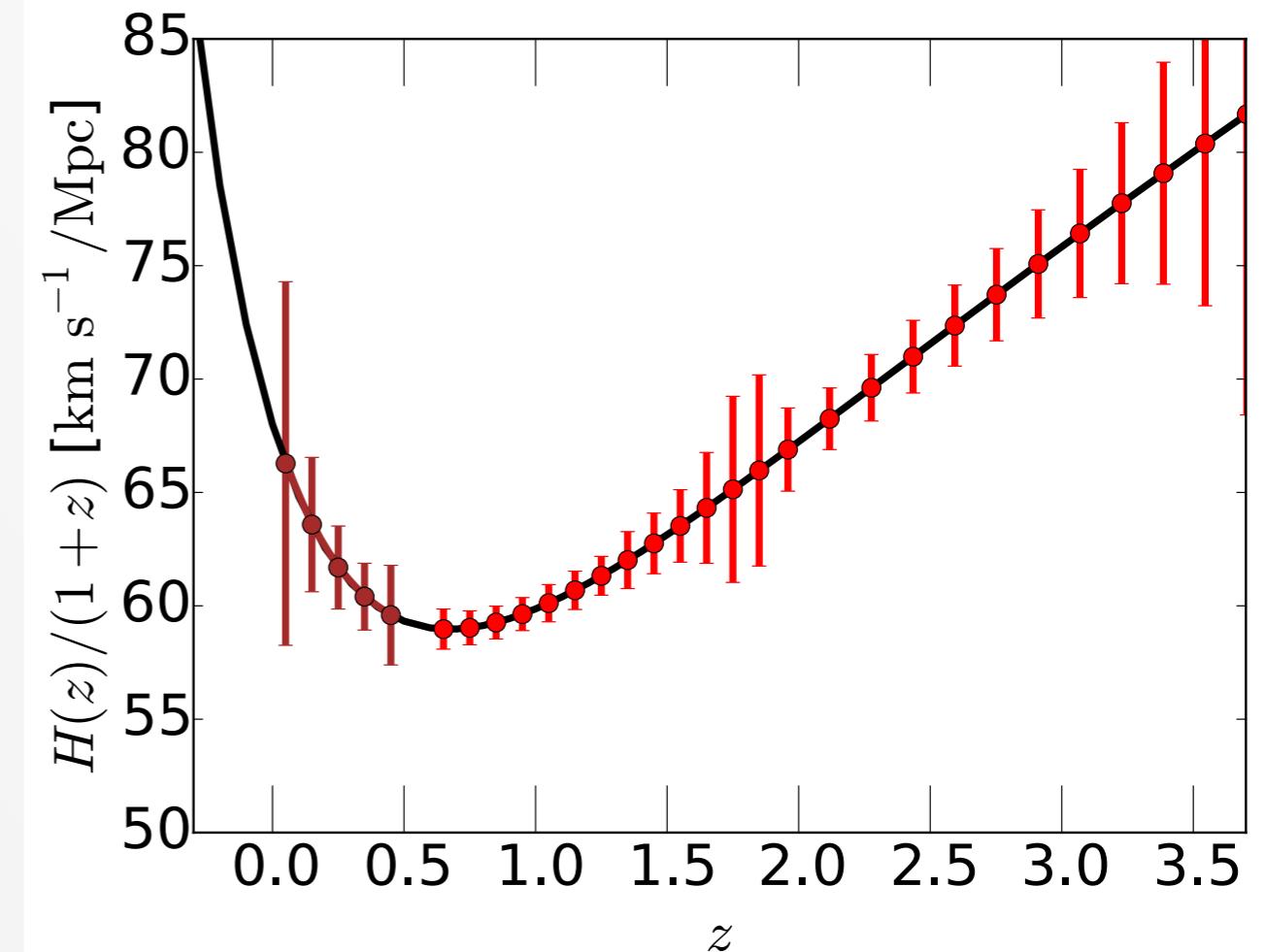
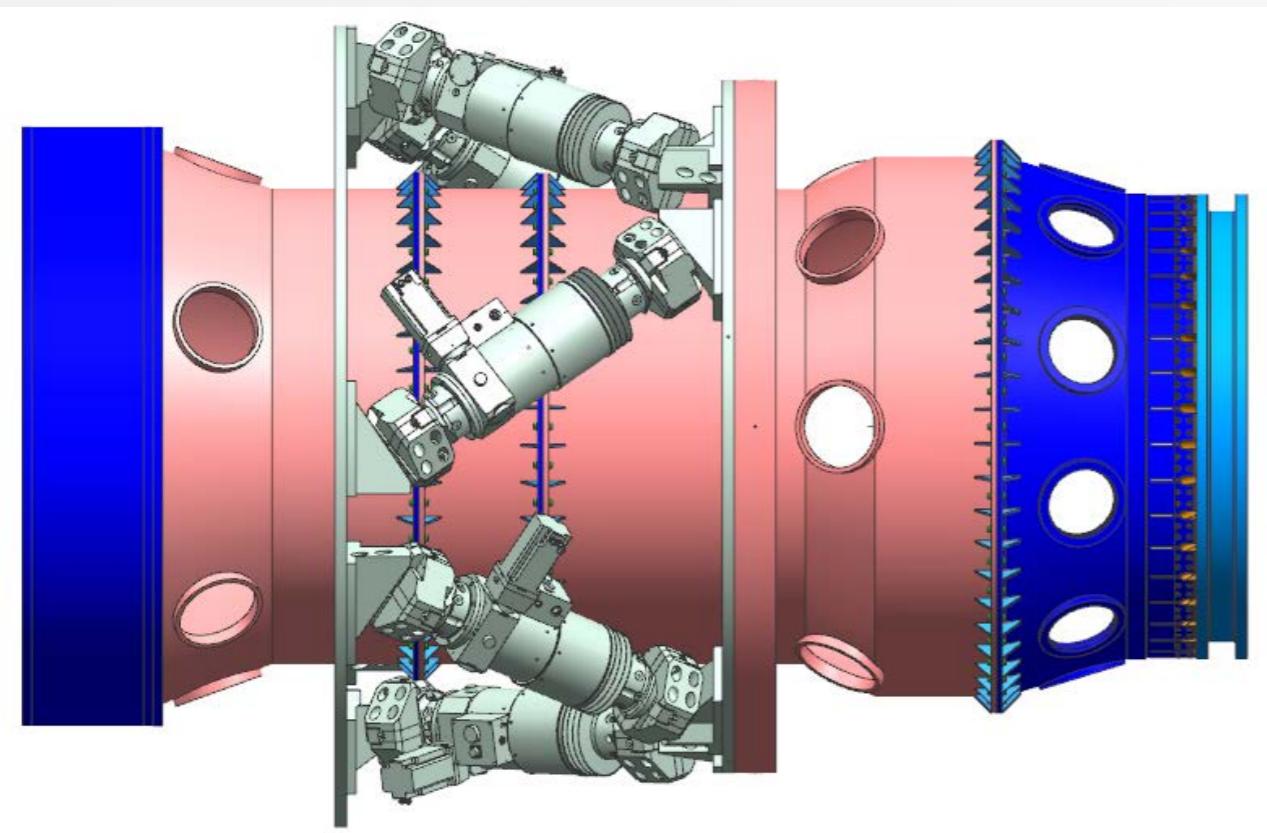


Top ~10 Future Areas of HI Abs Research

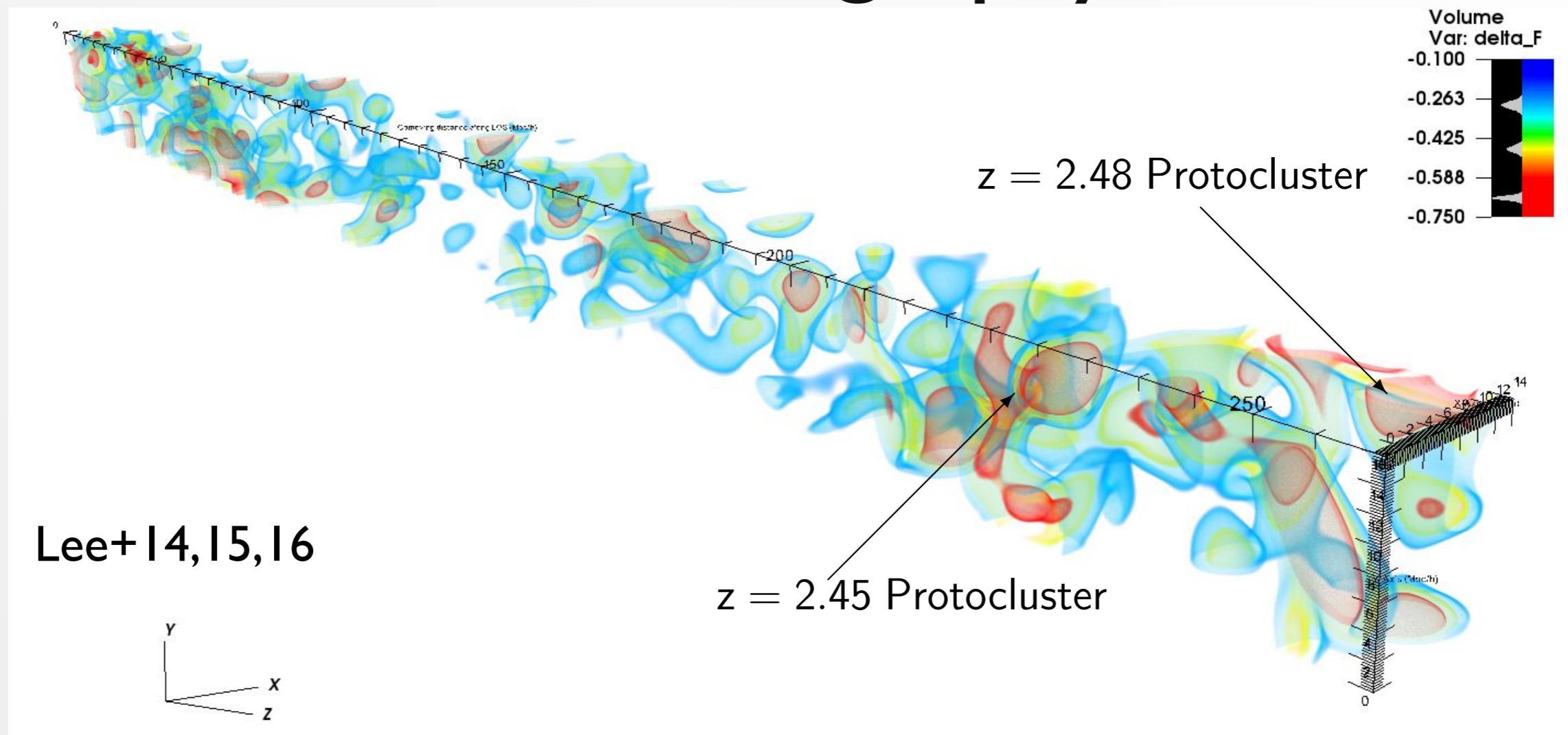


DESI / PFS



- Over 1 million quasar spectra
 - Generally S/N ~ 1 (or less!)
- “Complete” mapping of the Northern sky
 - BAO, IGM clustering, etc. on steroids..

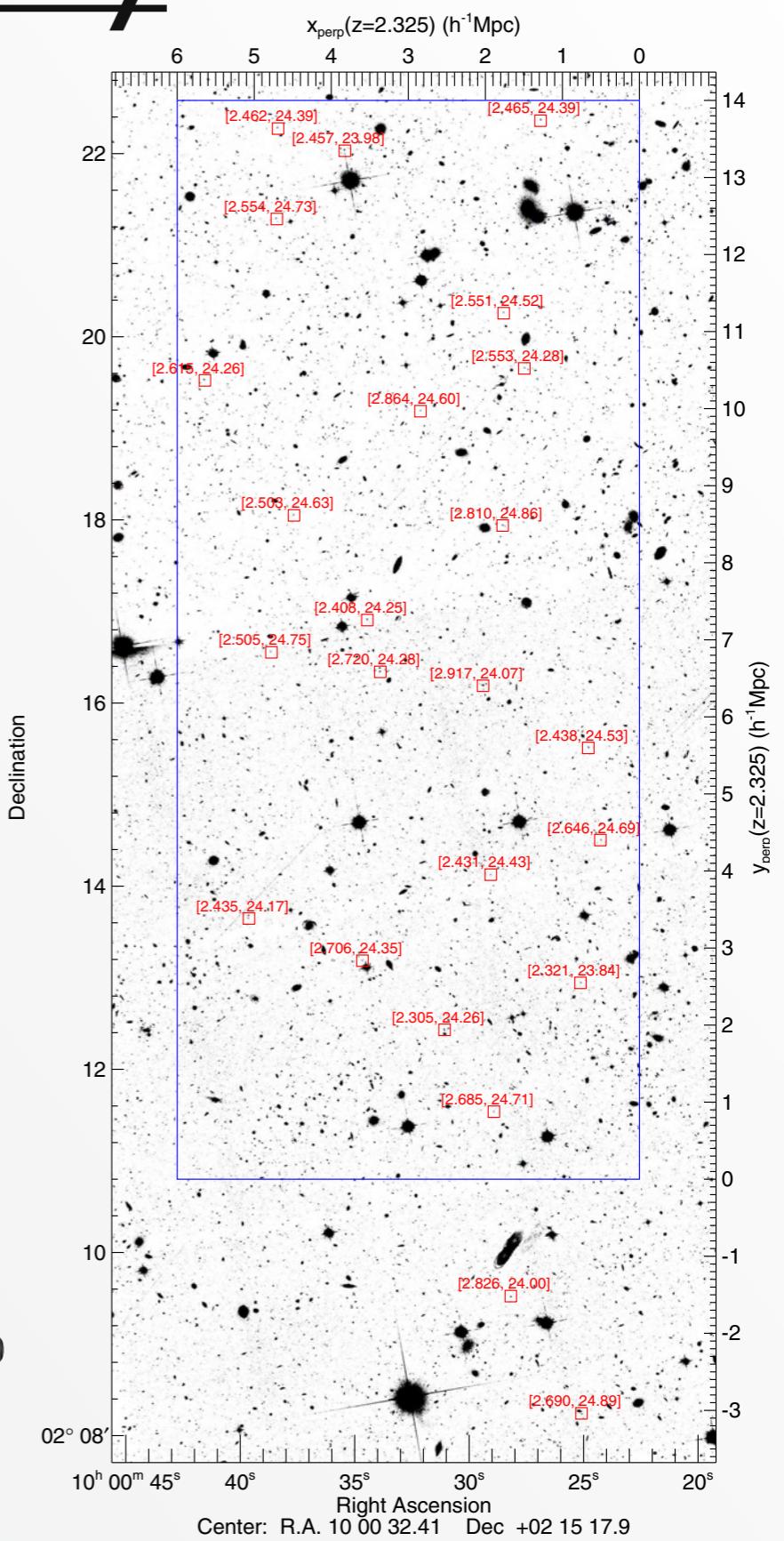
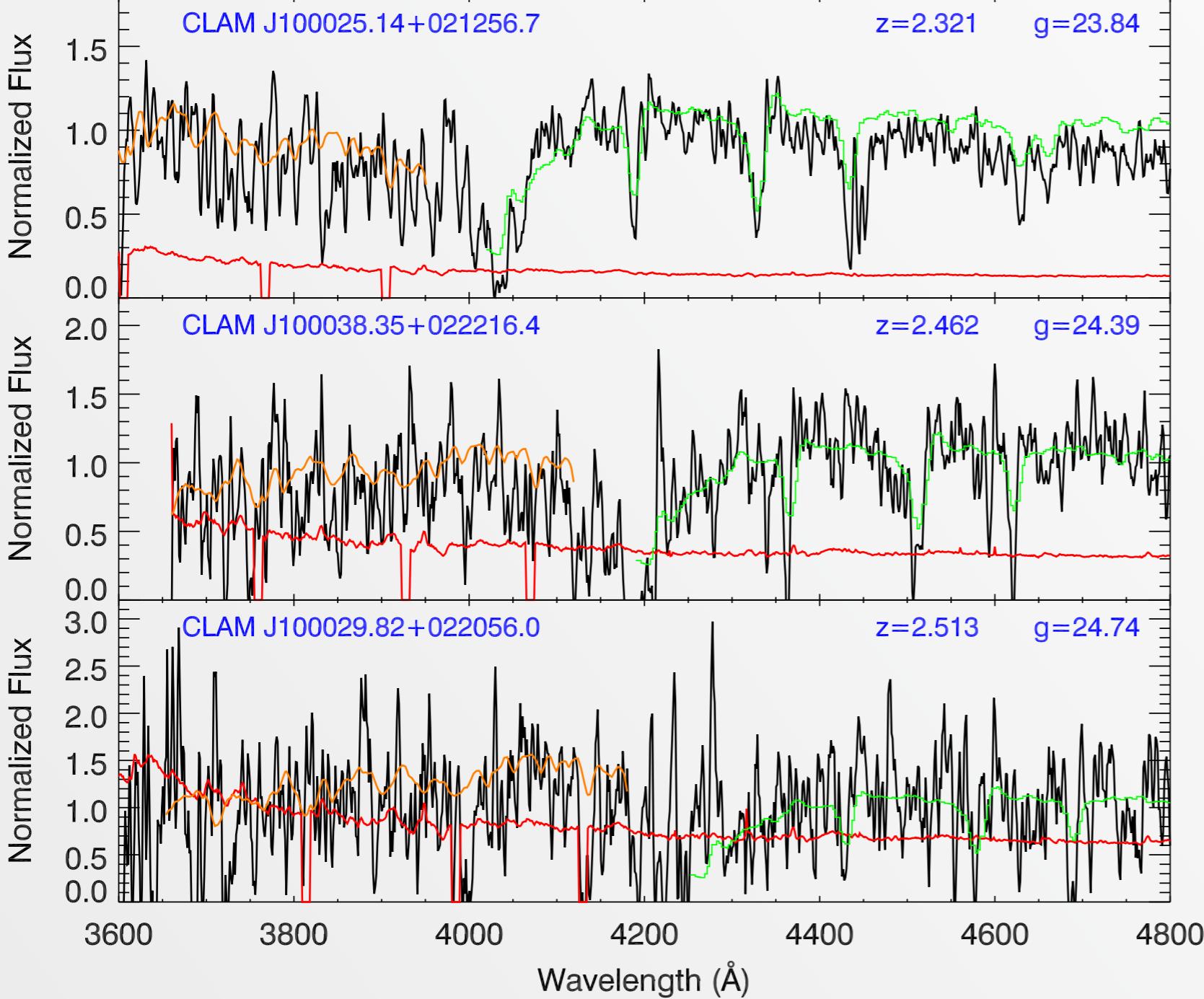
IGM Tomography



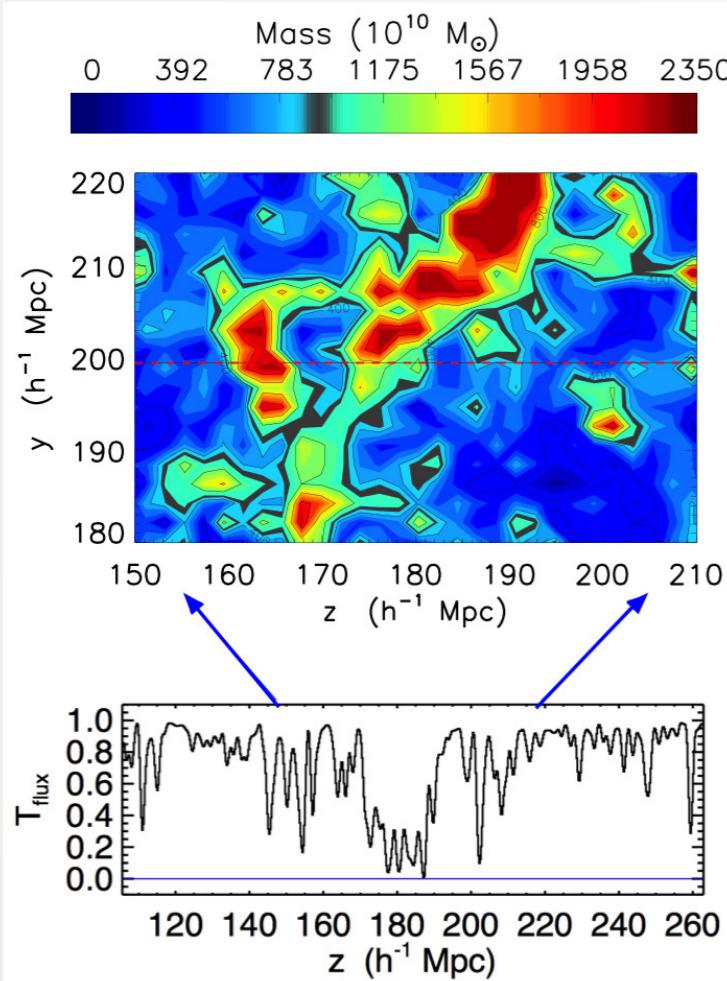
- Resolving the density structure of the $z > 2$ universe
 - Galaxy surveys are still too expensive (and sparse)
- Use the IGM
 - Quasars are too rare on the sky (~ 10 Mpc separation)
 - Use background galaxies as the light source

IGM Tomography

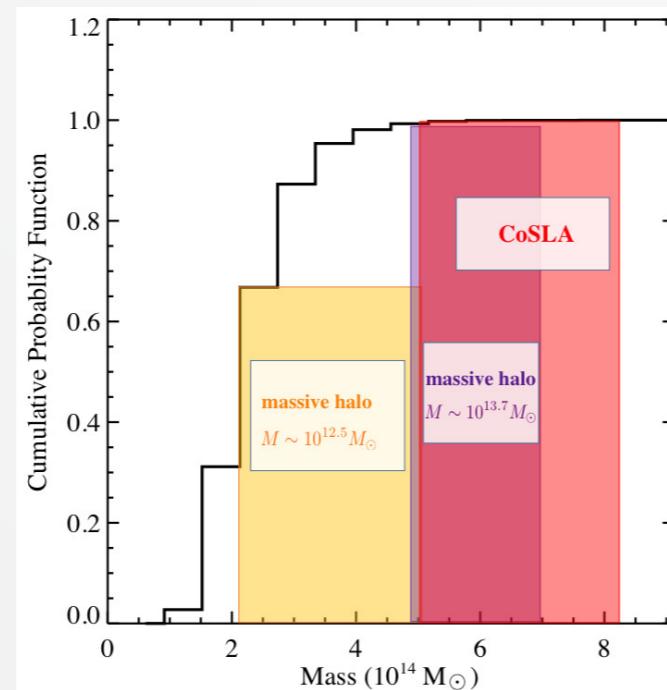
Lee+14



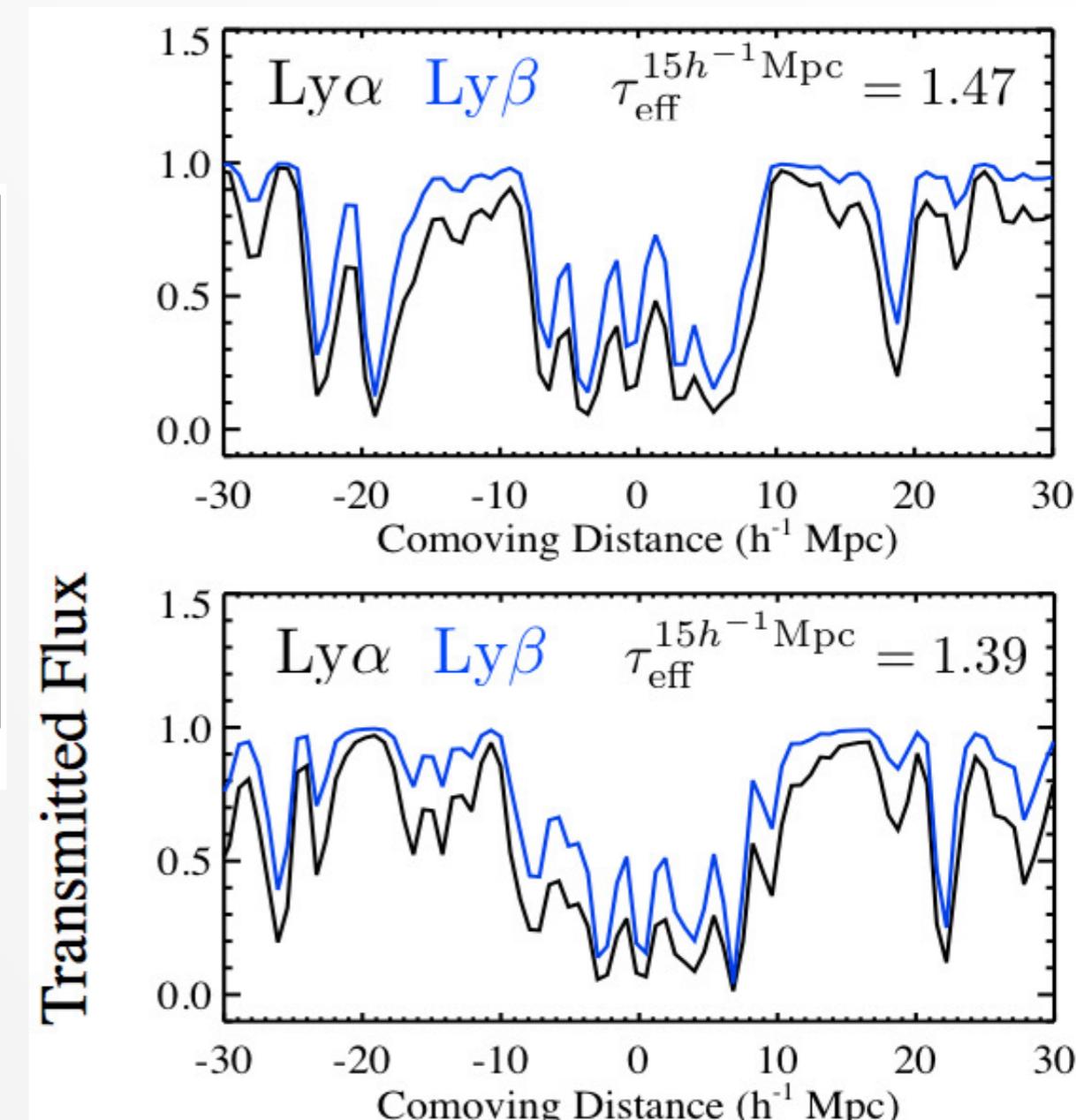
Searching for Protoclusters



Cai+16

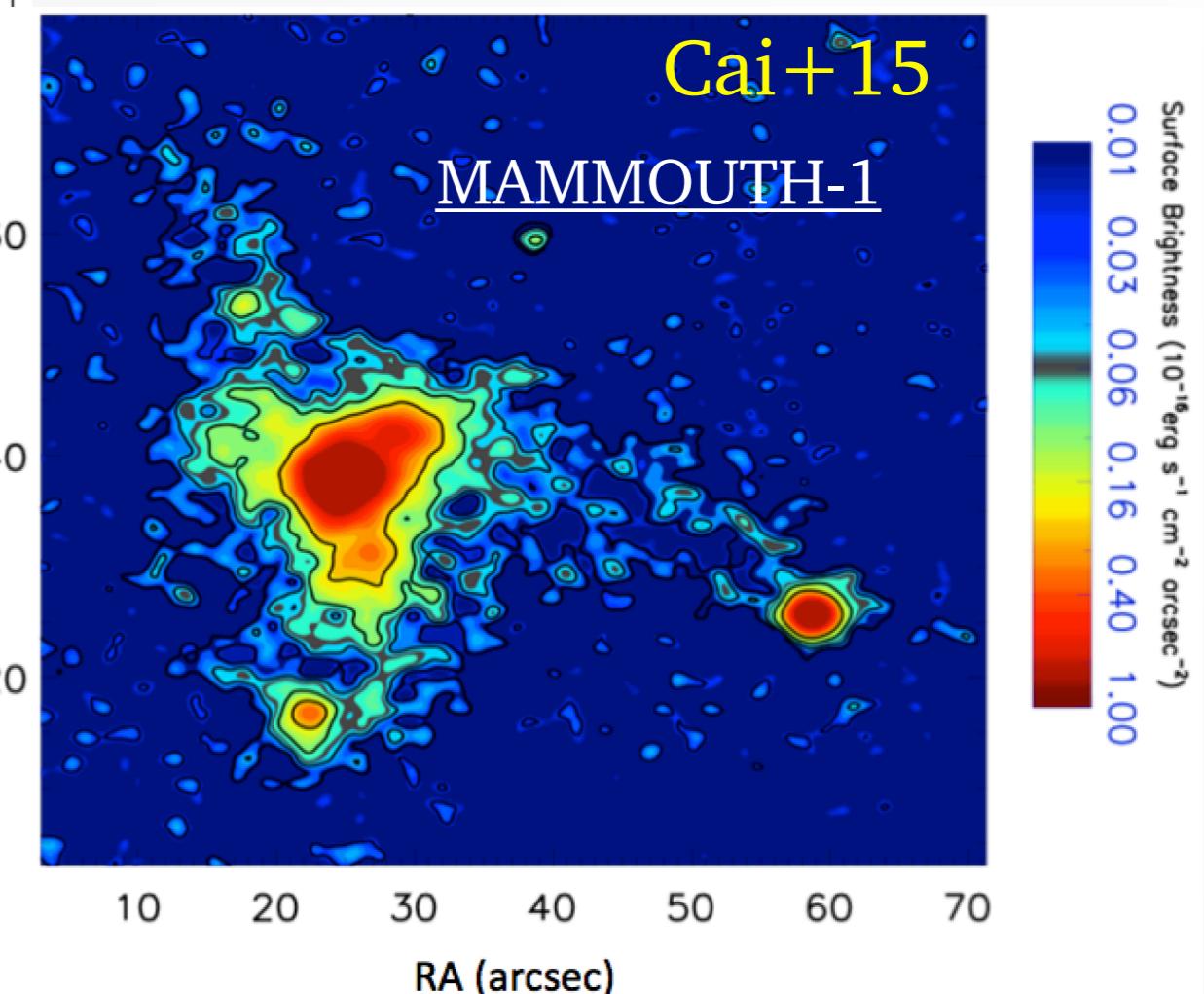
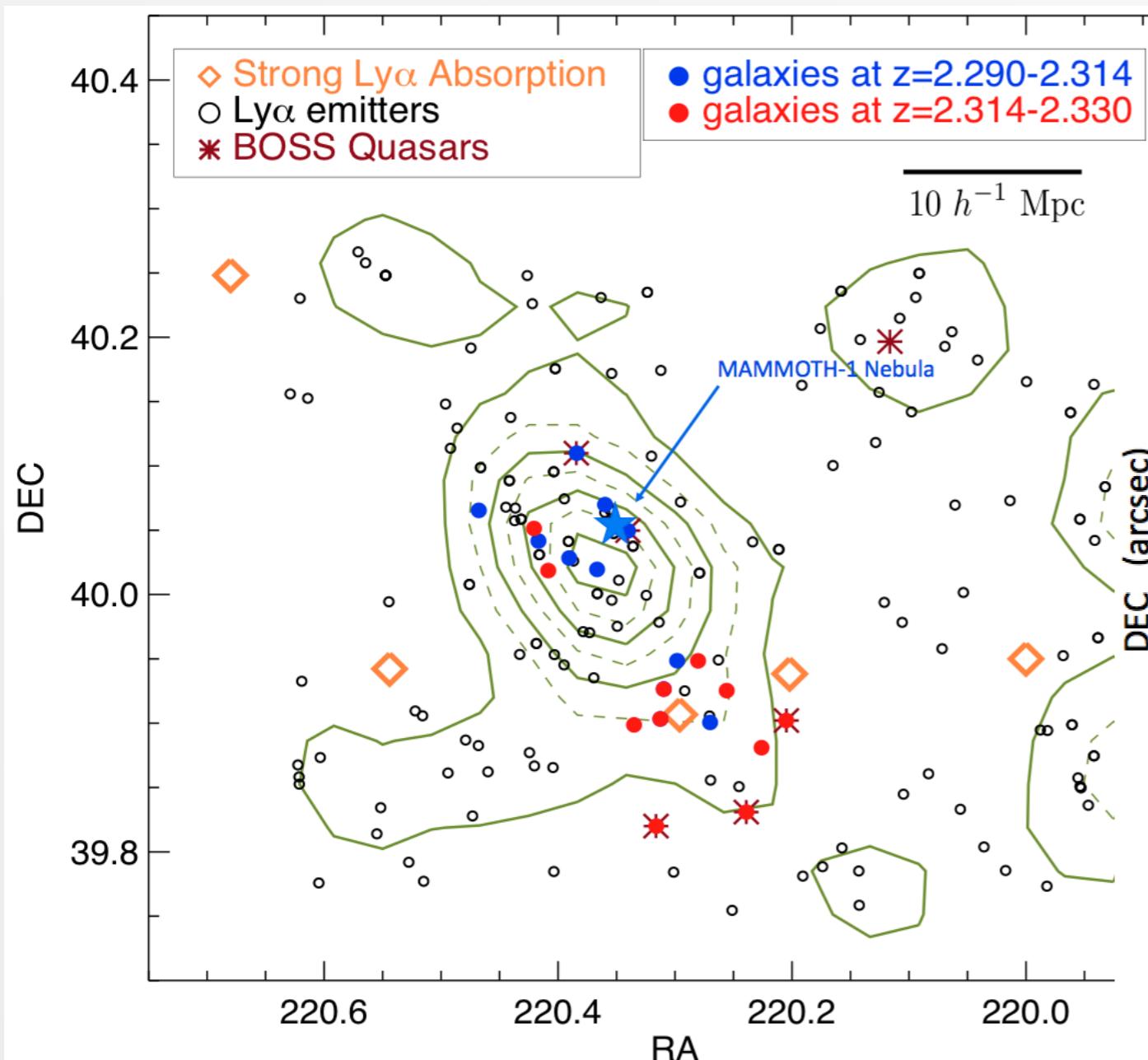


- Protocluster
 - $M > 10^{14} \text{ Msun}$ structure
 - Spans $\sim 15 \text{ cMpc}$ at $z \sim 2$
- Concept
 - Search for protoclusters with the IGM
 - Sustained high τ_{eff} on 15Mpc scales



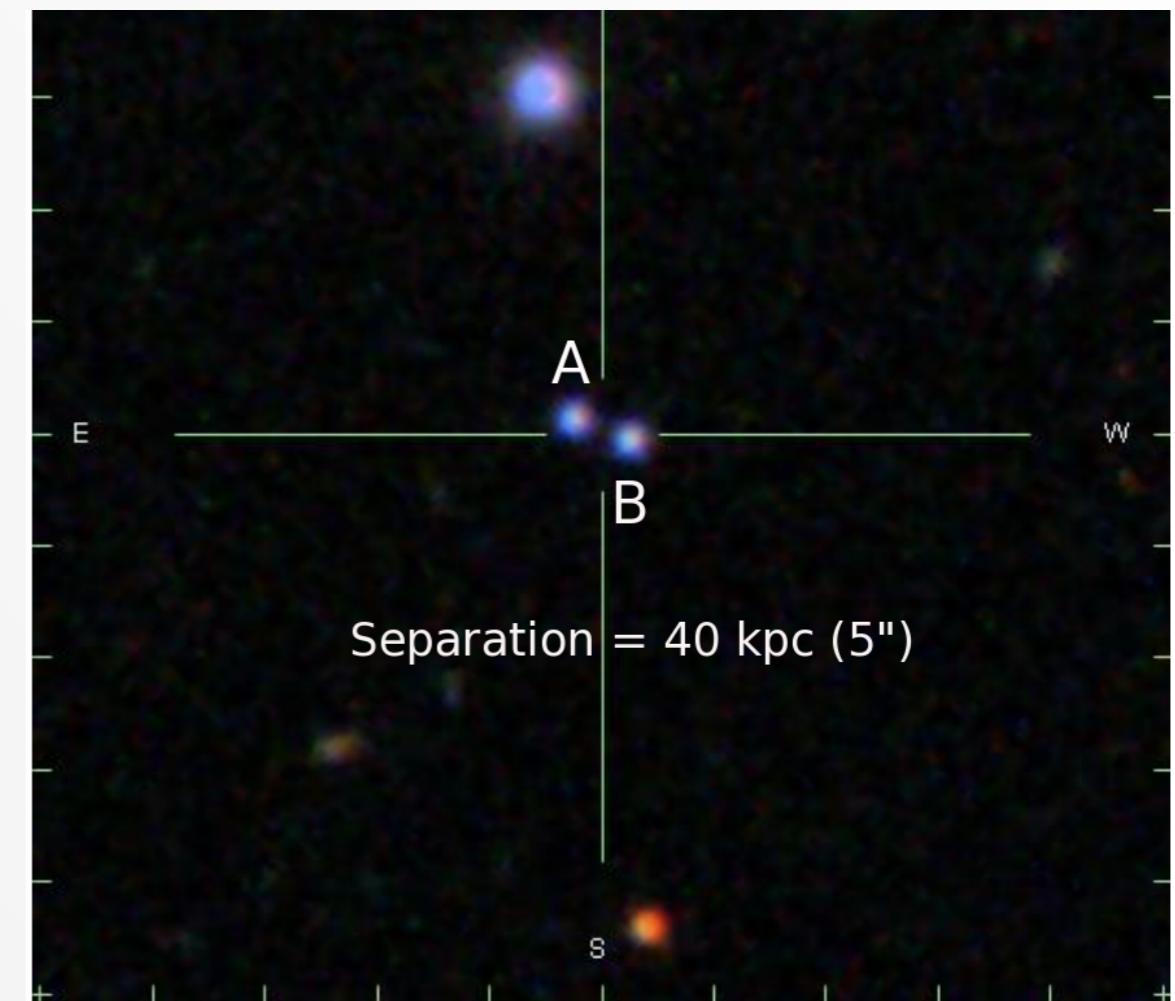
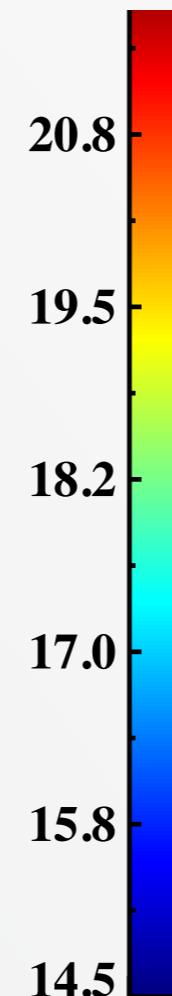
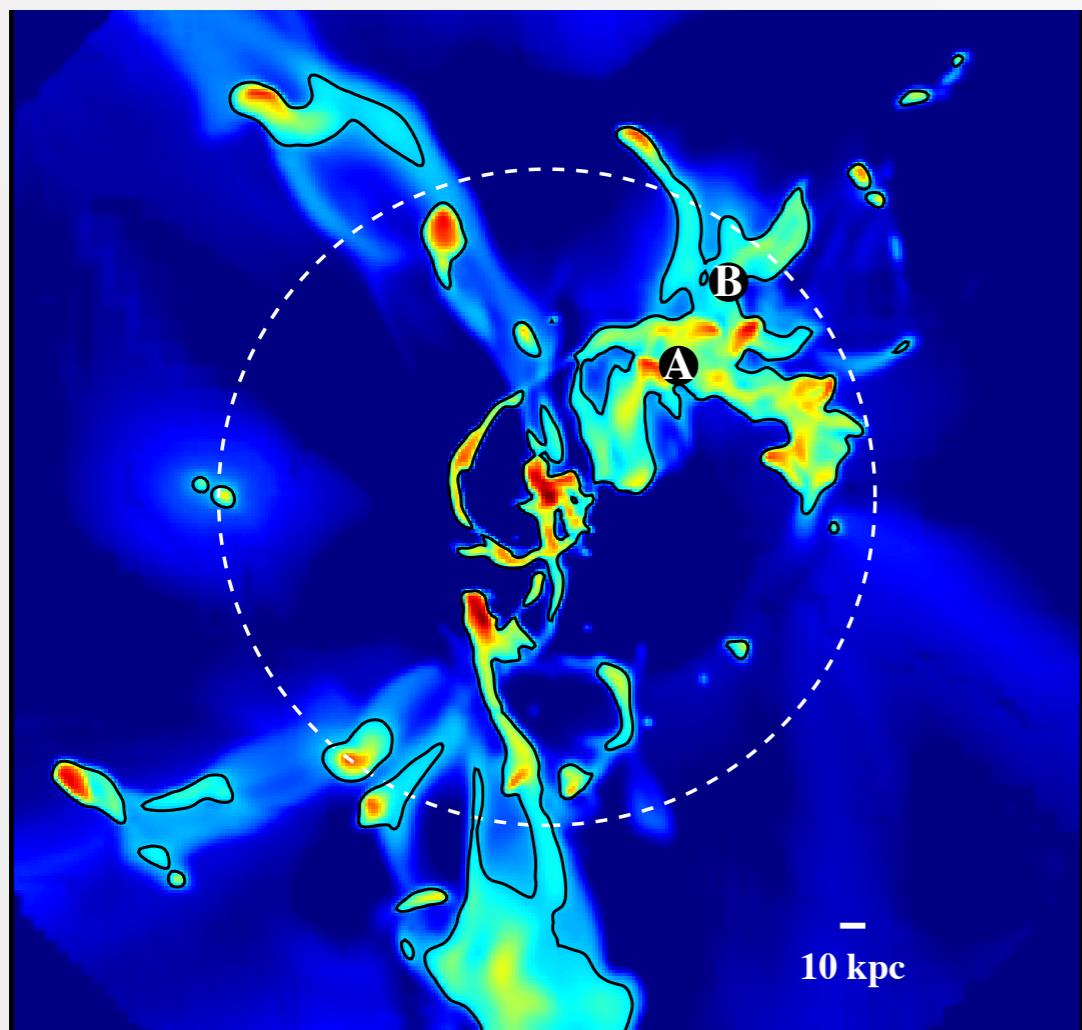
Searching for Protoclusters

Cai+16b



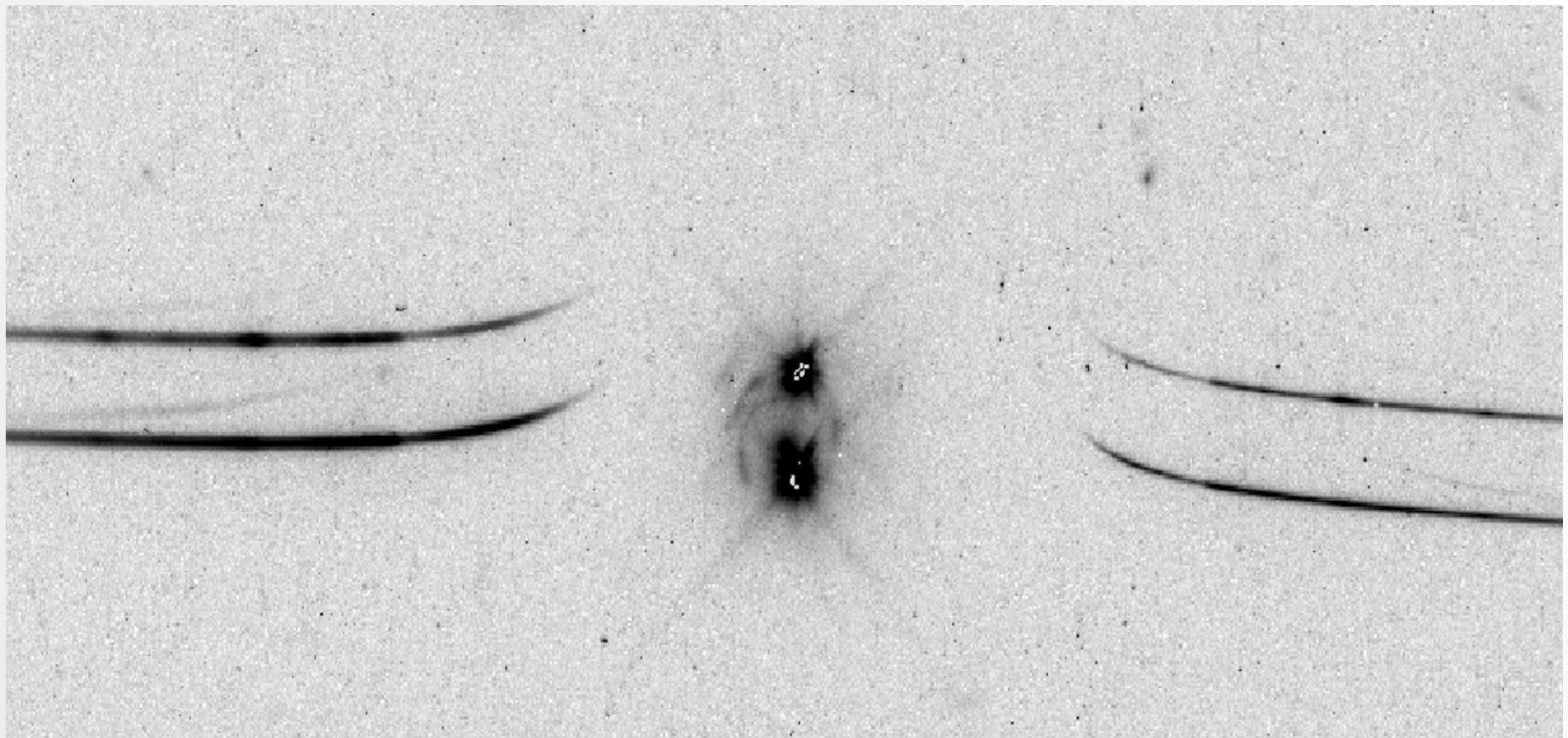
Dissecting Galaxy Halos

Fumagalli, Hennawi+



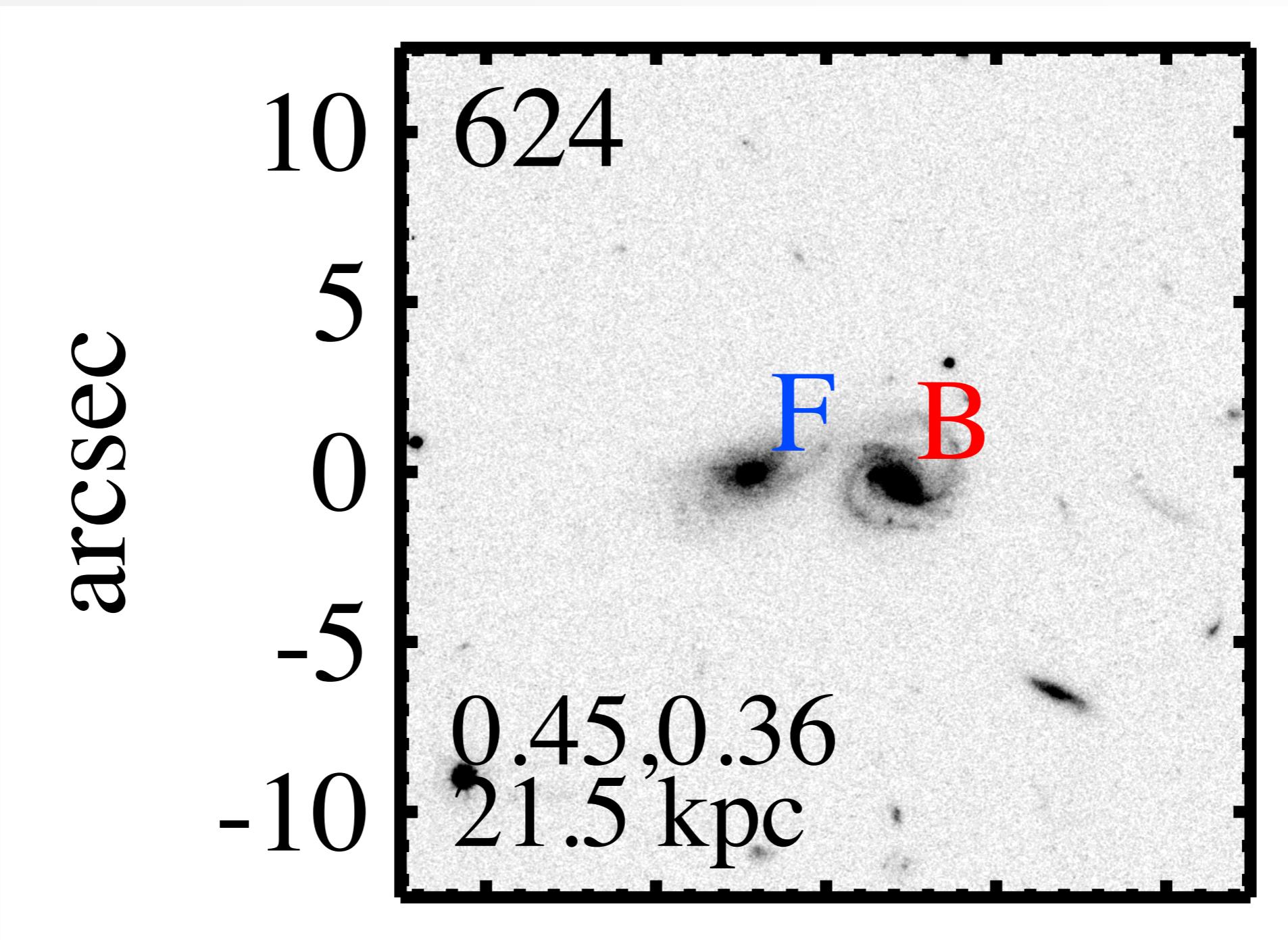
Dissecting Galaxy Halos

Fumagalli, Hennawi+



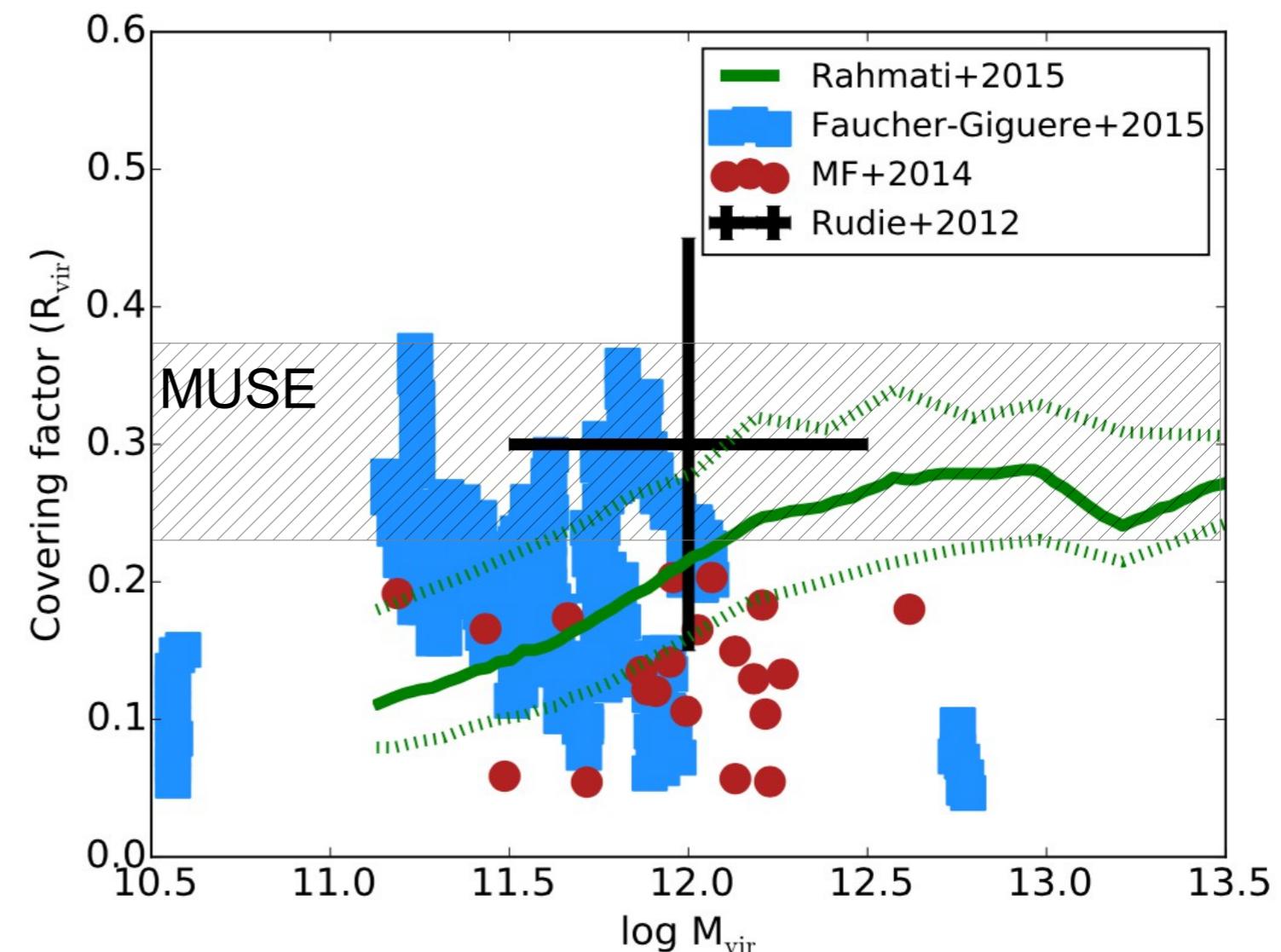
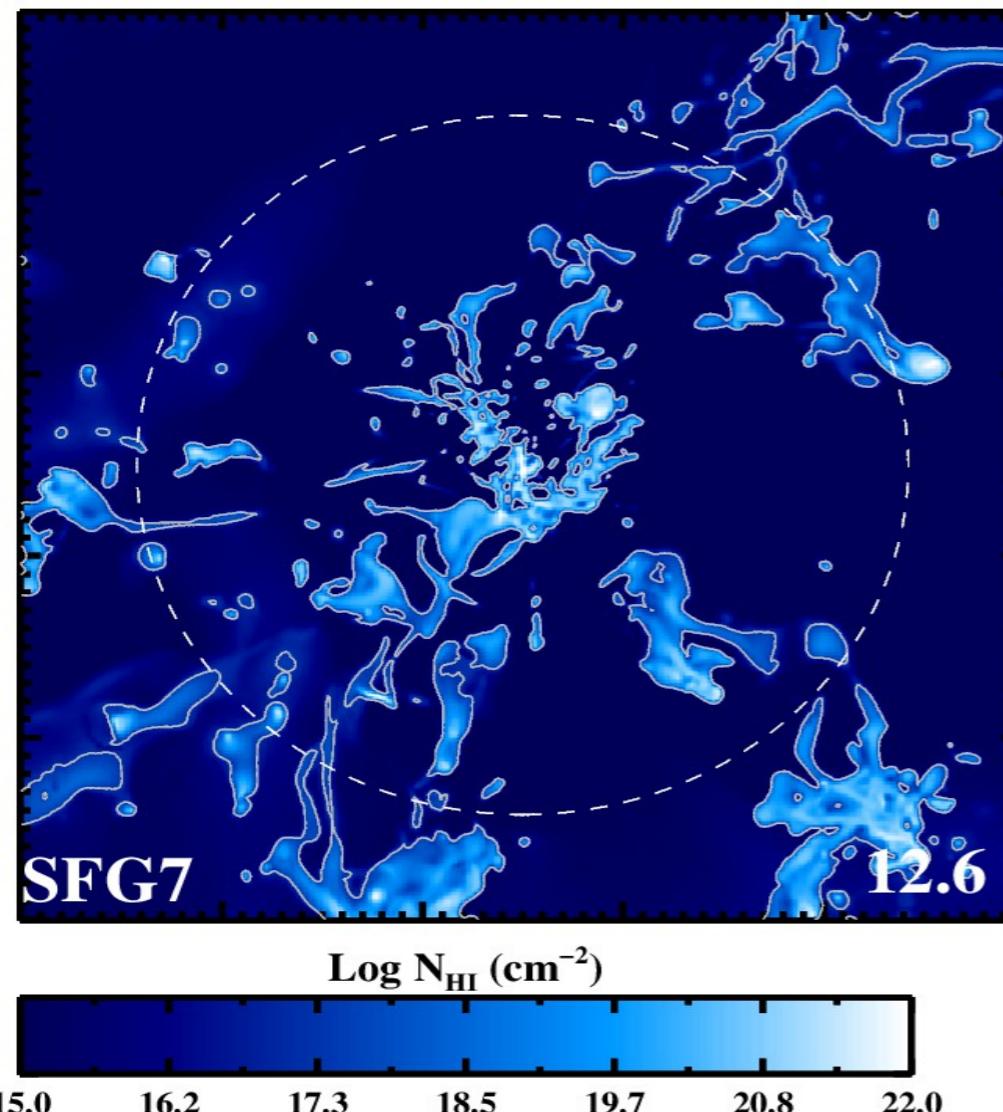
Dissecting Galaxy Halos

Rubin+



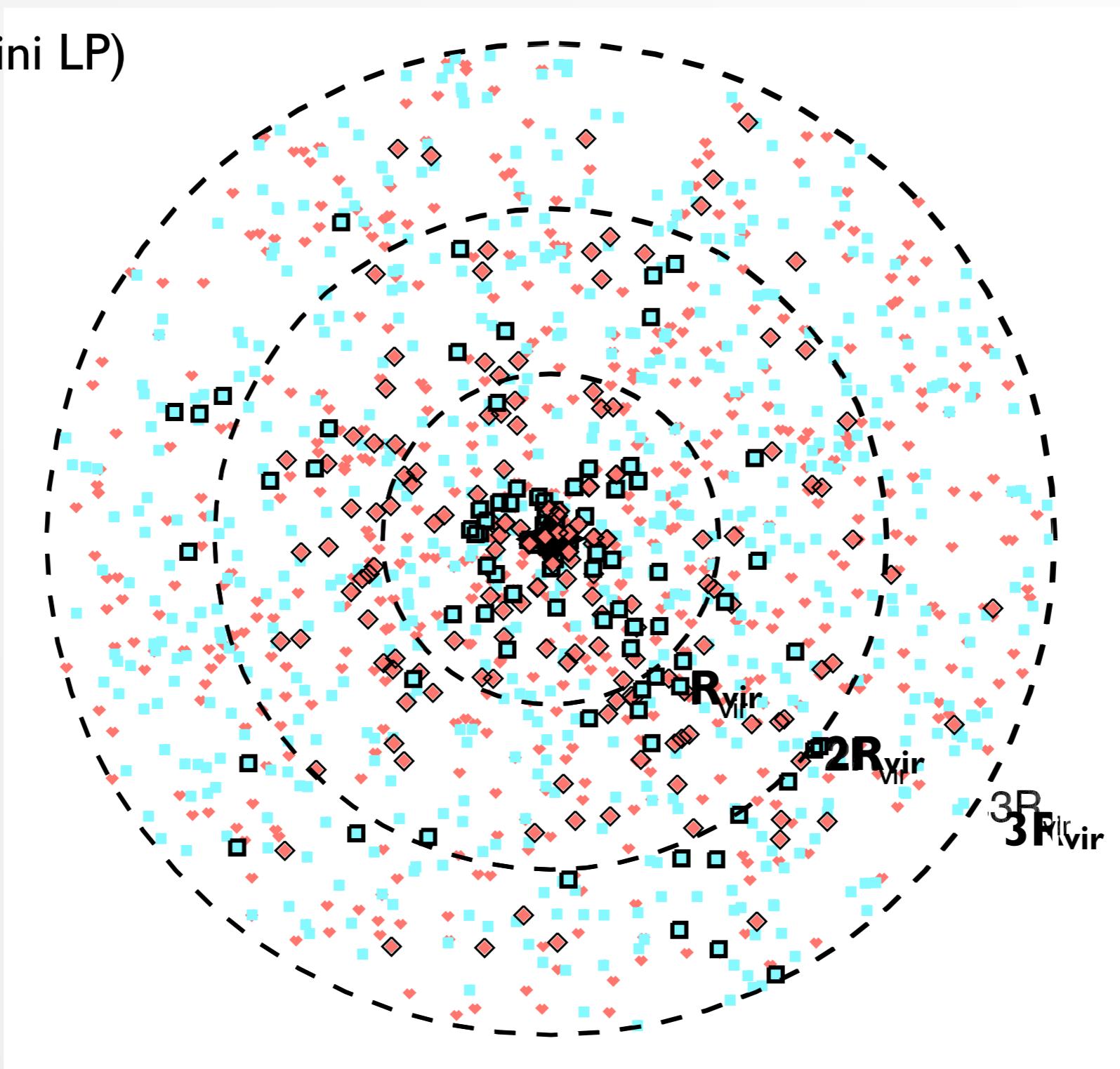
Galaxy-HI Absorption Association

Fumagalli (PI: MUSE LP)



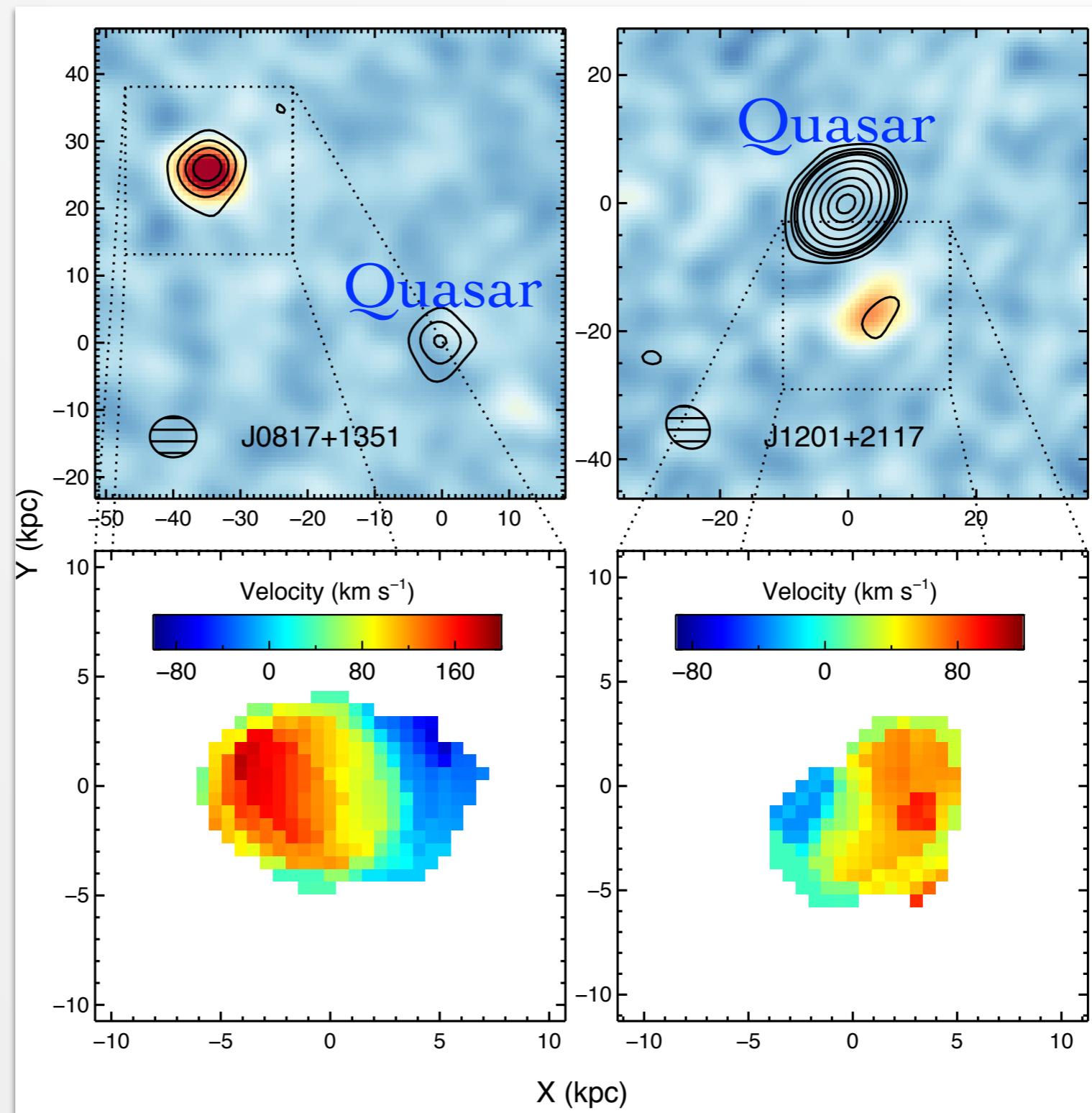
Galaxy-HI Absorption Association

Werk (PI: Gemini LP)

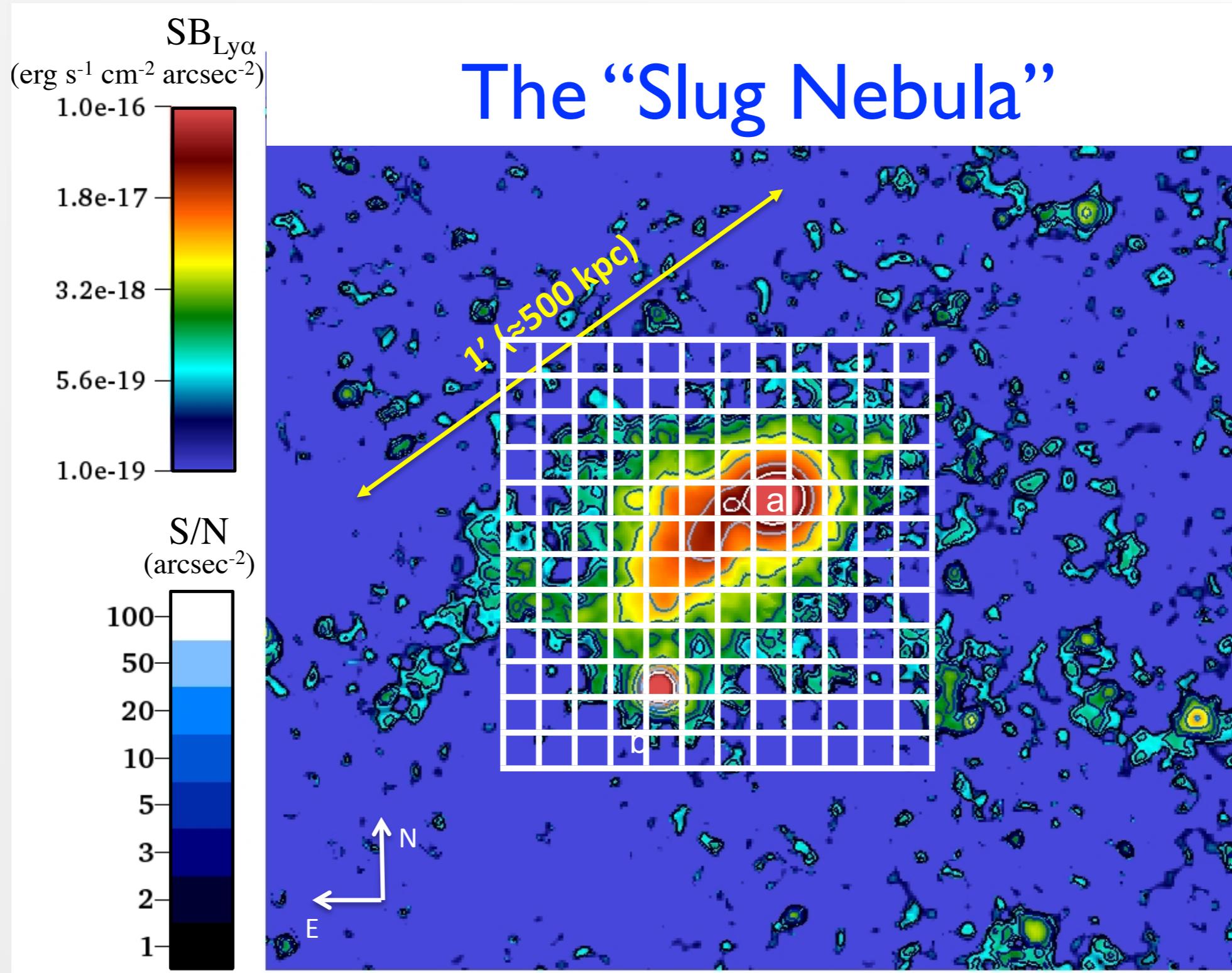


Galaxy-HI Absorption Association

Neeleman (ALMA)



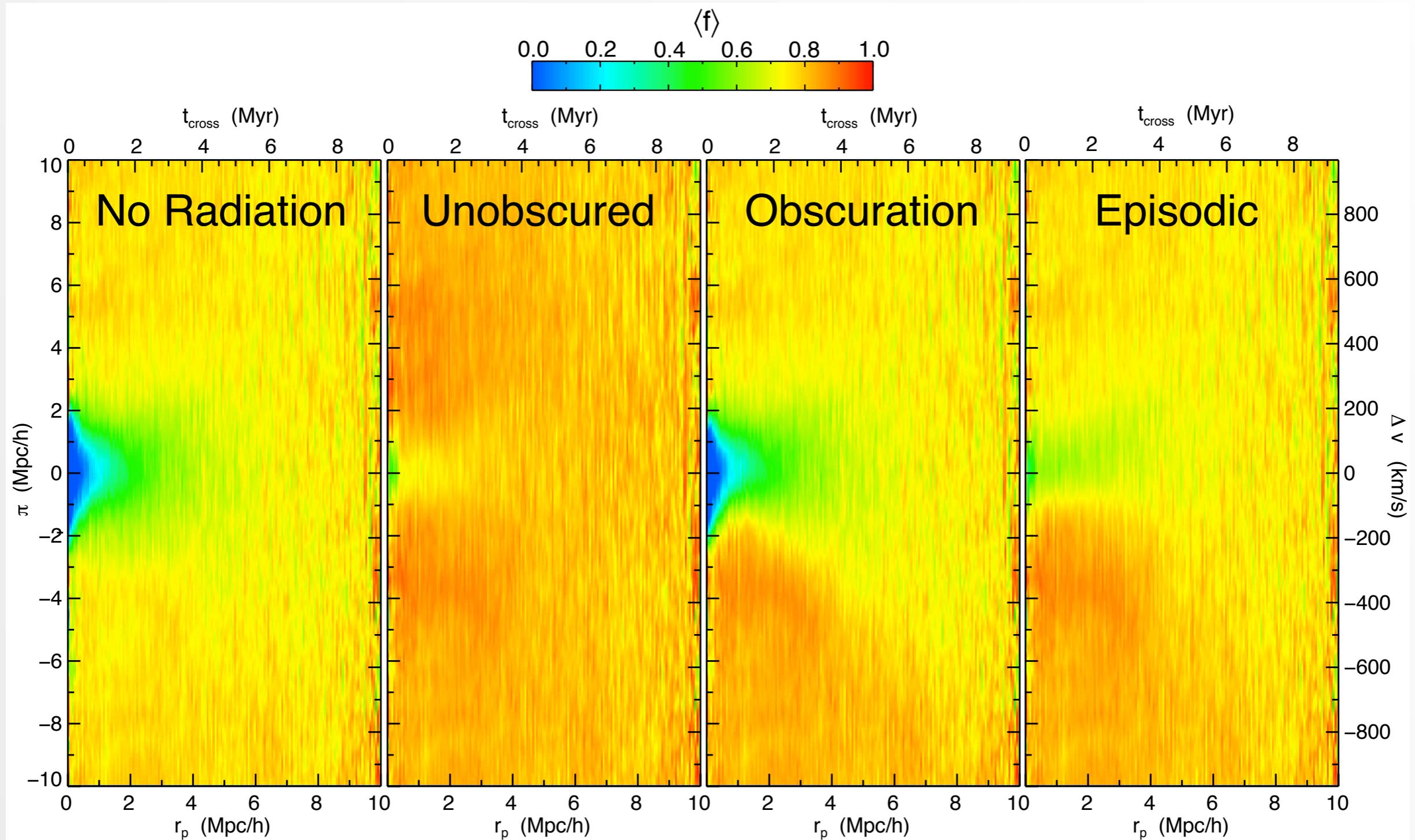
Martin (PI)



Resolving Quasar Emission

Hennawi+

Transverse Proximity Effect



ELT IGM

$$\frac{dz_{|\chi}}{dt_{\text{obs}}}(t_{\text{obs}}) \approx \frac{z_{|\chi}(t_{\text{obs}} + \Delta t_{\text{obs}}) - z_{|\chi}(t_{\text{obs}})}{\Delta t_{\text{obs}}}$$

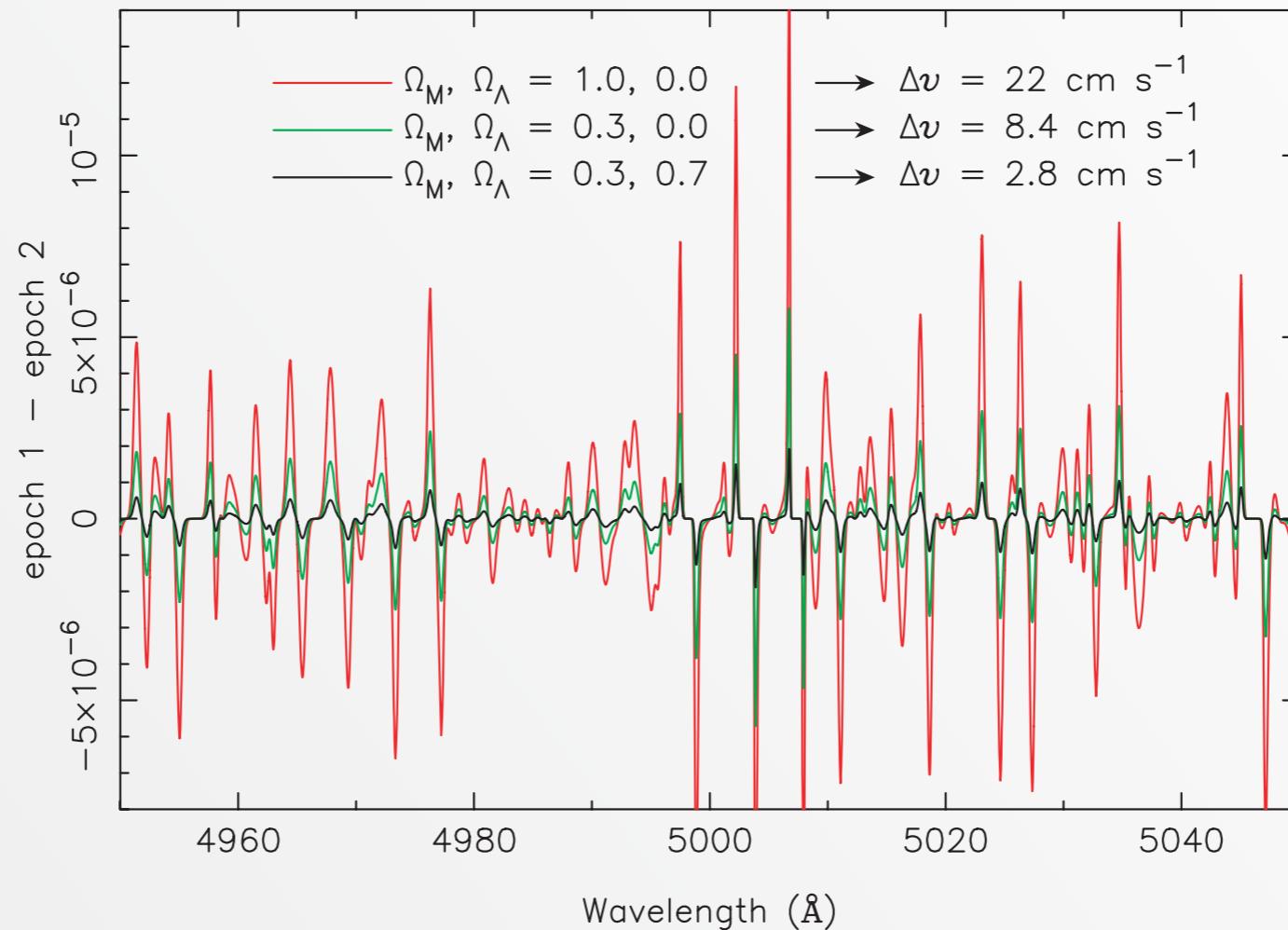


Figure 6. Flux difference between two artificial, noiseless spectra of the same Ly α forest at $z \approx 3$ simulated for two observing epochs separated by $\Delta t_0 = 10$ yr and for various combinations of Ω_M and Ω_Λ as indicated. The redshift drift implied by these parameters is also given.

Fini

