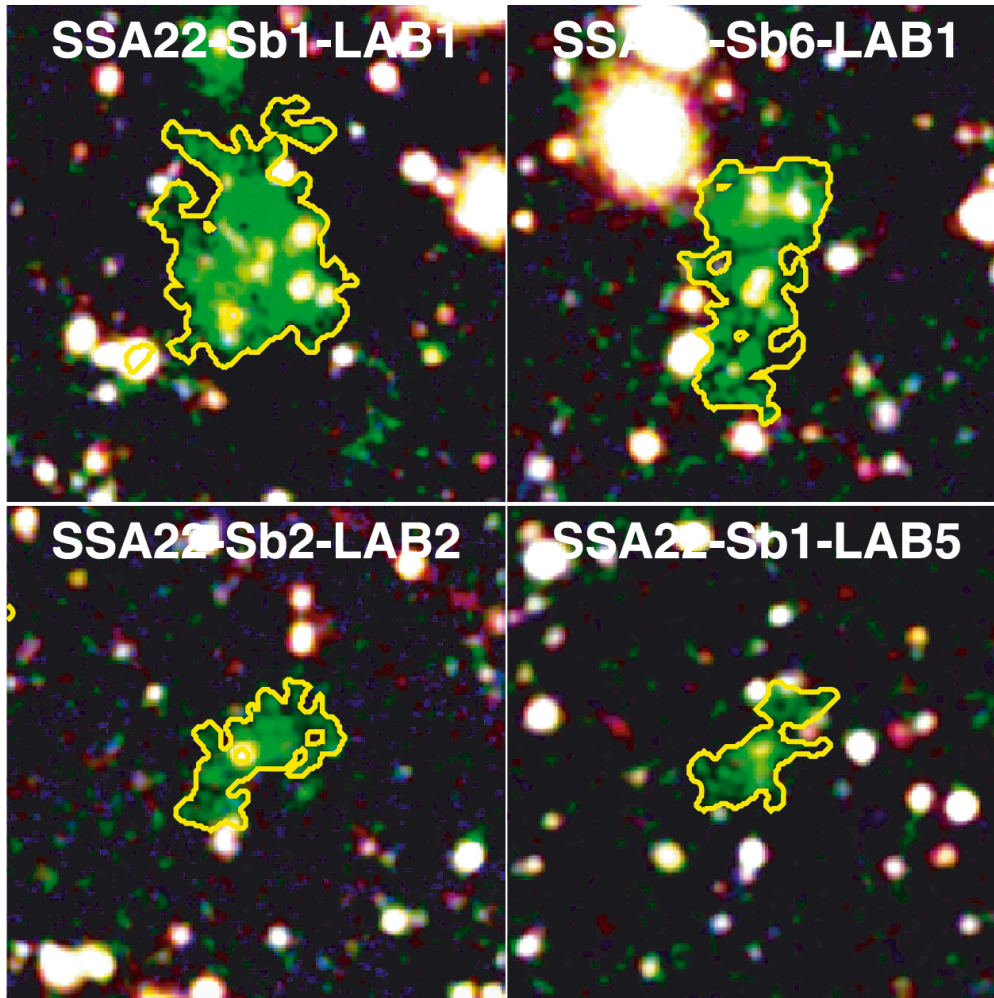


ALMA Observations of LABs

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Lyman- α Blobs (LABs)



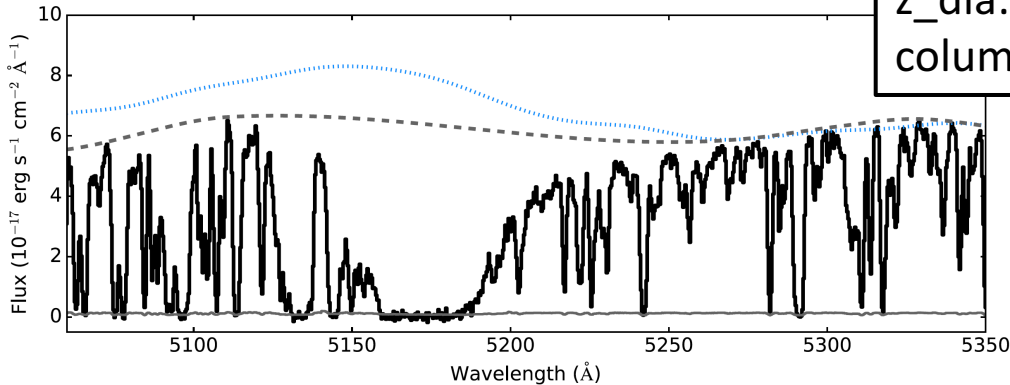
- LABs are extended, Ly α -emitting objects.
 - ~ 30 -300 kpc scale.
 - $L_{\text{Ly}\alpha} \sim 10^{43-44}$ ergs/s.
- Some scenarios are proposed.
 - gravitational cooling.
 - photo-ionization by star-formation/AGN.

LABs and DLAs

Fumagalli+17

$z_{\text{dla}}: 3.25$

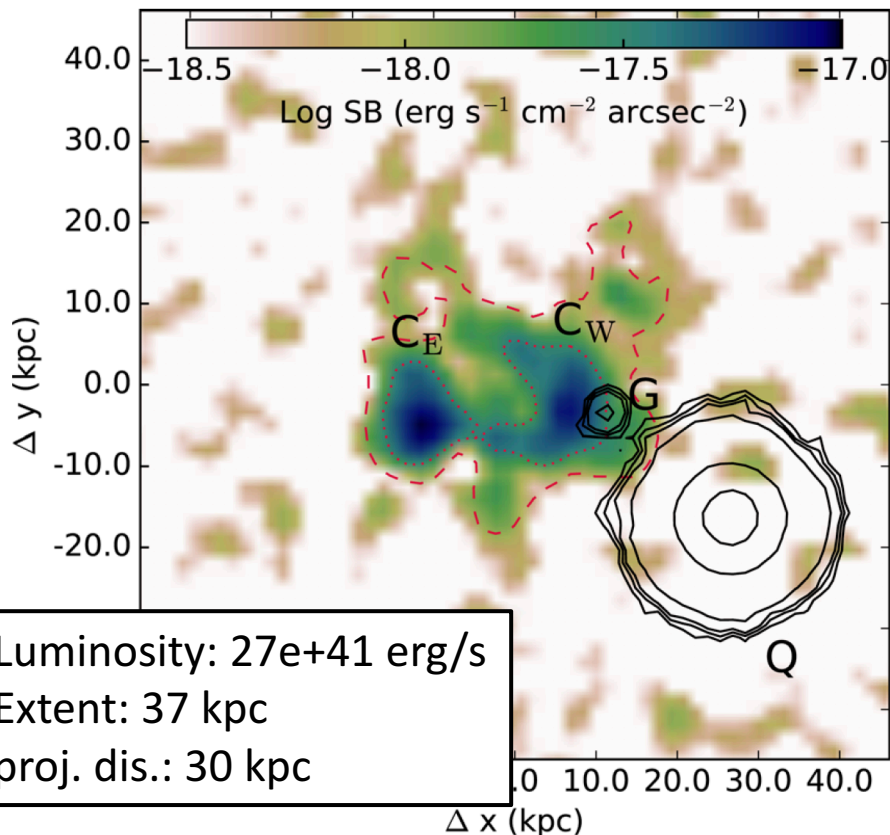
column density: $\log(N_{\text{HI}}/\text{cm}^{-2}) > 20.6$



- Some DLAs are associated with LABs.

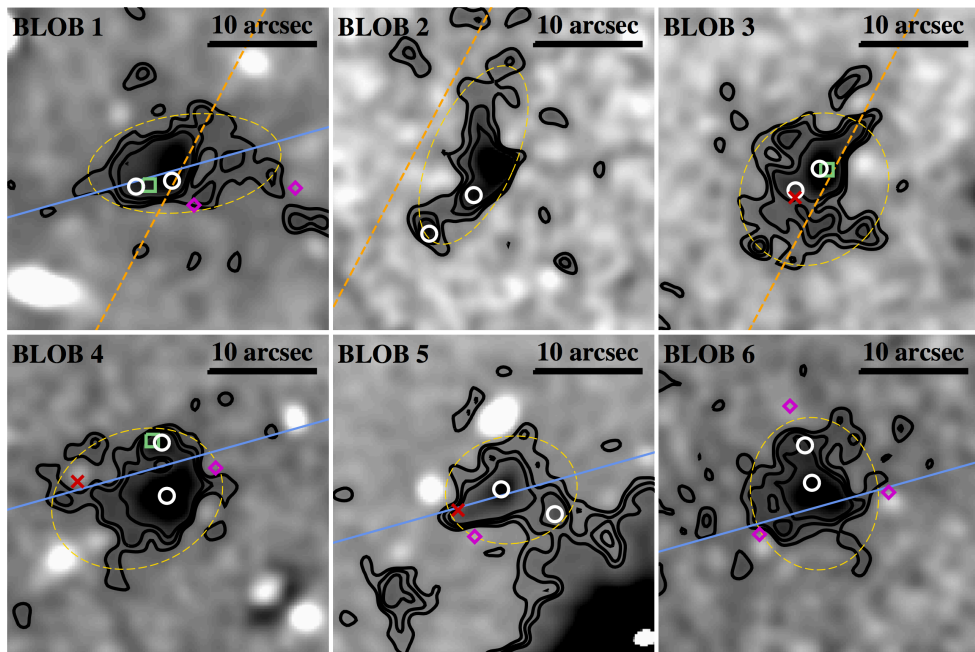
(e.g., Fumagalli+17 North+17)

- We can observe such combination if a forming SFG 'illuminate' HI gas near the background QSO.

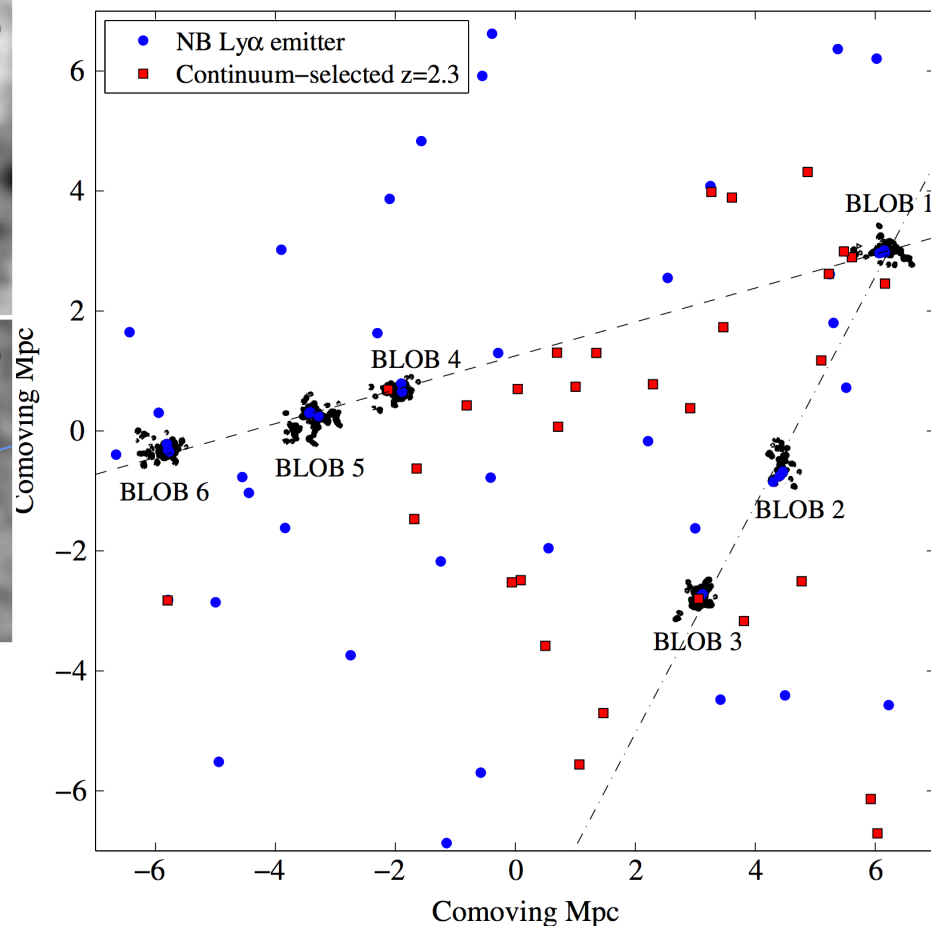


Luminosity: $27e+41$ erg/s
Extent: 37 kpc
proj. dis.: 30 kpc

LABs and Cosmic Web



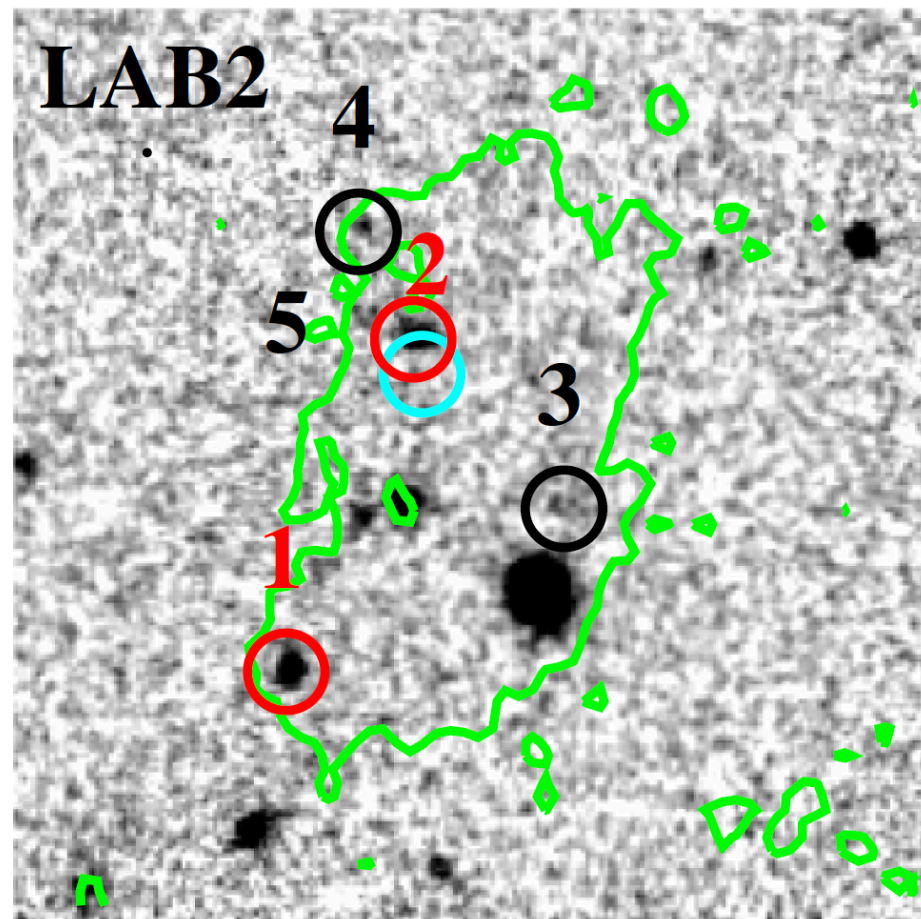
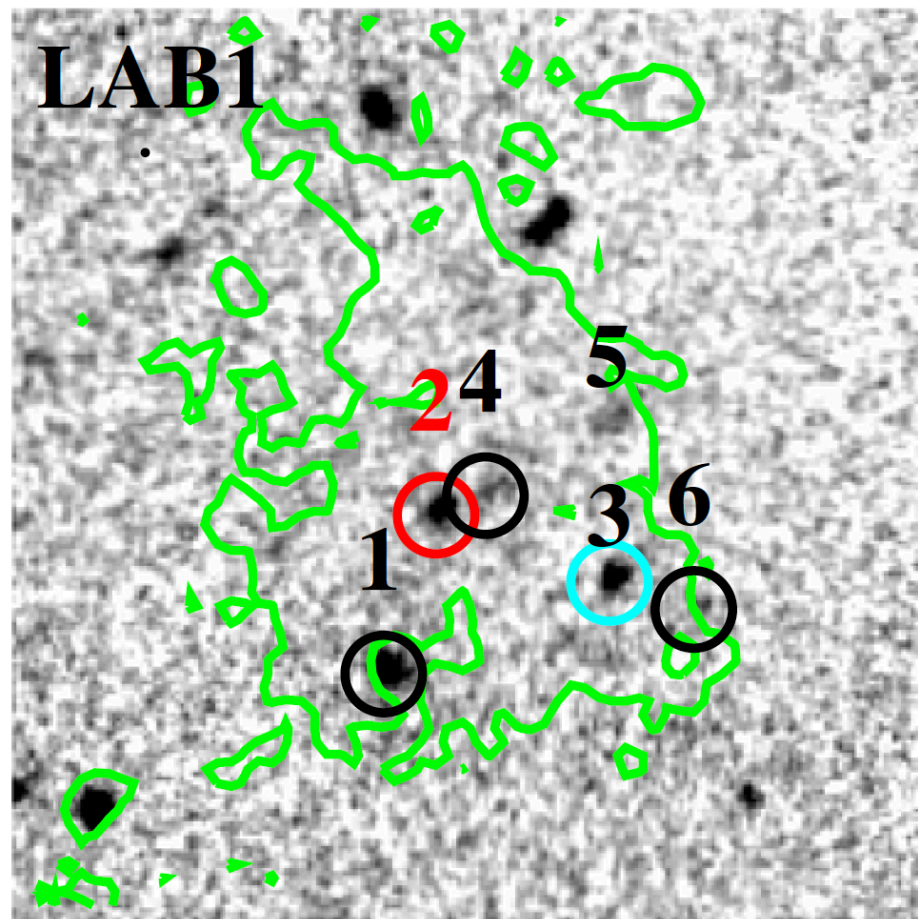
Erb+11



- LABs can be a tool to trace larger cosmic structure
- Emission and absorption methods are complementary.

LABs and 'Resident'

Uchimoto+12 / Kubo+13

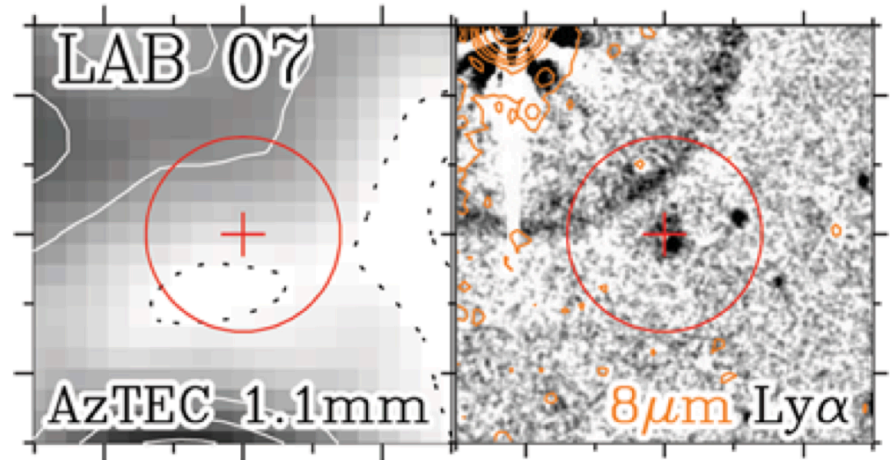
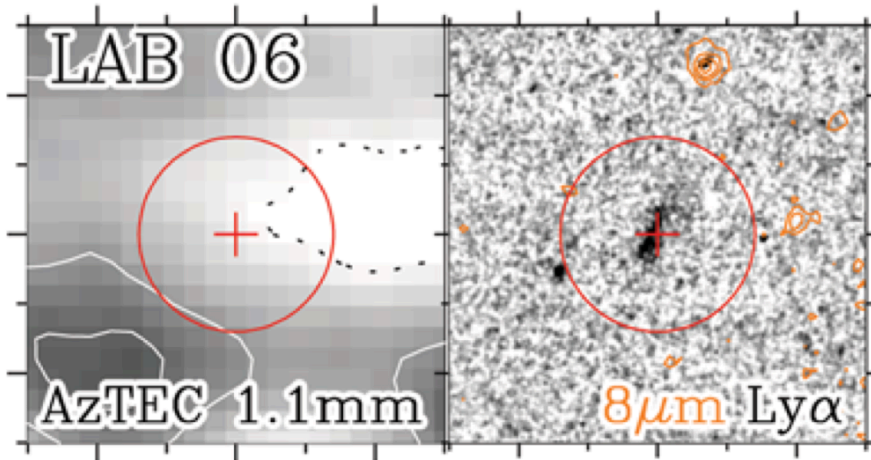
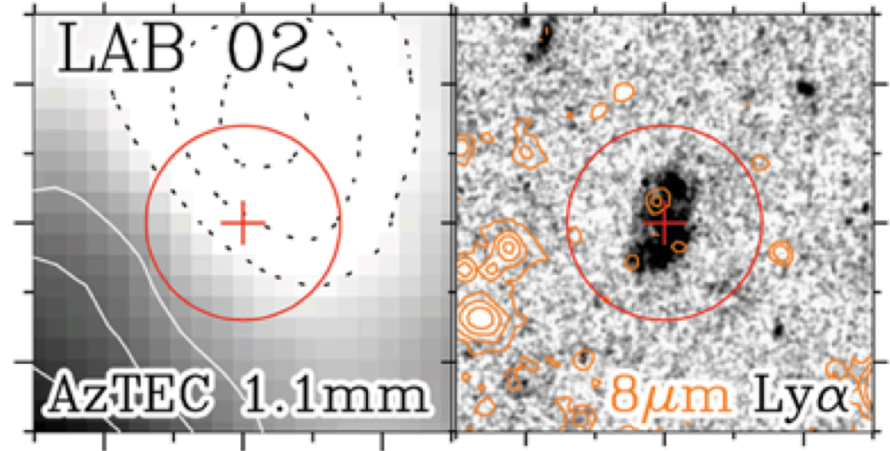
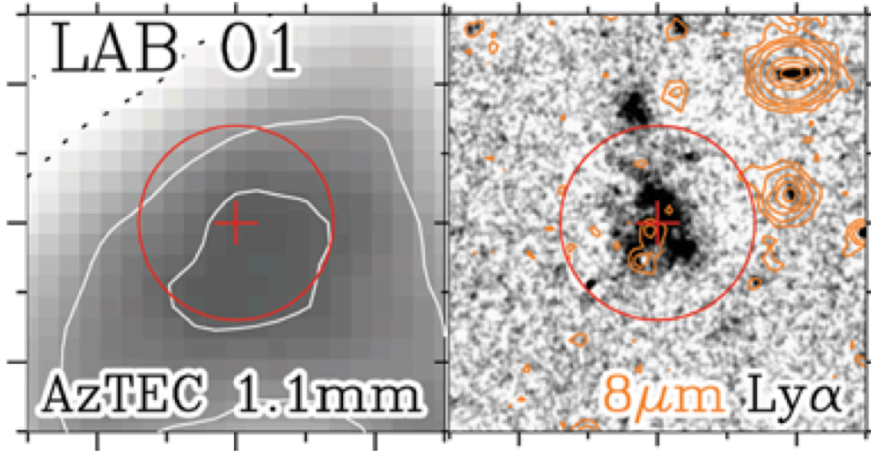


- Most LABs appears to have galaxy counterparts. (see also Nilsson+06)
- Massive galaxies are often observed (e.g., Erb+11).

Expectation for ALMA

- LABs are likely to be sites of ongoing galaxy formation.
- ALMA can play a key role:
 - identify galaxies which reside in LABs.
 - detect galaxies associated with DLAs.
 - uncover hidden heating source.
 - reveal the ISM nature of galaxies in LABs.
 - test the 'super-wind' model, tracing [CII].

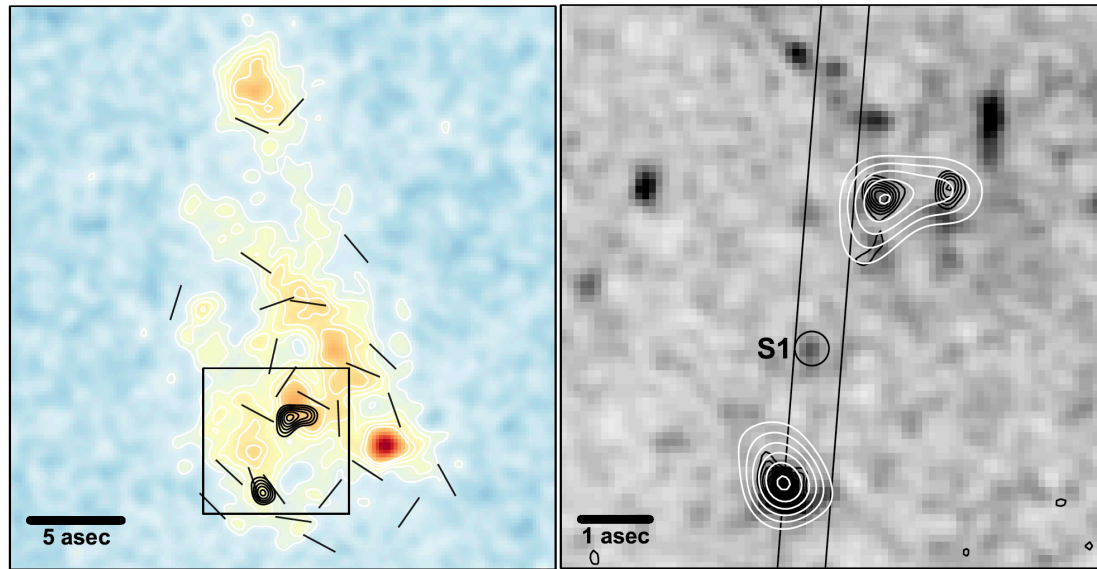
LABs and DFSGs



Tamura+13

- LABs doesn't show strong correlation with SMGs.
- Tracing dust-obscured SF had been difficult.

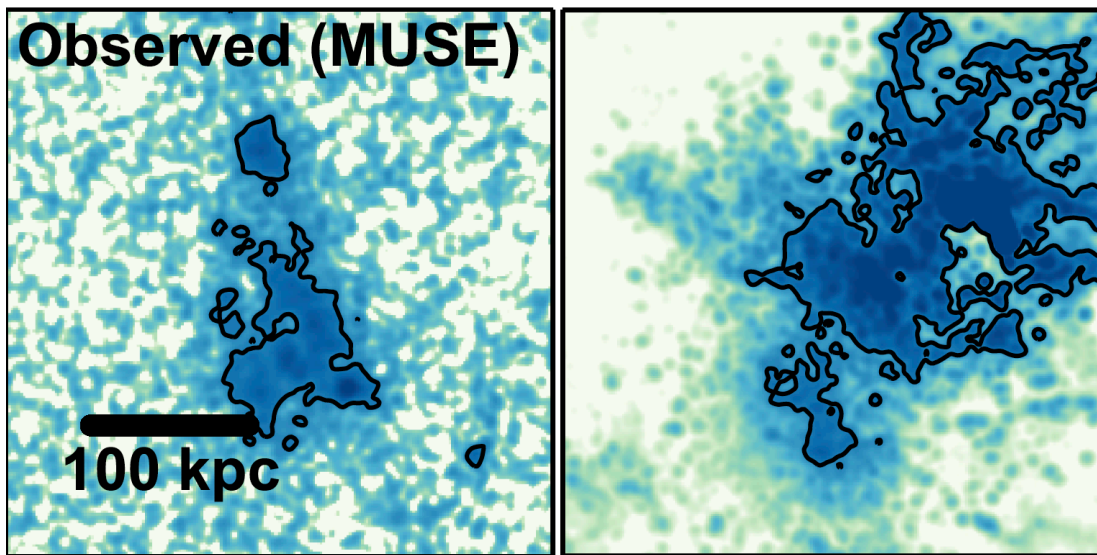
SSA22-LAB1 w/ SMGs



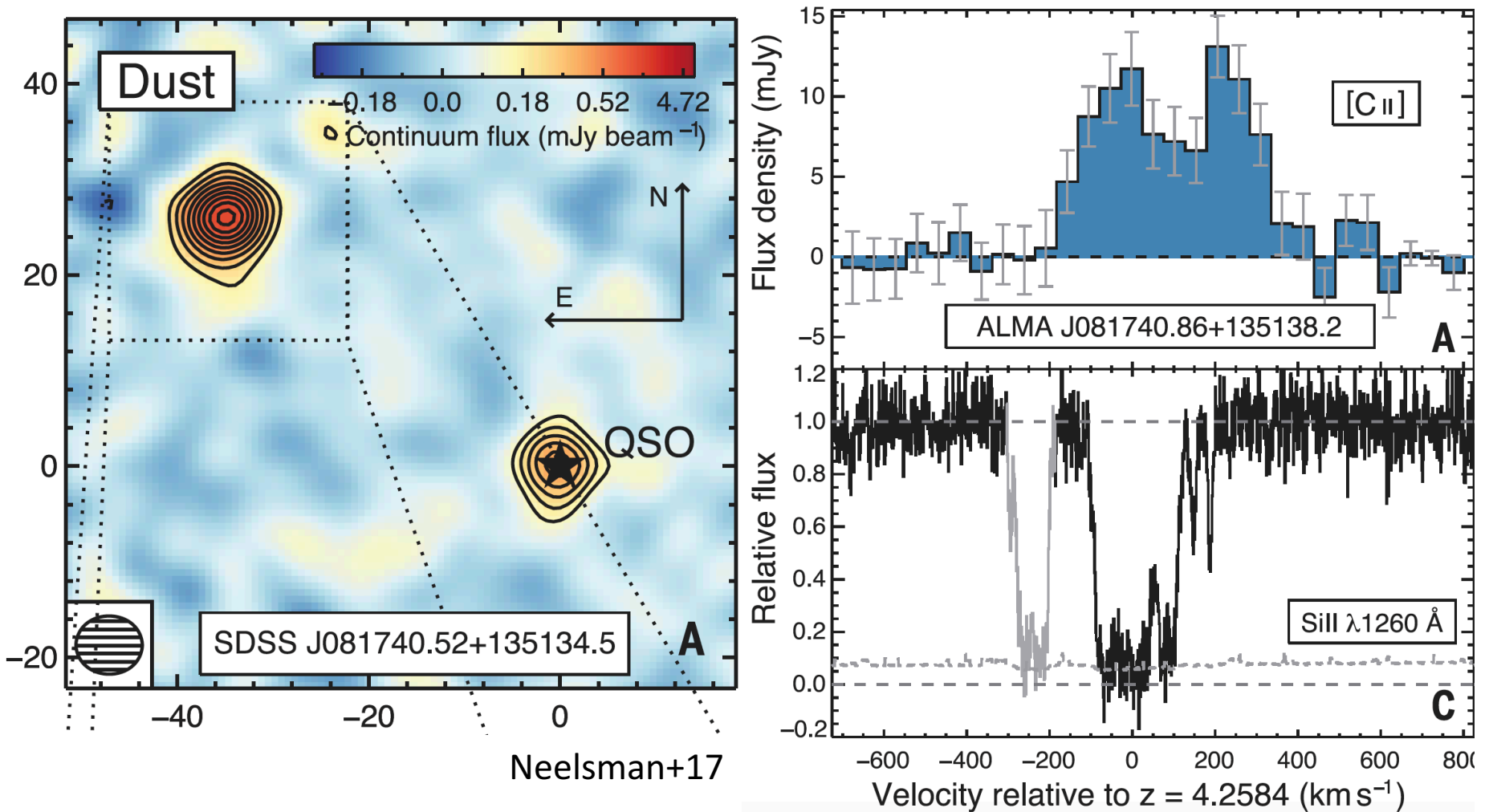
- 2 SMGs with $\text{SFR} \sim 150 \text{ M}_{\odot}/\text{yr}$ reside in LAB1.

- There would be a number of faint galaxies.

- Ly α photons escaping from SMGs are scattered in neutral hydrogen around the satellites?

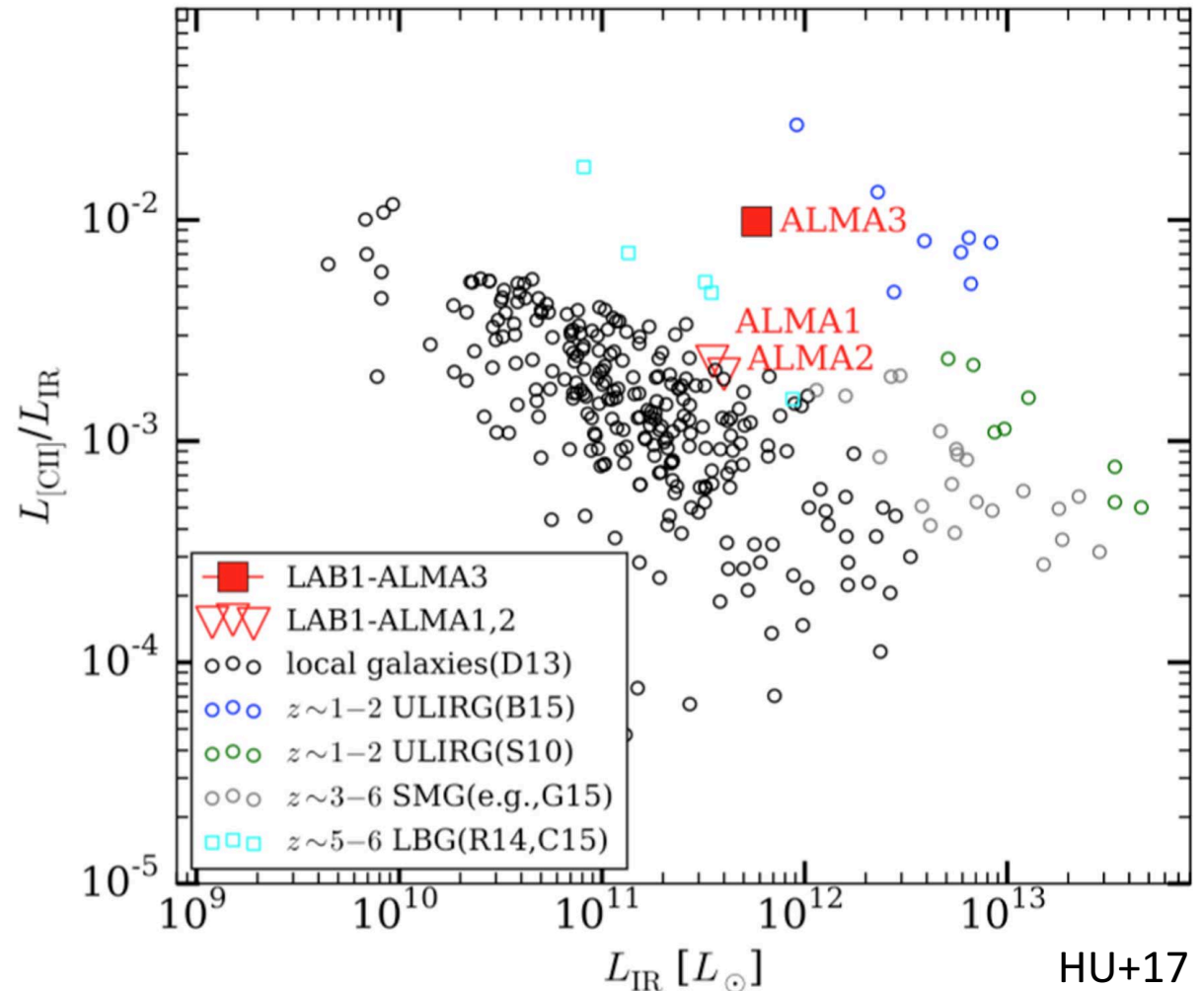
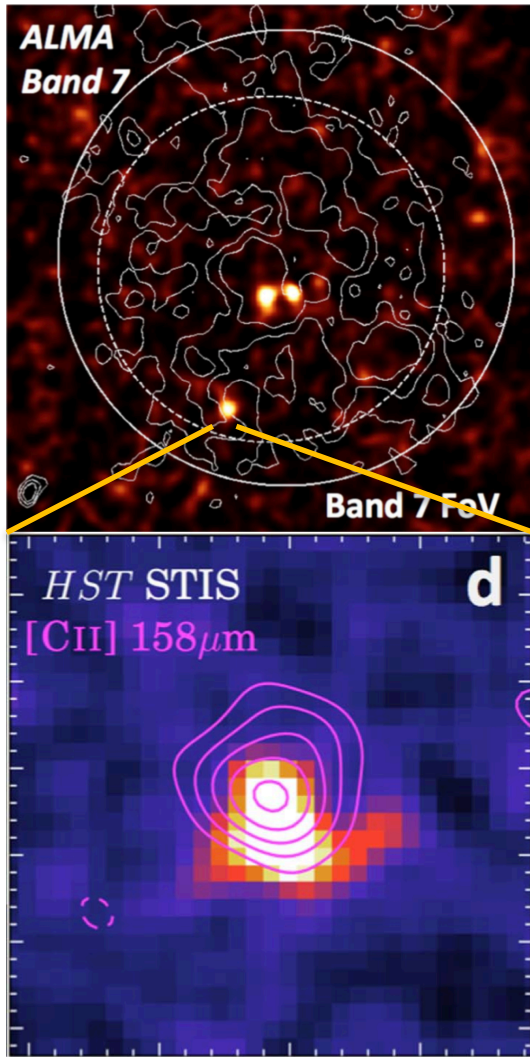


DLA and ISM-rich galaxies



- The galaxy would be embedded in a large reservoir of HI neutral HI gas.

SSA22-LAB1: ISM diagnostics



- One SMG show high [CII]/IR and [CII]/[NII] ratios.
- Extended star-formation? Shock-enhanced [CII]?

Summary

- ALMA provides a powerful tool to investigate LABs/DLAs.
- Lots of LABs are associated with SMGs. So such dusty star-forming galaxies would be somehow related to generate the extended Ly α emission.
- Next generation telescopes like TMT may allow us to use galaxies as a background source, which would provide more insights on LABs.