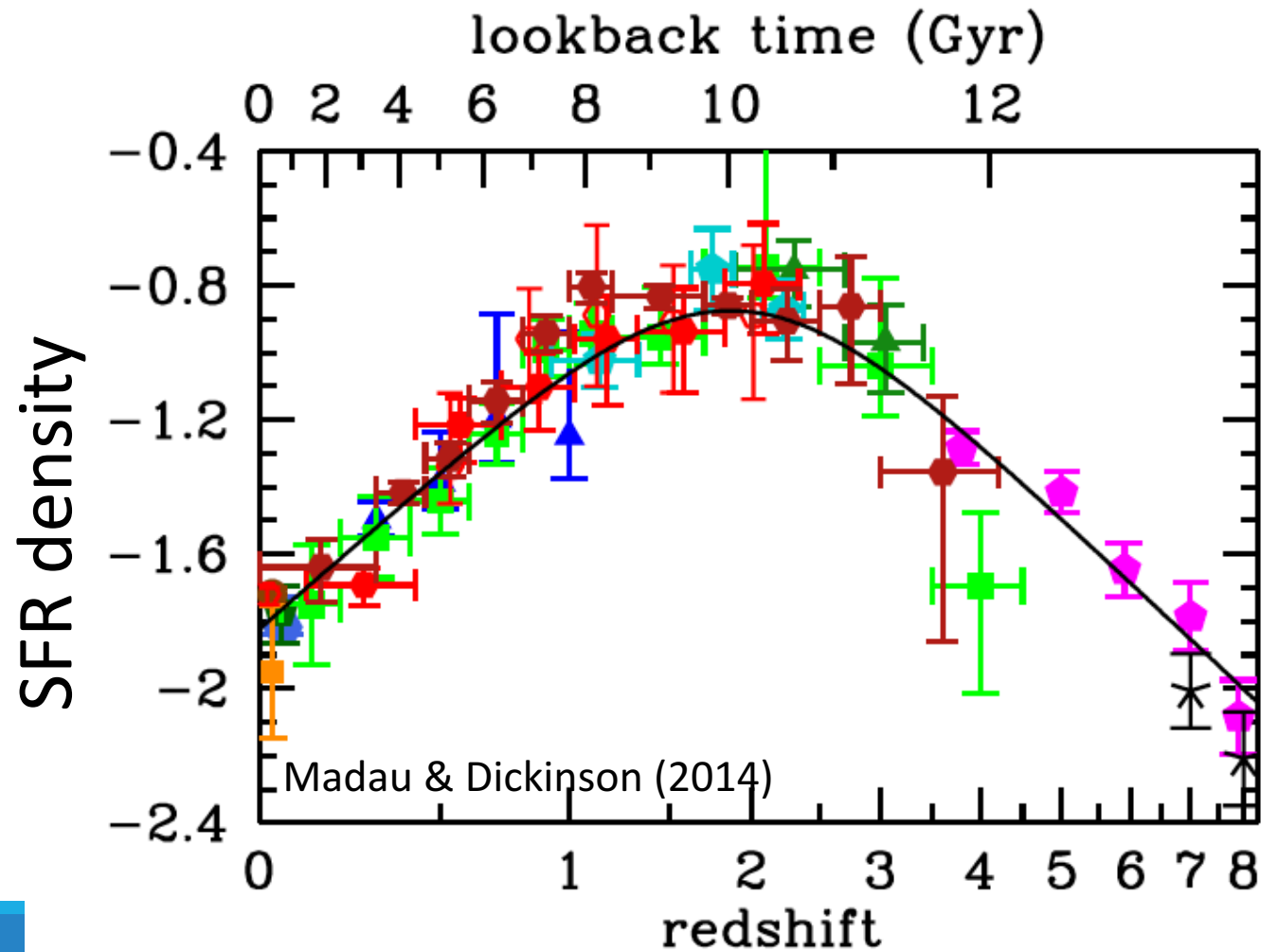


The Hubble Ultra Deep Field

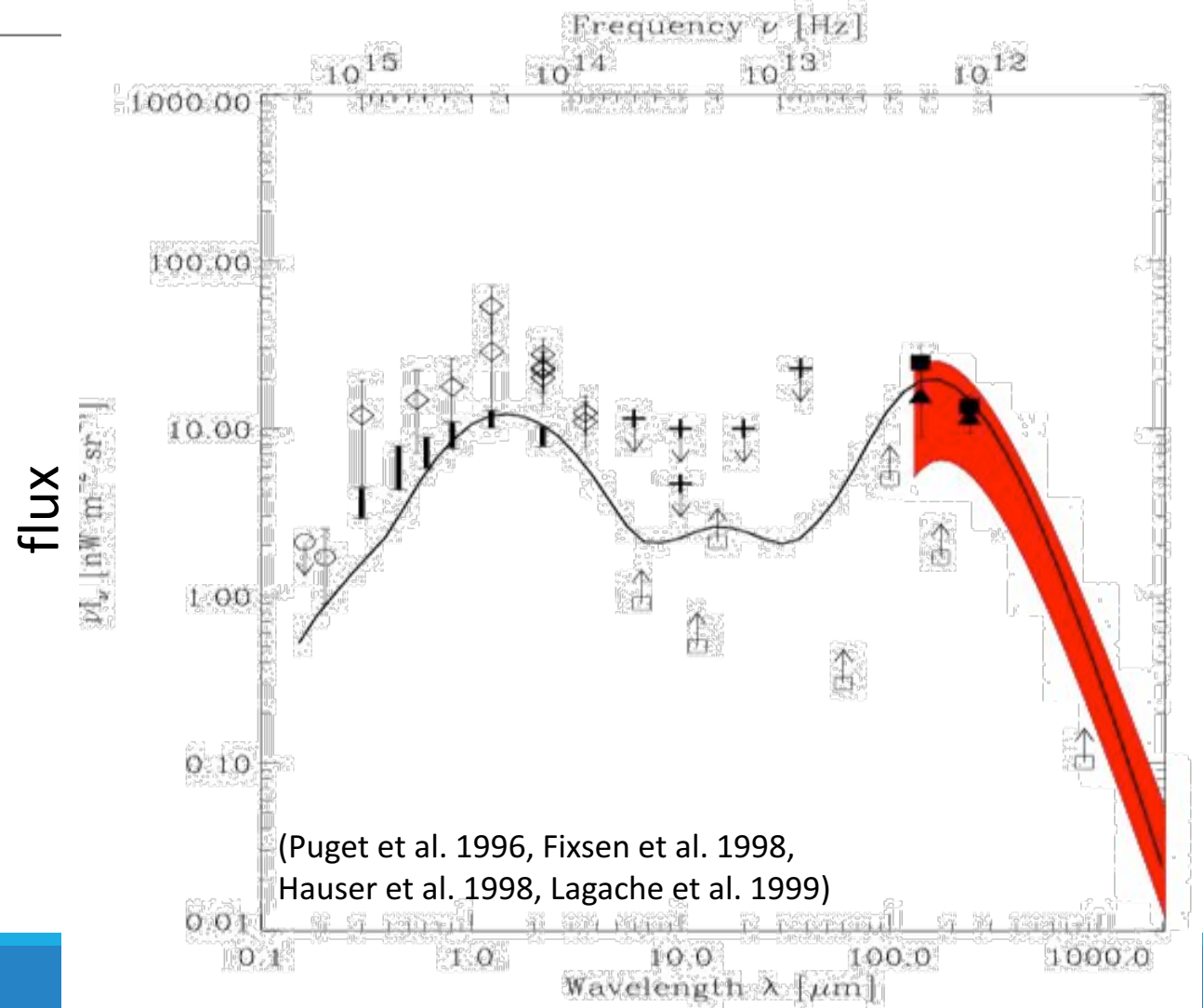
Why should we care about sub-mm?



Why should we care about sub-mm?



Half the light in the Universe is obscured

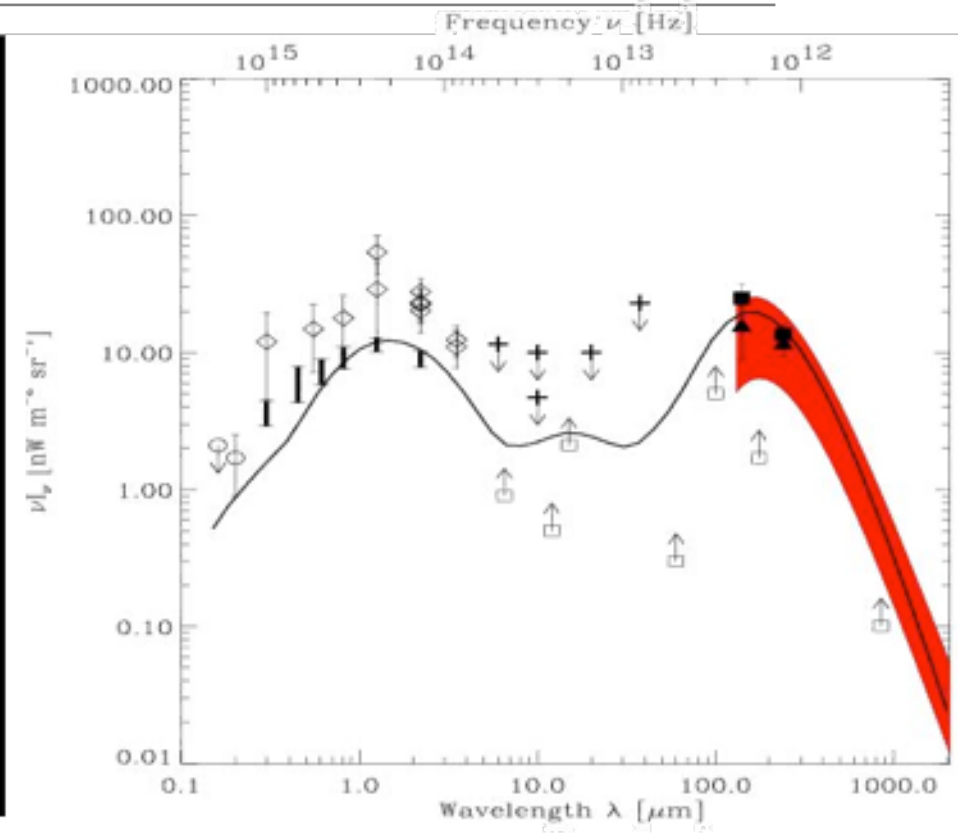


Half the light in the Universe is obscured



Optical (HST)

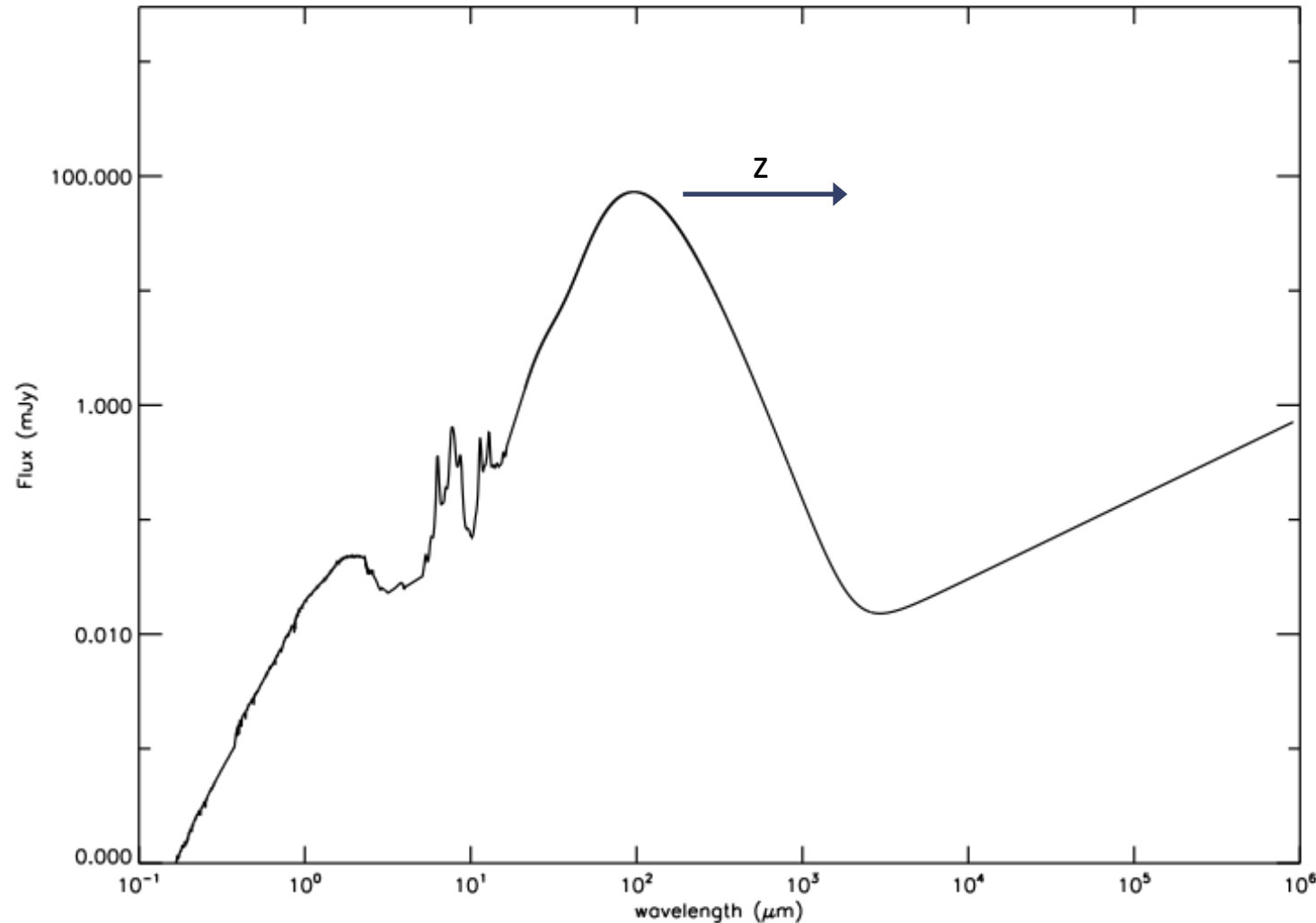
Far-IR (ALMA)



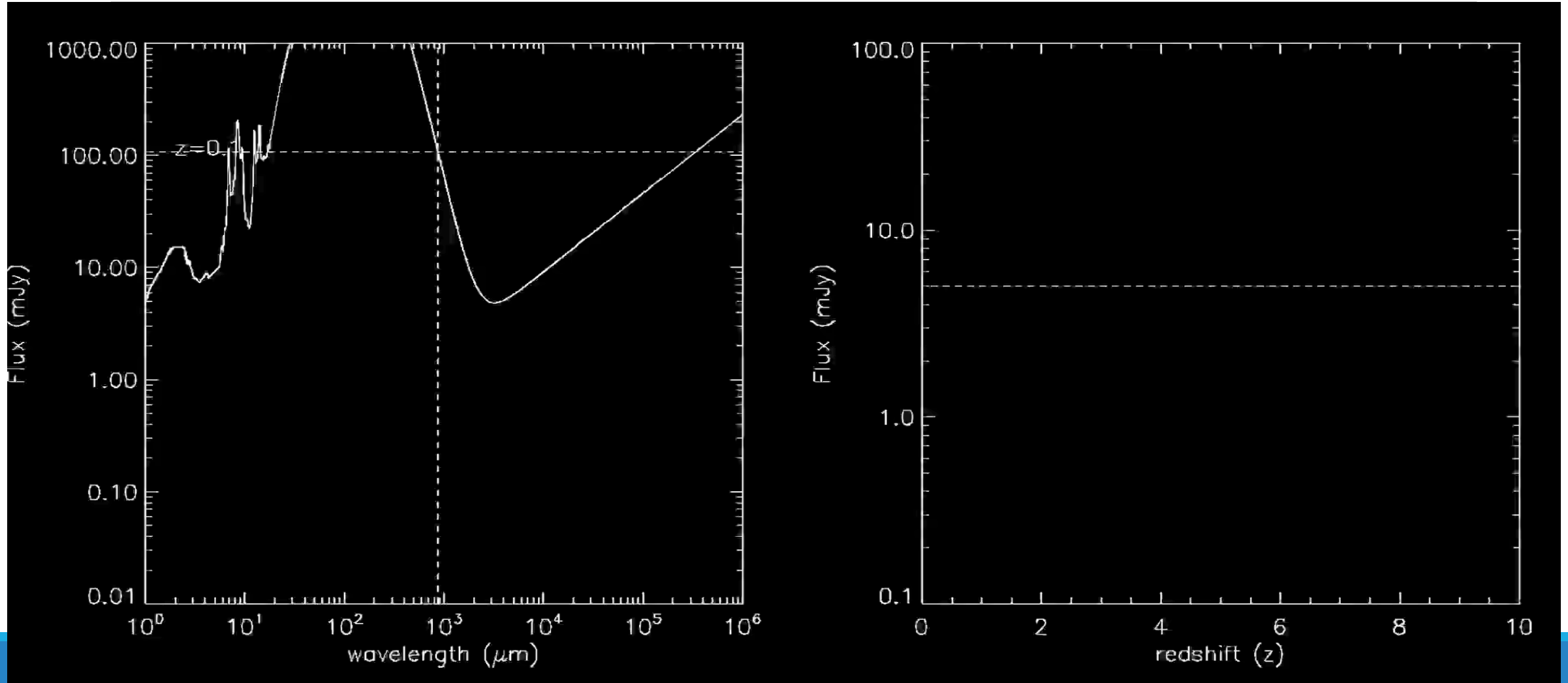
ULIRGs – an important population at $z > 2$

- Most luminous FIR gals at $z \sim 0$ are Ultra-Luminous InfraRed Galaxies (ULIRGs)
- $L_{\text{FIR}} > 10^{12} L_{\odot}$
- $\text{SFR} \sim 10^2 - 10^3 M_{\odot} \text{ yr}^{-1}$
- $> 95\%$ Luminosity comes out in FIR ($\sim 10 - 1000 \mu\text{m}$)
- Host $< 1\%$ of star formation at $z = 0$ but more important at high- z

Finding ULIRGs at high redshift- easy with the sub-mm



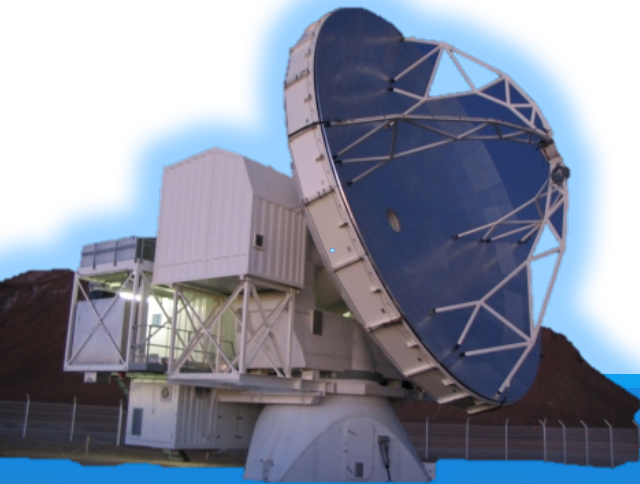
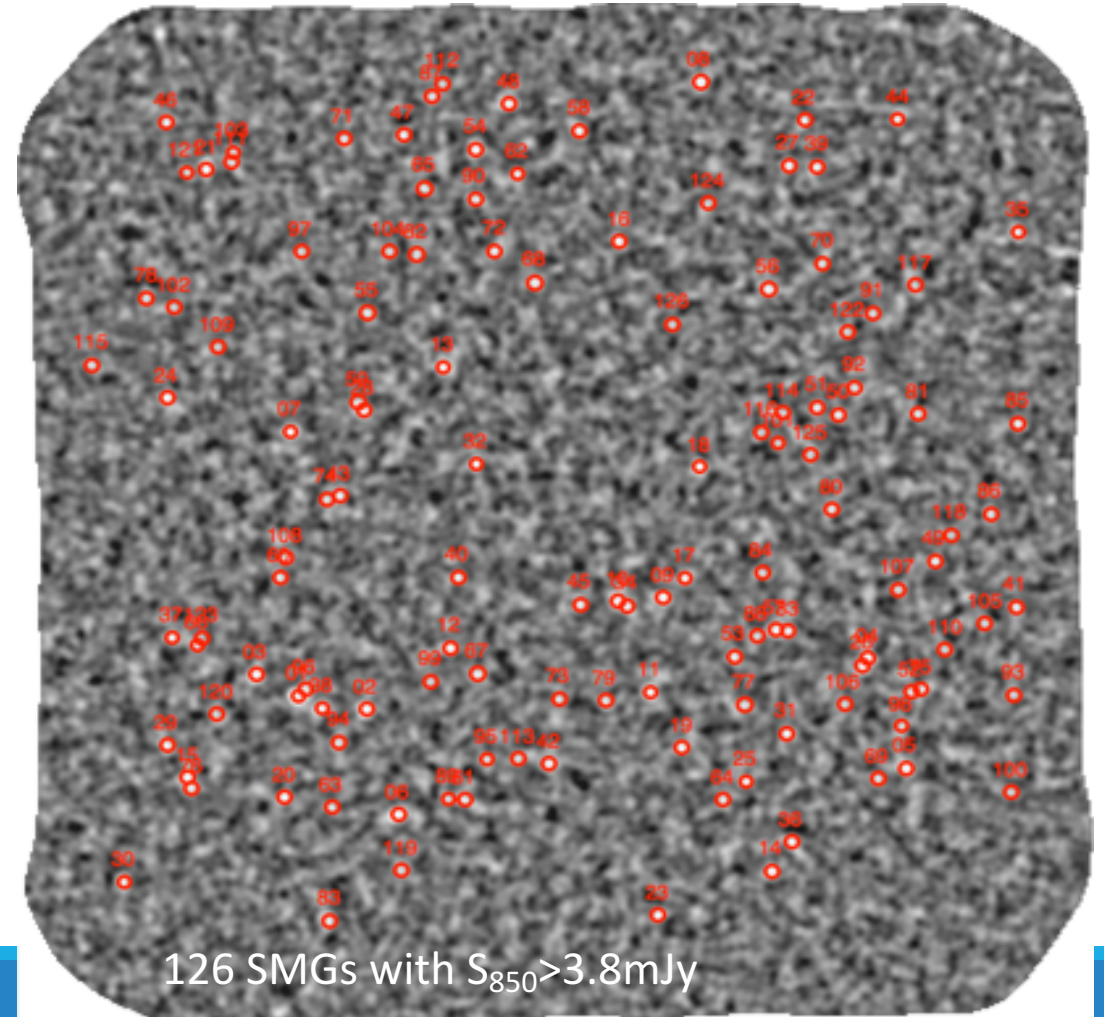
Negative k-correction in the sub-mm



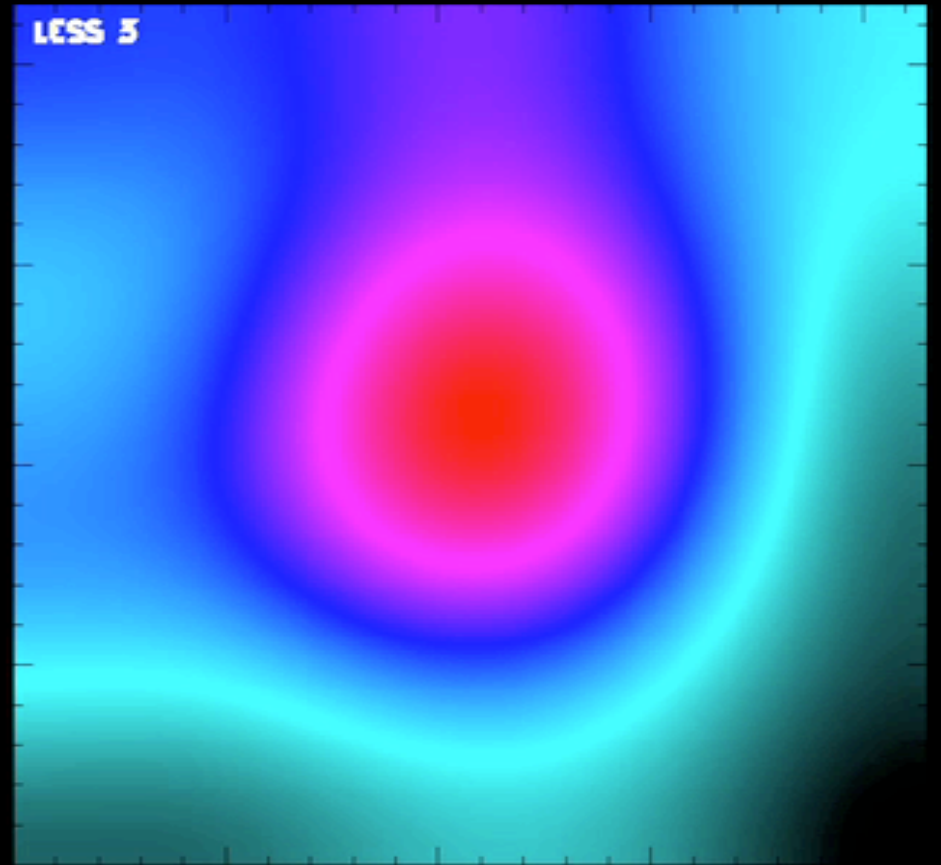
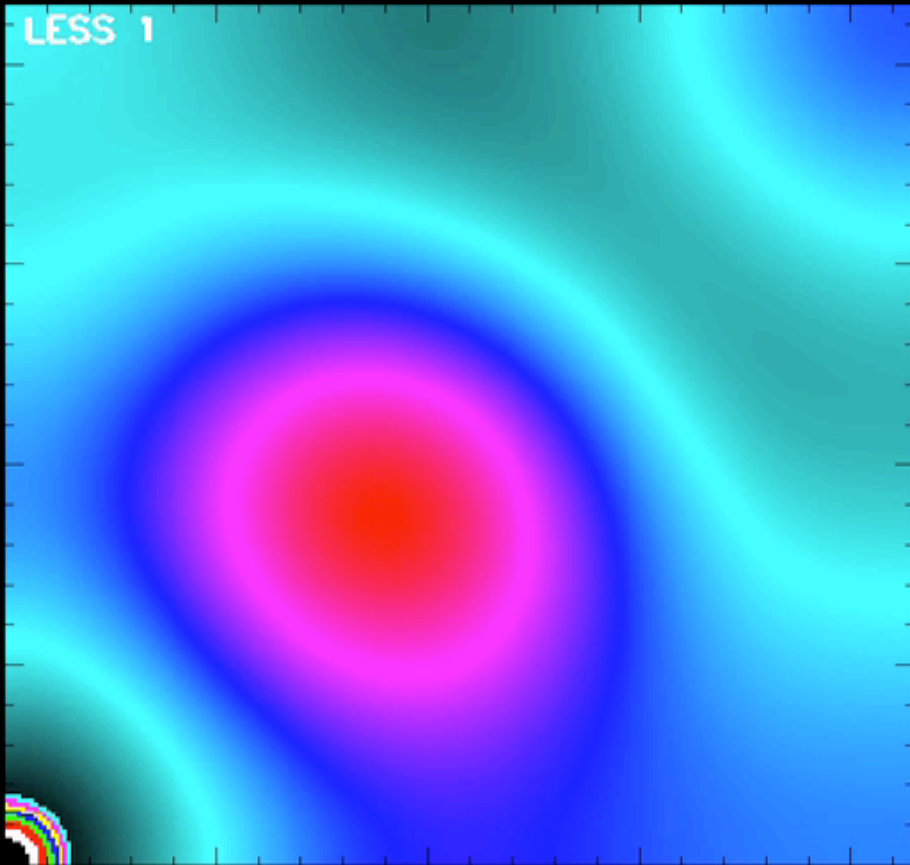
Single-dish surveys- low resolution

- LABOCA Extended Chandra Deep Field South Submillimeter Survey (LESS)
- 126 SMGs at $850\mu\text{m}$
- $\sigma_{870}=1.5\text{mJy}$ over $30'\times 30'$

Weiss et al. (2009); Biggs et al. (2010); Coppin et al. (2009, 2011); Dunlop et al. (2010); Greve et al. (2011); Hickox et al. (2011); Wardlow et al. (2011); Chapin et al. (2011); de Breuck et al. (2011); Nagao et al. (2012)

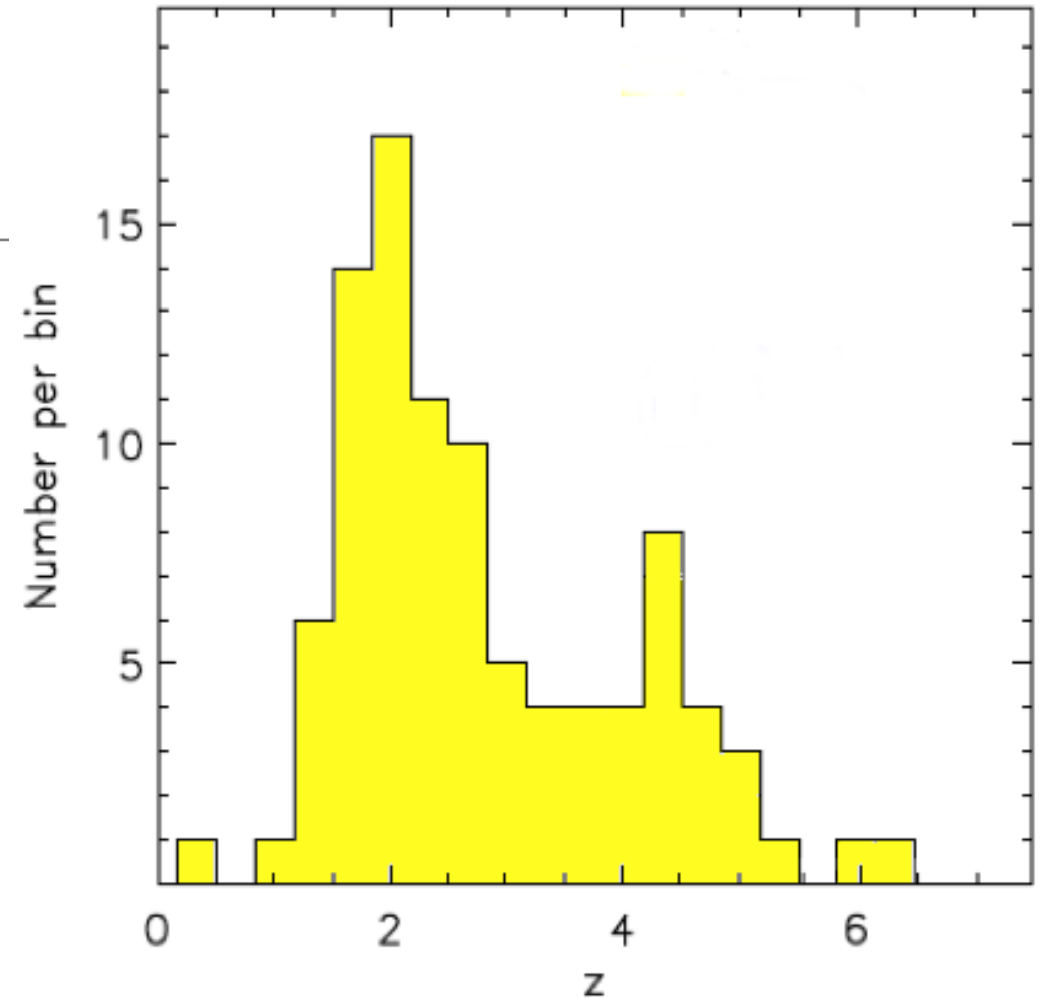


ALMA improves resolution by a factor of ~ 10



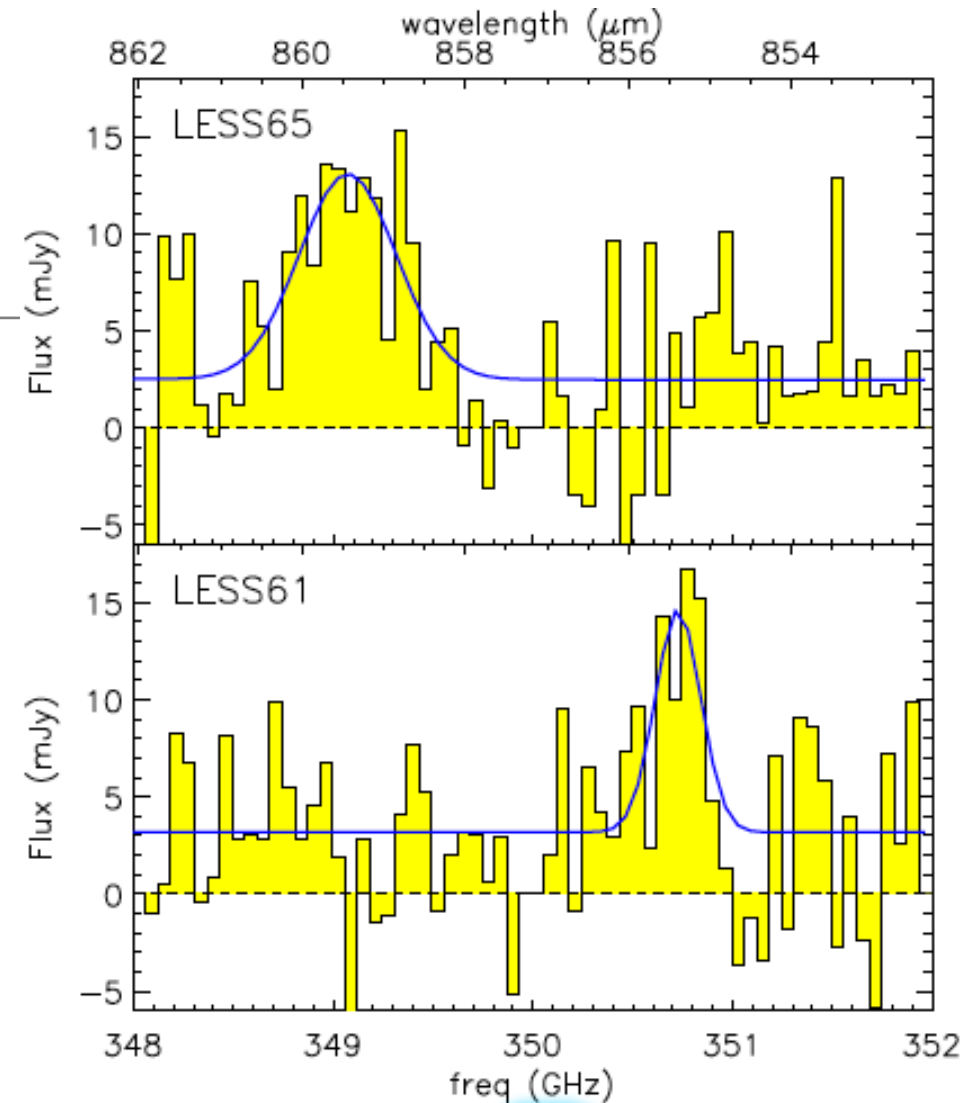
ALMA-LESS

- Cycle 0 ALMA study of 126 SMGs from LESS
- 99 SMGs with precisely-located counterparts
- Photometric redshifts give median $z_{\text{phot}} = 2.5 \pm 0.2$
- ~25% of 870- μm selected SMGs at $z > \sim 4$
- Two serendipitous detections of [CII] emission lines



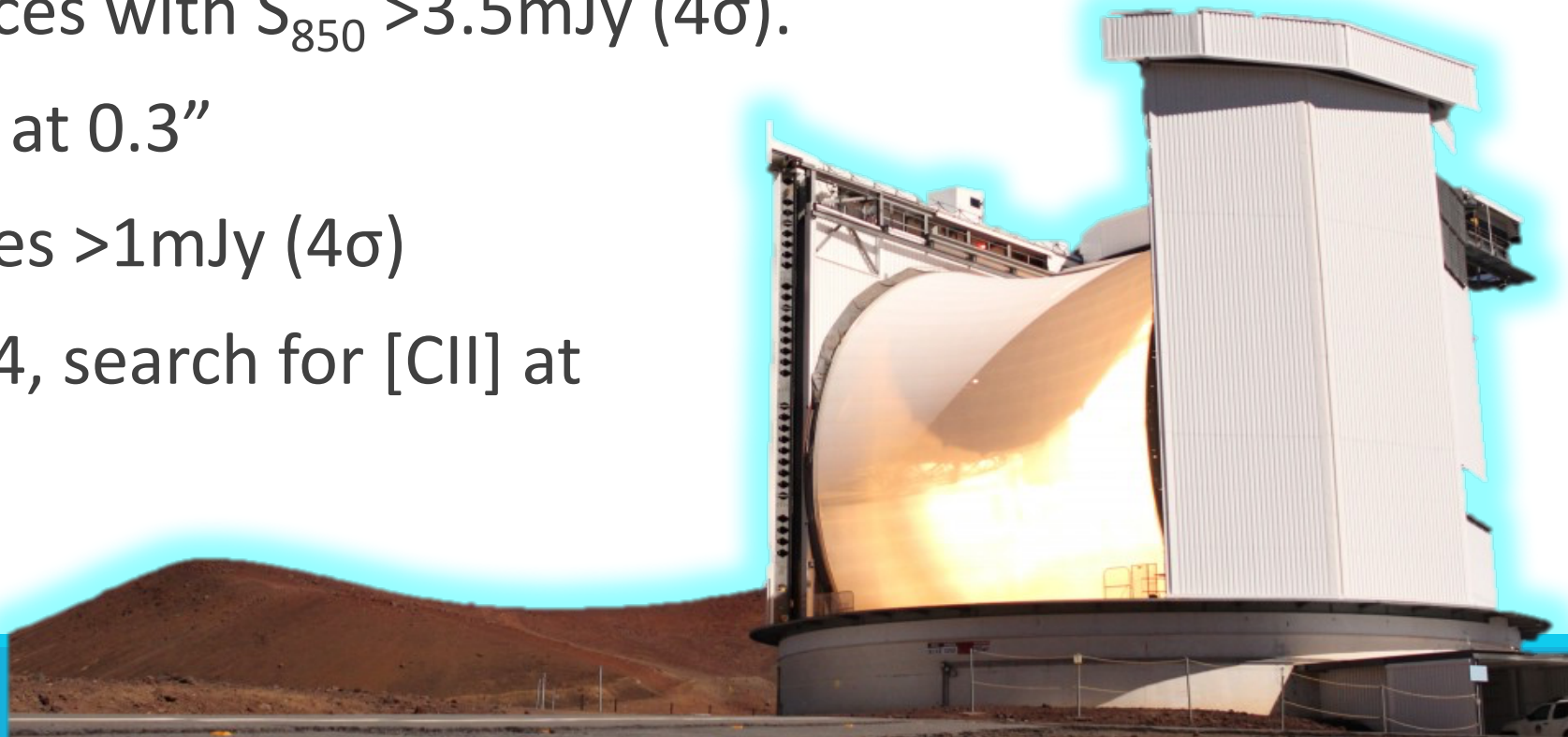
ALMA-LESS

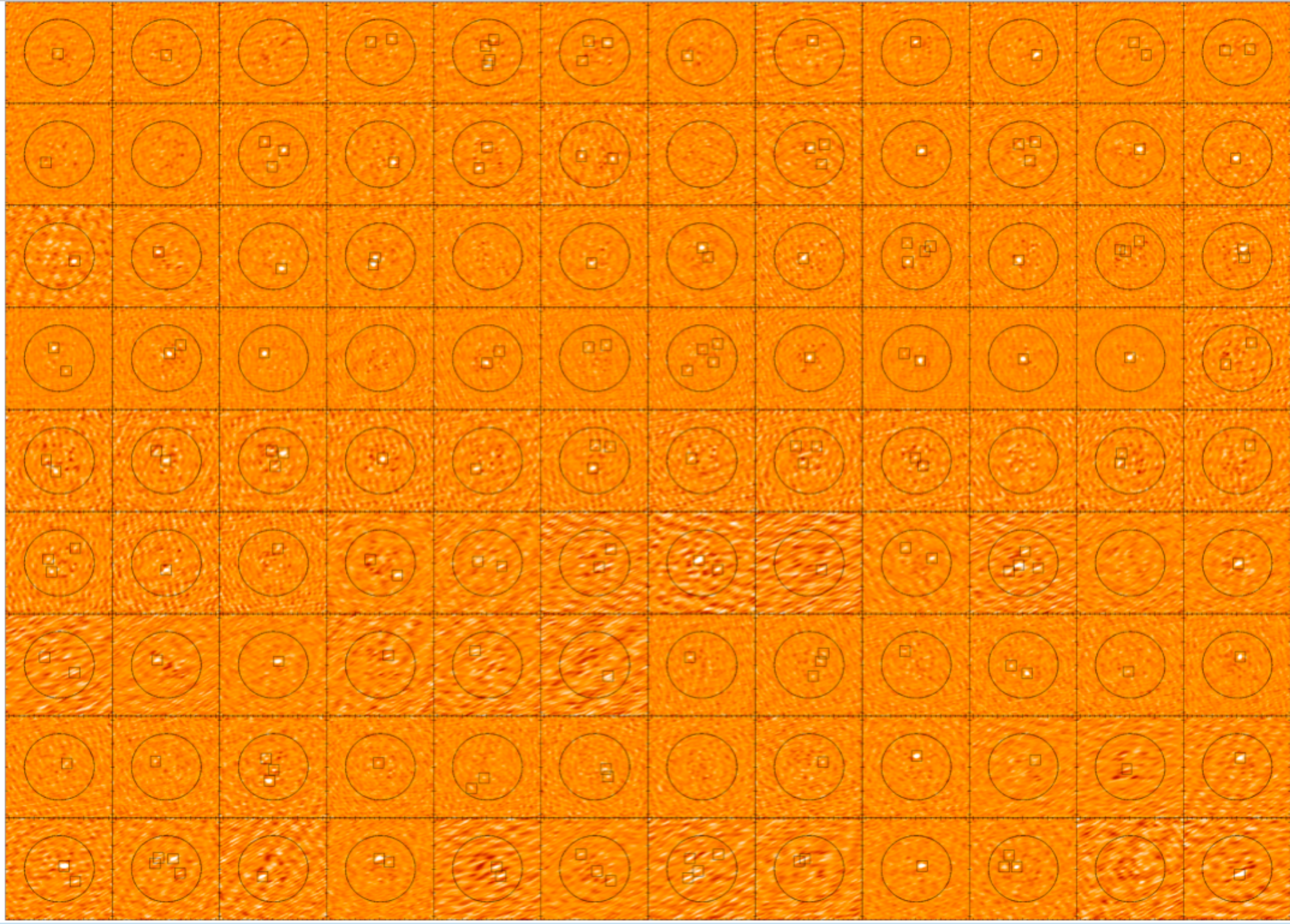
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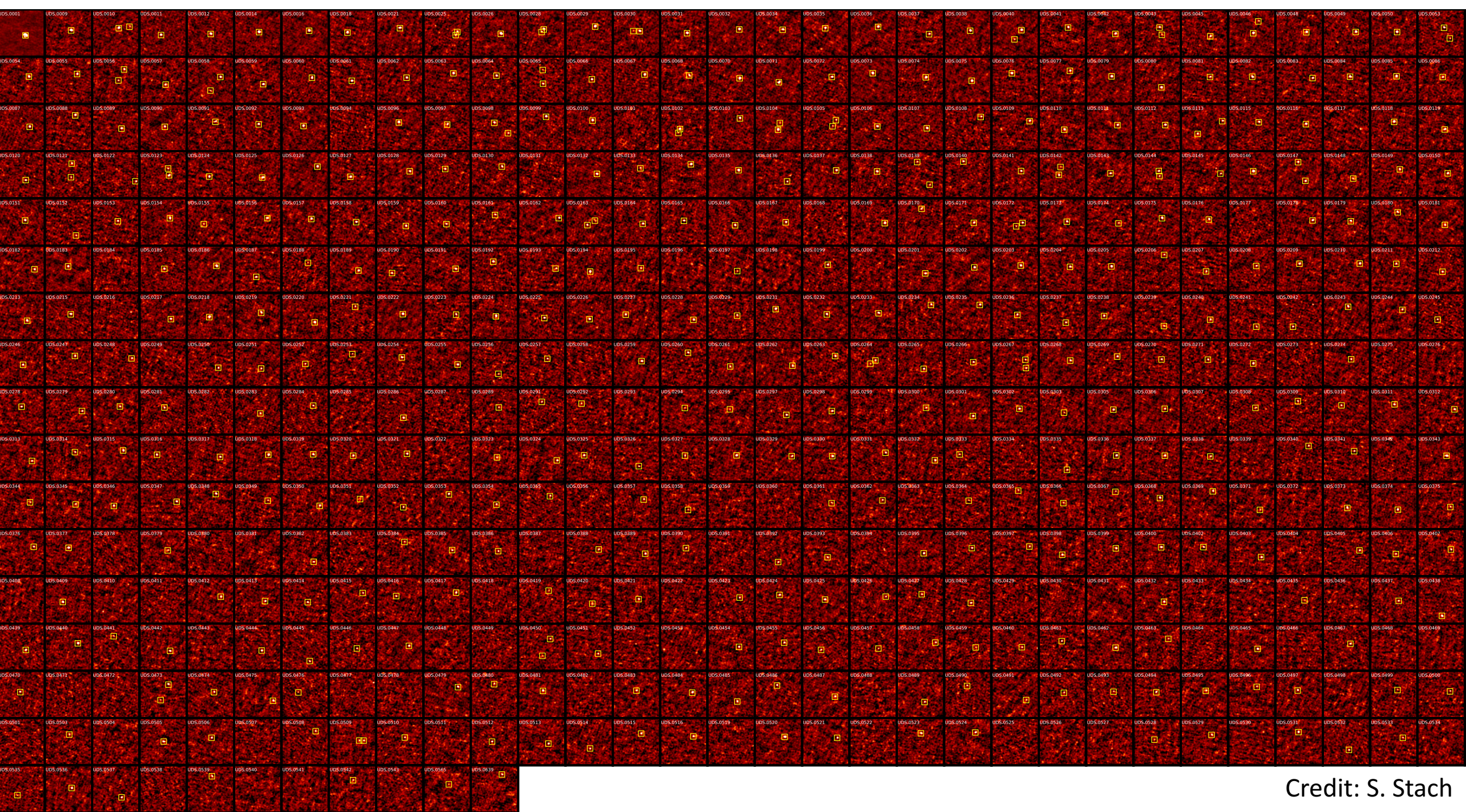


ALMA in the UDS: 4x the area of LESS

- UDS imaged with SCUBA-2 as part of the Cosmology Legacy Survey
- 533 sub-mm sources with $S_{850} > 3.5 \text{ mJy}$ (4σ).
- ALMA Cycle 3 & 4 at $0.3''$
- Sensitive to sources $> 1 \text{ mJy}$ (4σ)
- Expect ~ 100 at $z > 4$, search for [CII] at $z \sim 4.4-4.5$

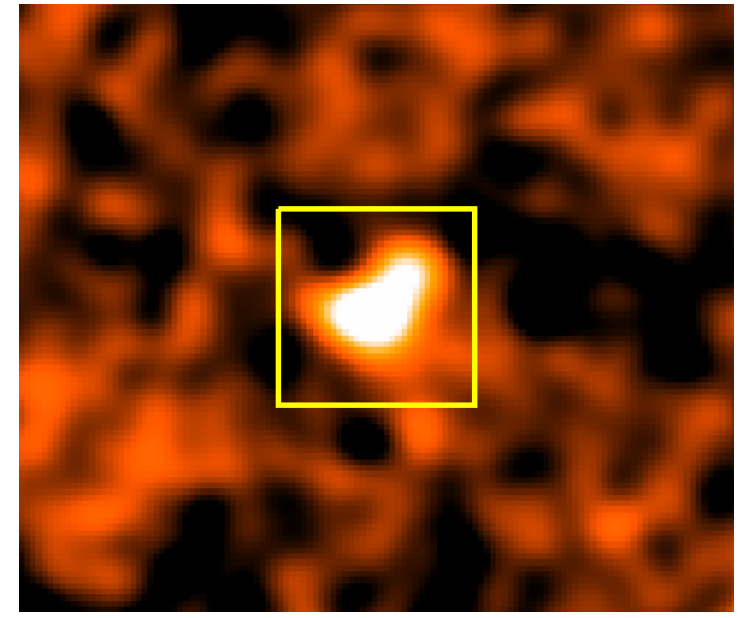
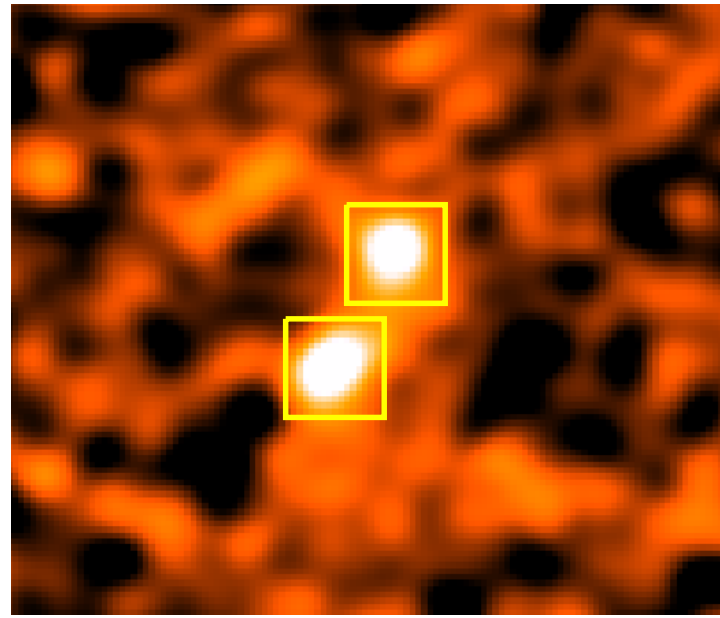
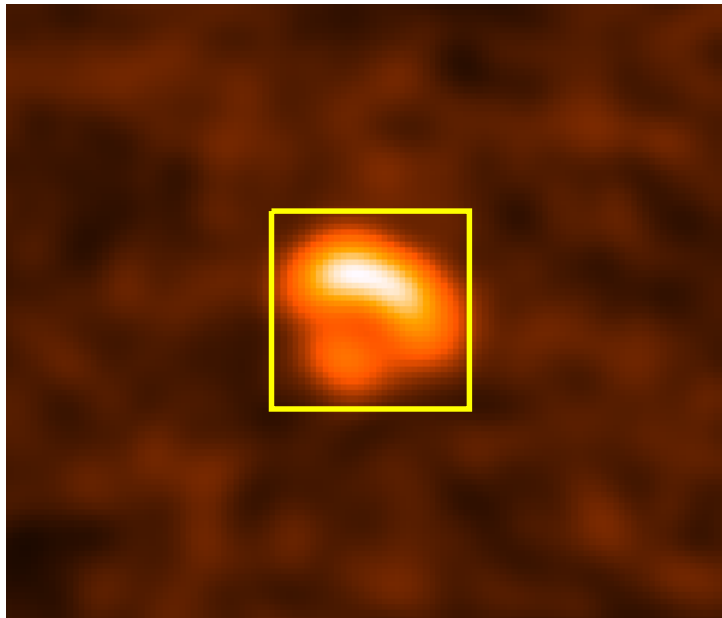




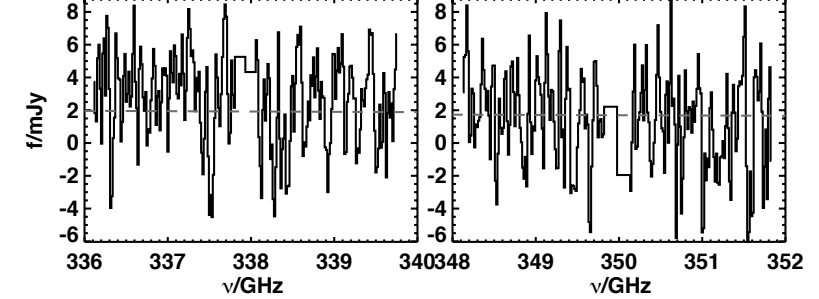
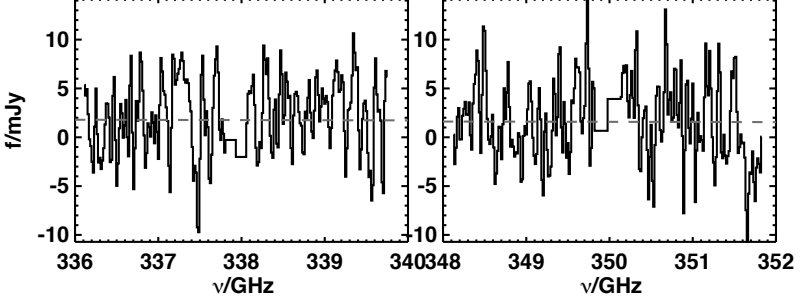
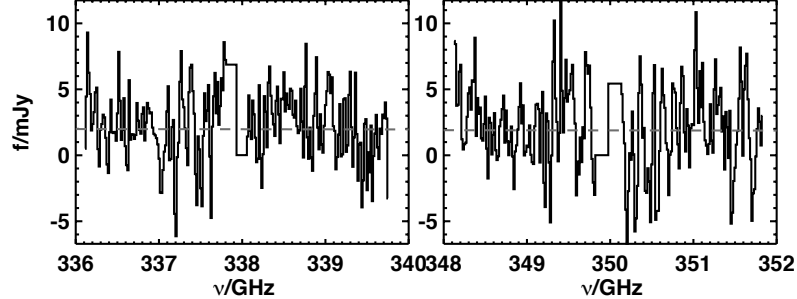
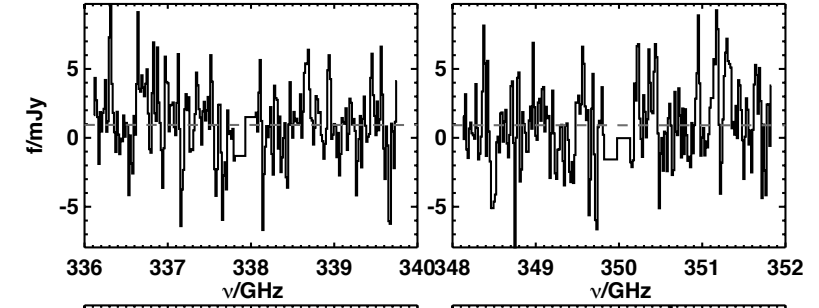
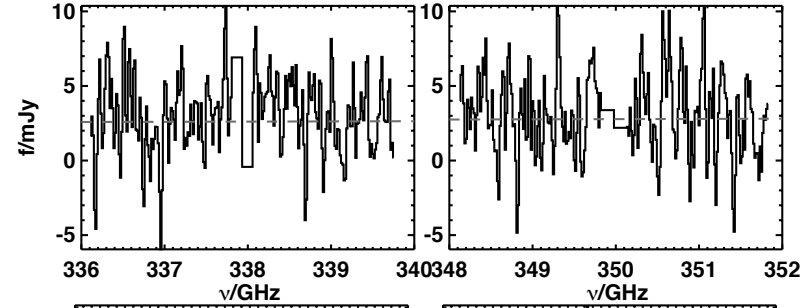
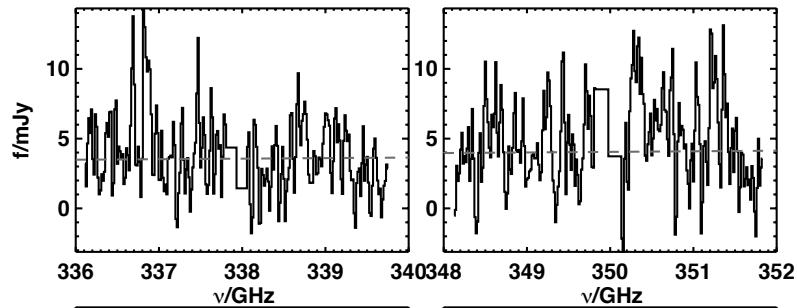
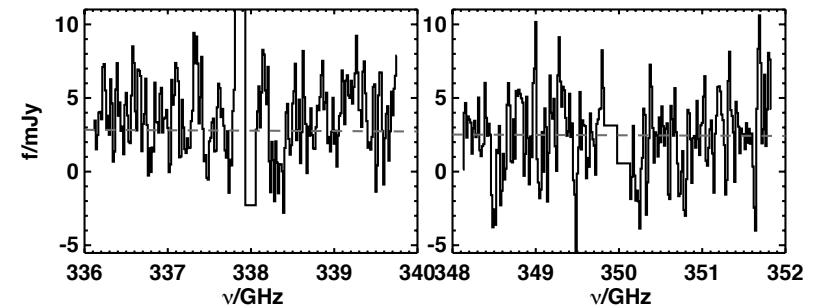
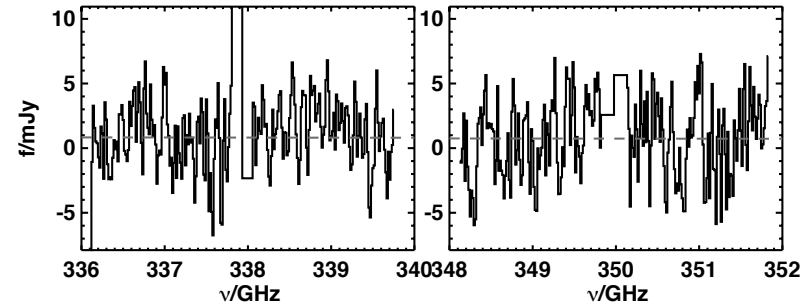
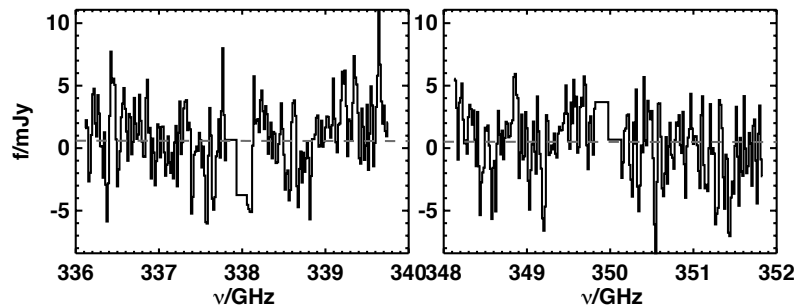


Credit: S. Stach

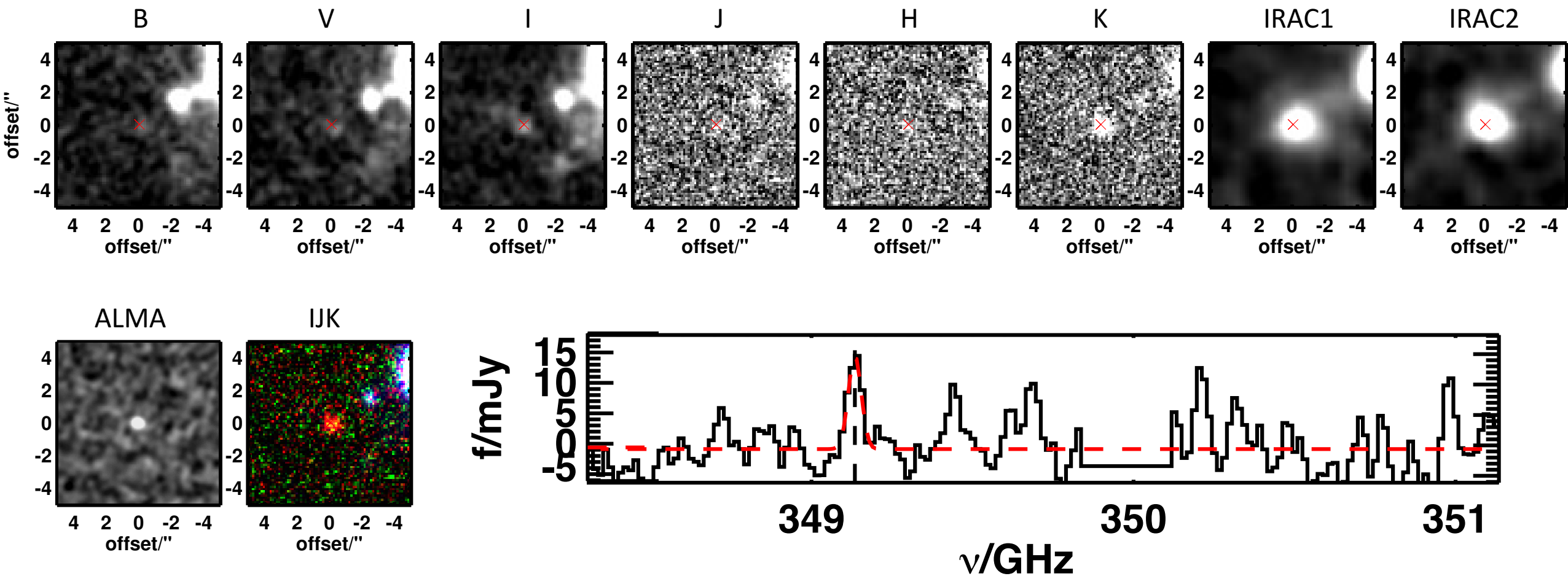
Largest sample of SMGs



ALMA FIR spectra



Potential [CII] emission at $z=4.44$



Conclusions

- ALMA observations of 507 SCUBA-2 sources in UDS
- 4x larger area than previously covered
- 0.3" resolution
- Spectra covering [CII] at $z=4.4-4.5$

