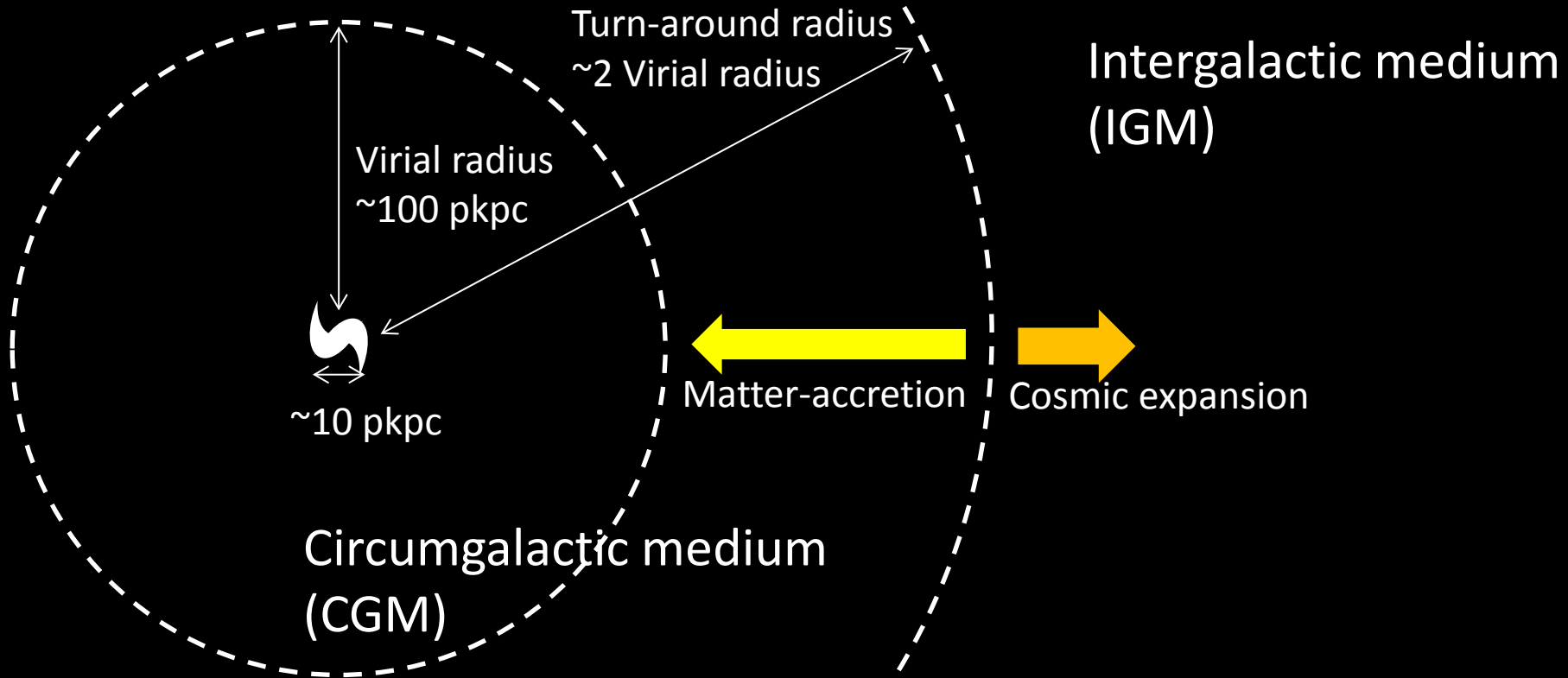


Subaru/PFSによる周銀河間媒質・ 銀河間媒質探査の展望

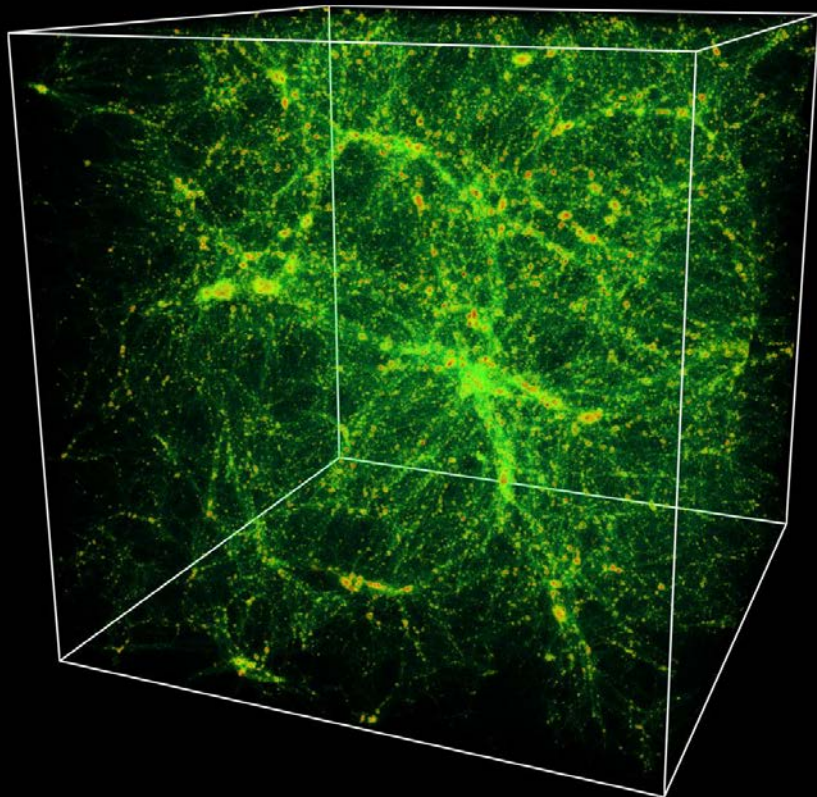
井上昭雄（大阪産業大学）

銀河、周銀河媒質、銀河間媒質

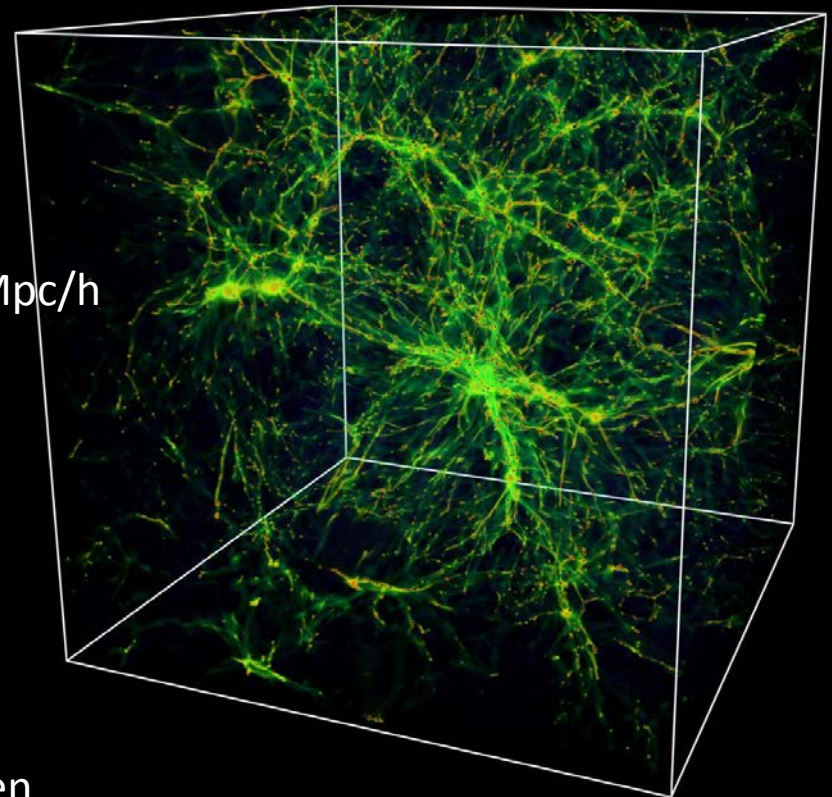


Cosmic Web

Dark matter density @ $z=3$



Gas density @ $z=3$

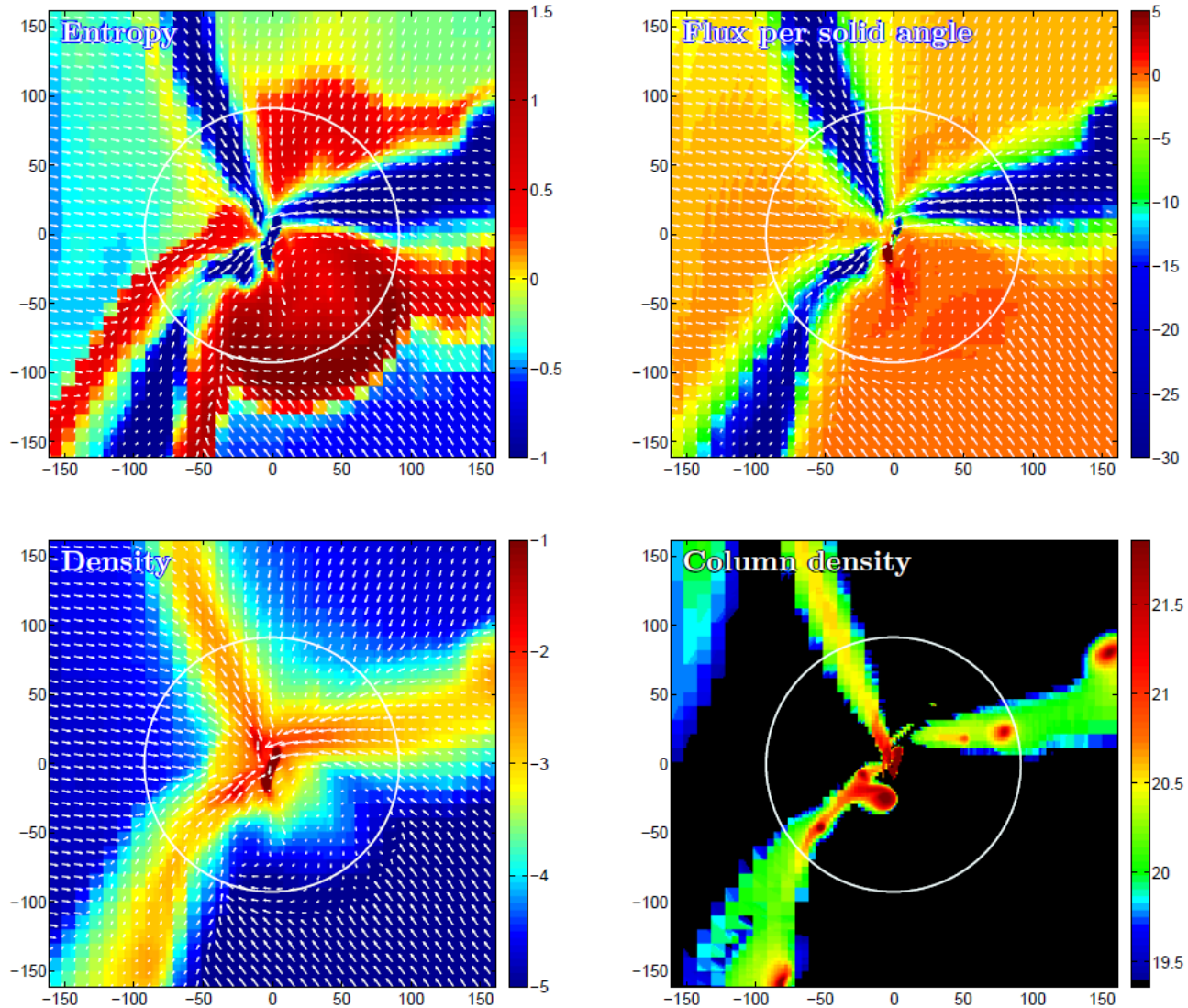


25 cMpc/h

R. Cen

Cold stream

Dekel et al. 2009 Nature
1e12 Msun halo at $z=2.5$

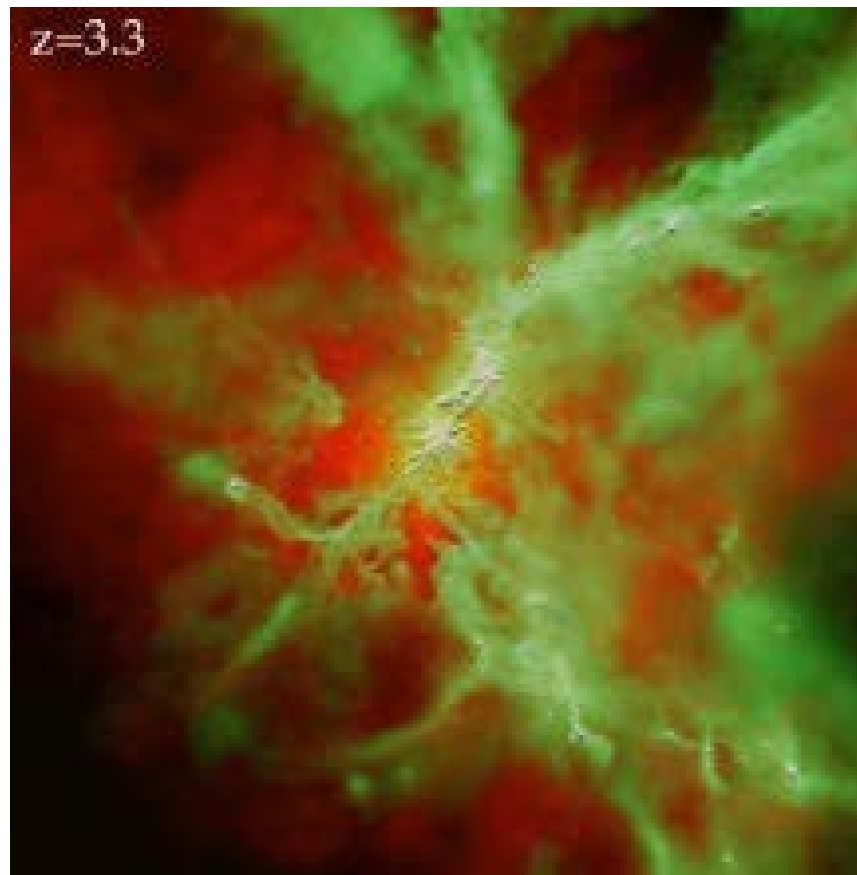


Outflow

P. Hopkins



- A Milky Way like galaxy ($M_{\text{halo}}=1e12 \text{ Msun}$)

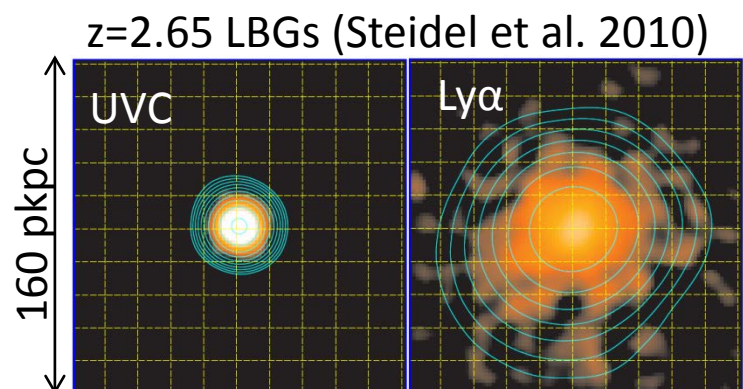


Gas (cold, warm, hot)
200 pkpc

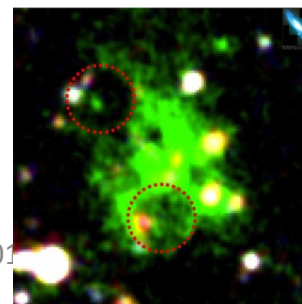
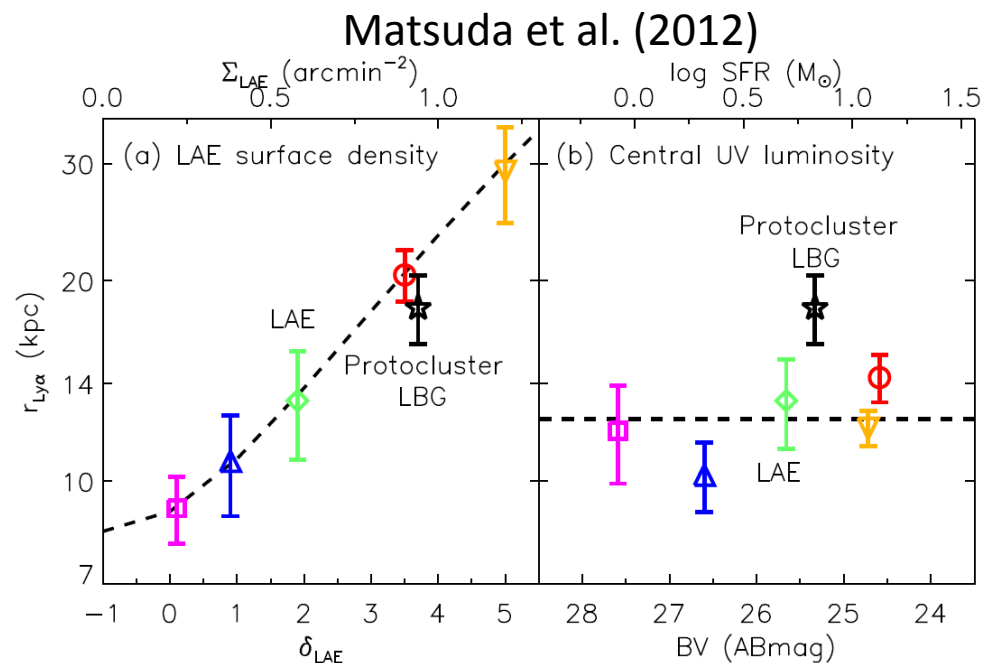
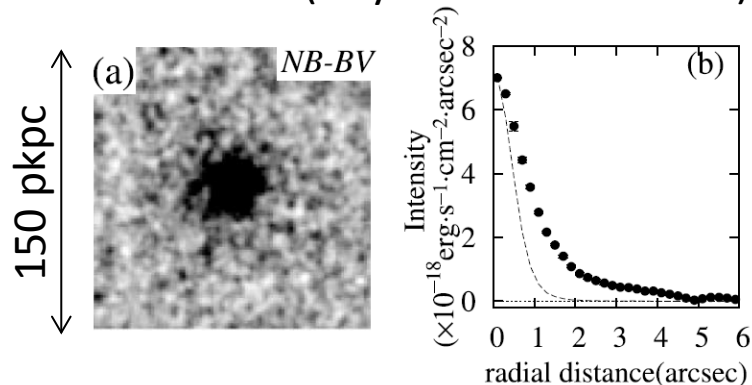
Emitting CGM

See also Momose et al. (2014)

- Ly α halo around LBGs/LAEs, Ly α blobs (LABs)



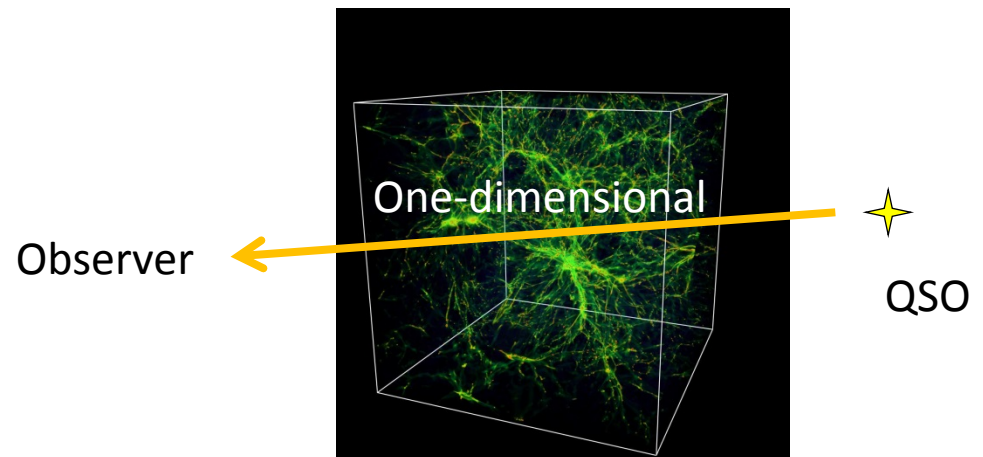
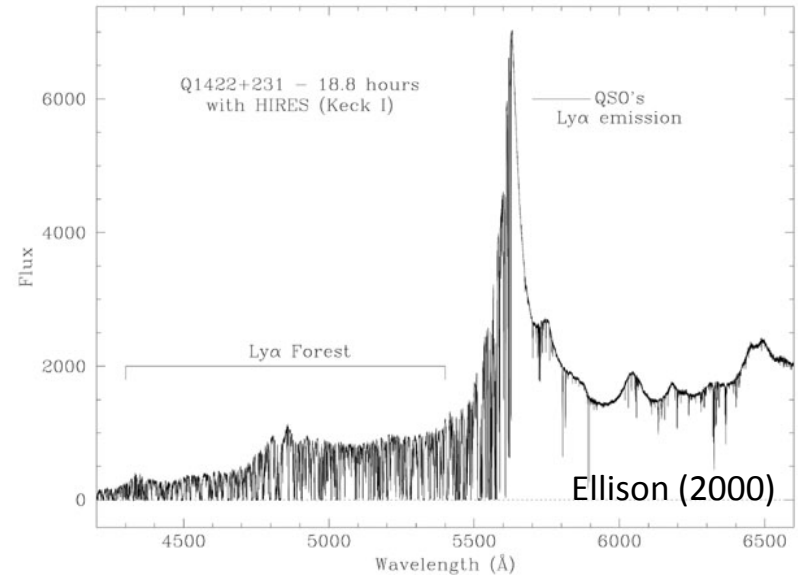
$z=3.1$ PC LBGs (Hayashino et al. 2004)



LAB1
(Matsuda et al. 2004)

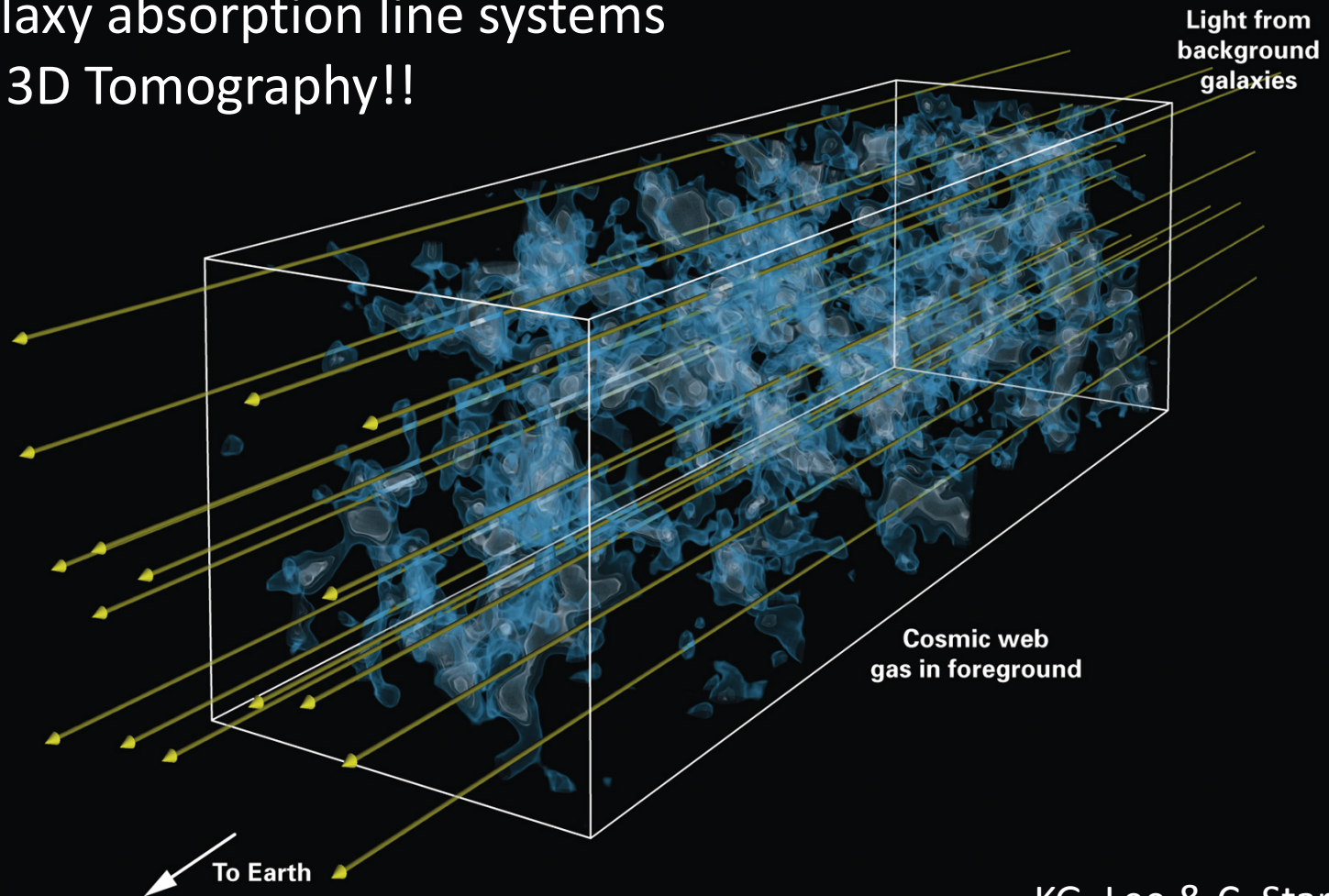
IGM: QSO absorption line systems

- Ly α forest (LAF)
 $\log(N_{\text{HI}}/\text{cm}^2) < 17.2$
- Lyman limit system (LLS)
 $\log(N_{\text{HI}}/\text{cm}^2) > 17.2$
- Damped Ly α system (DLA)
 $\log(N_{\text{HI}}/\text{cm}^2) > 20.3$
- Metal line system



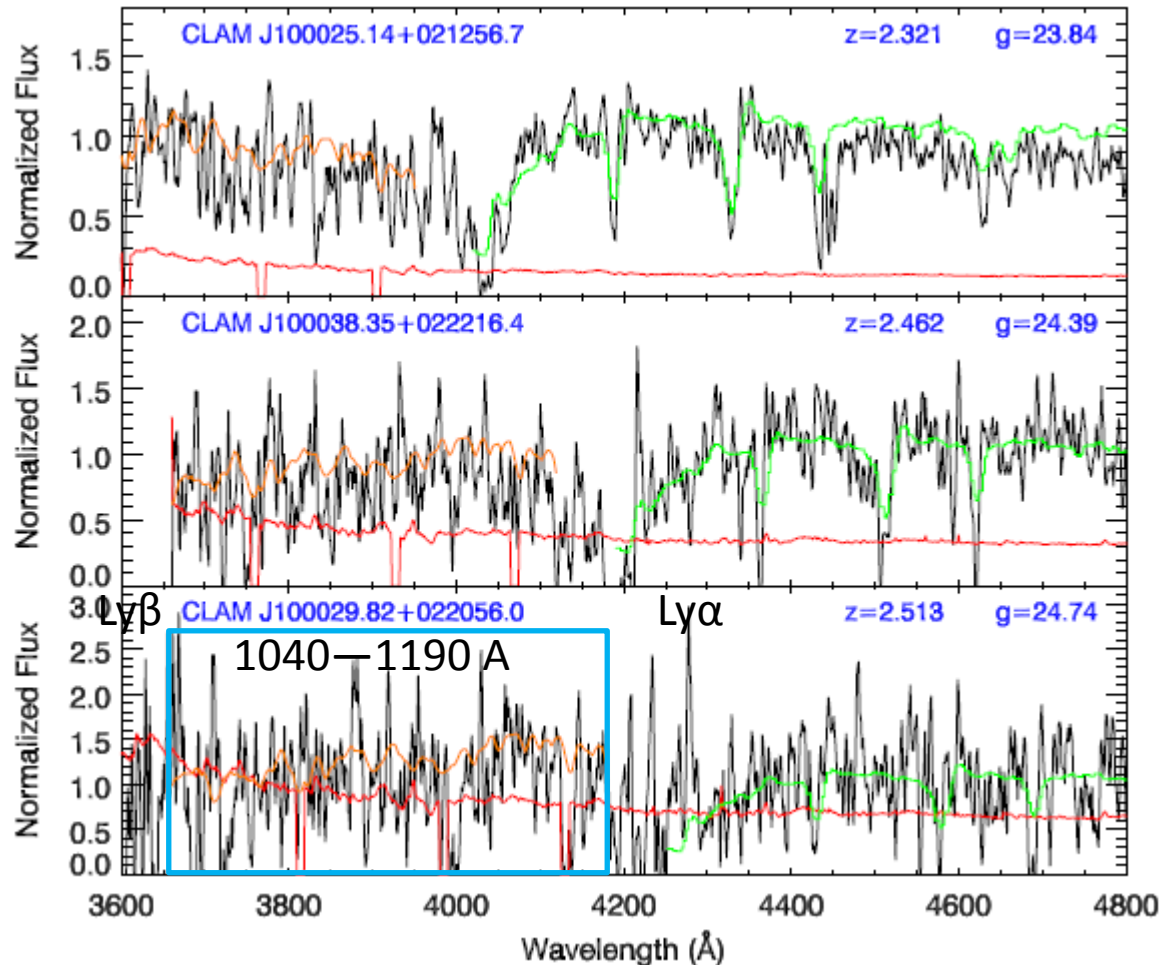
IGM tomography: Lee et al. (2014)

Galaxy absorption line systems
→ 3D Tomography!!



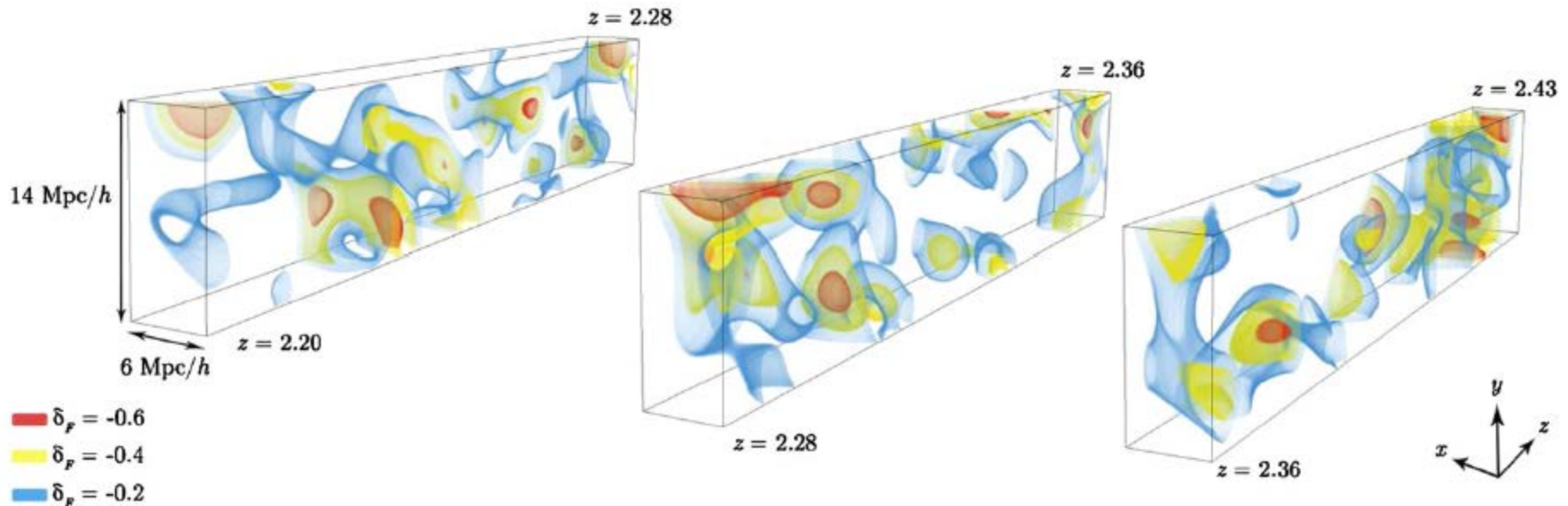
KG. Lee & C. Stark

IGM tomography: Lee et al. (2014)



IGM tomography: Lee et al. (2014)

24 LBGs at $z=2.3-2.8$ within $5' \times 14'$

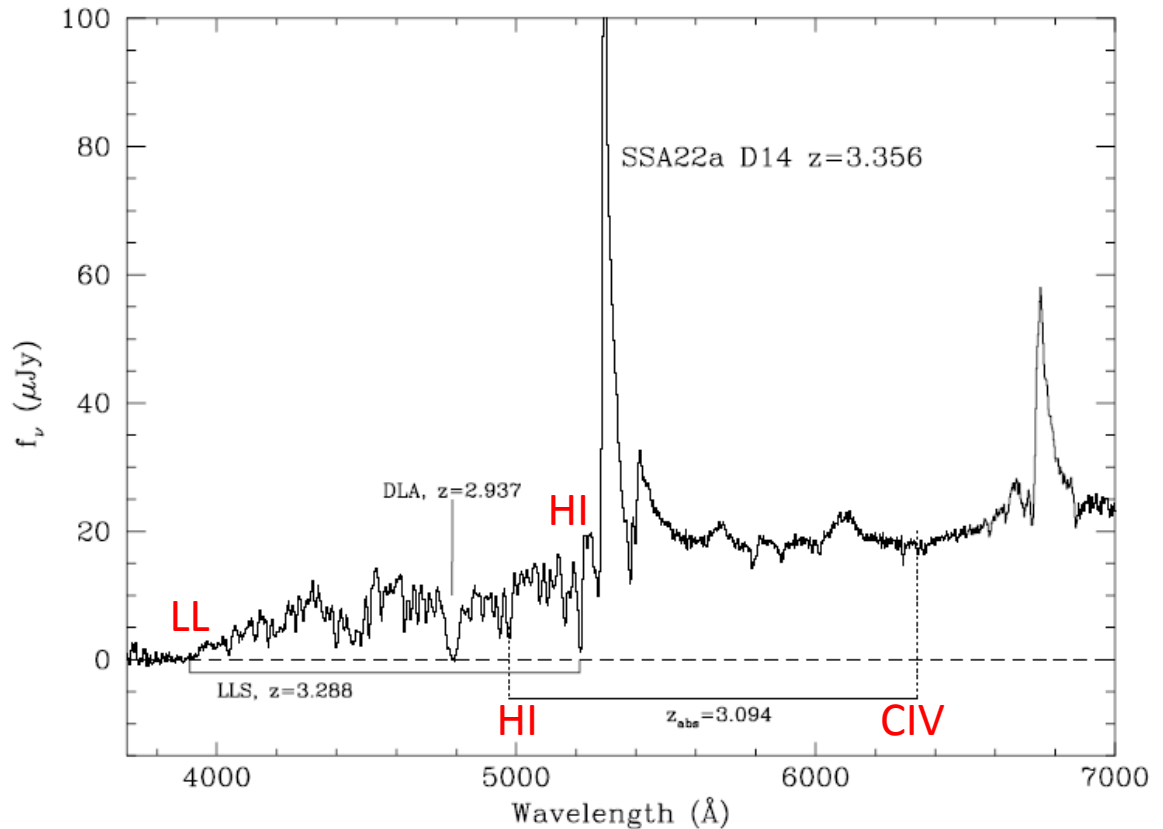
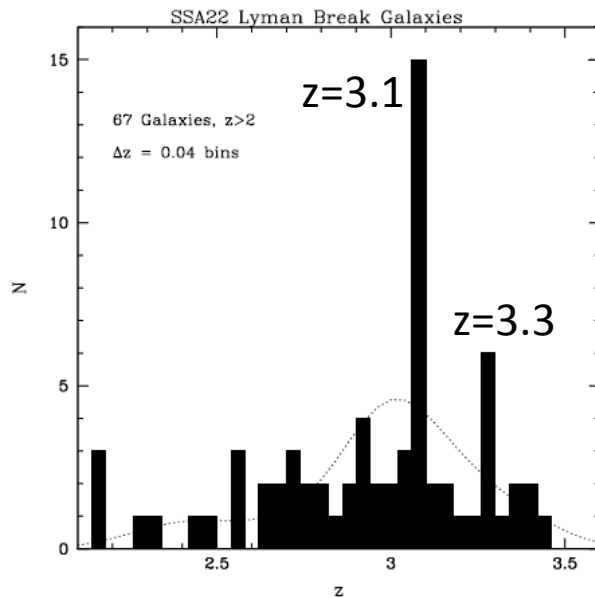


$$\delta_F = F / \langle F \rangle(z) - 1$$

Mean IGM transmission

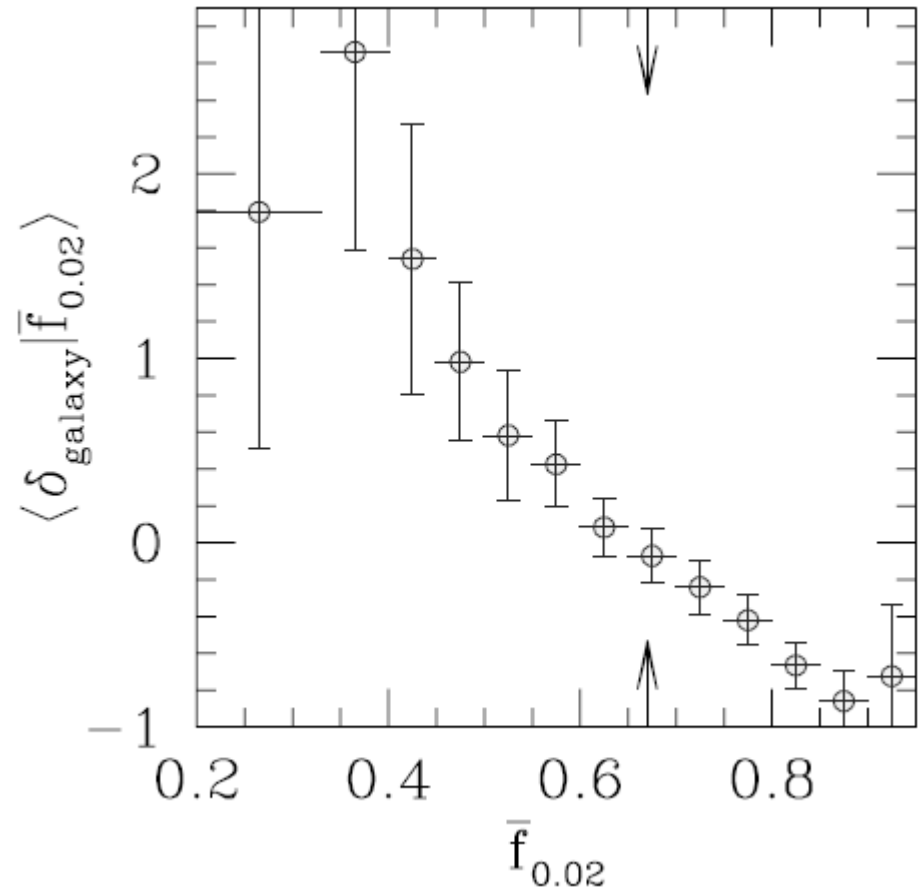
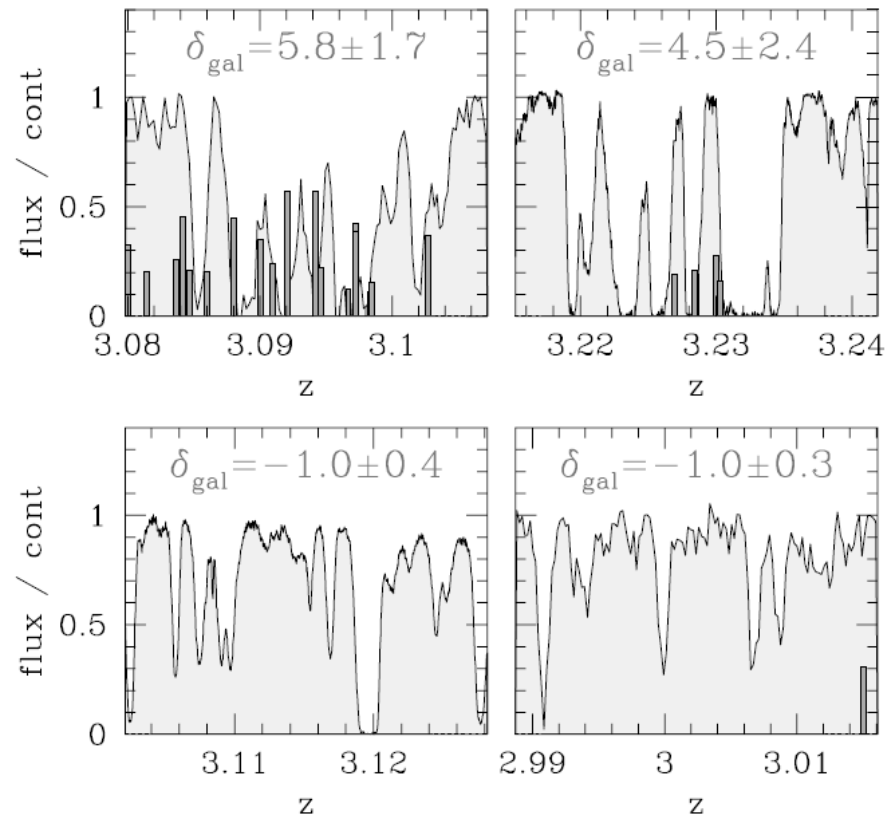
Continuum normalized flux = IGM transmission

IGM-galaxy: Steidel et al. (1998)



IGM-galaxy: Adelberger et al. (2003)

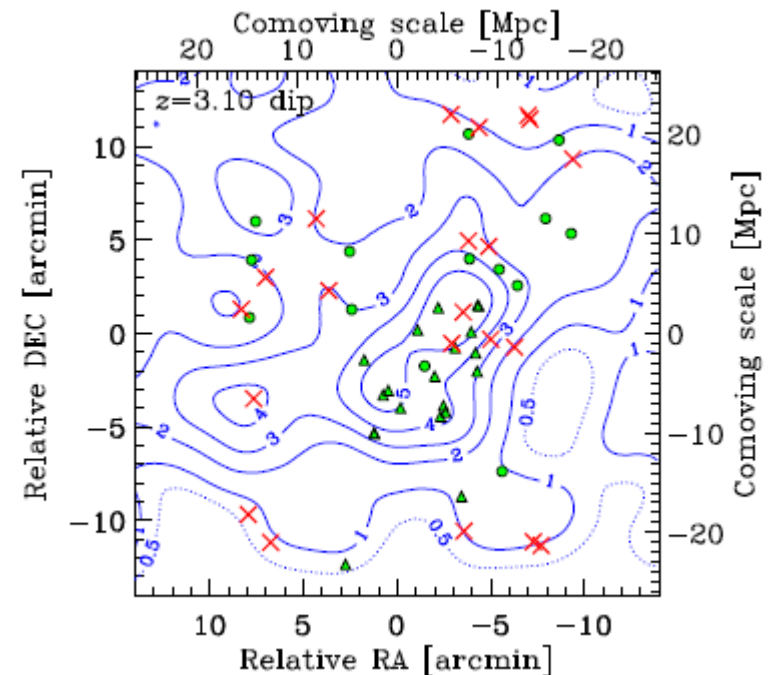
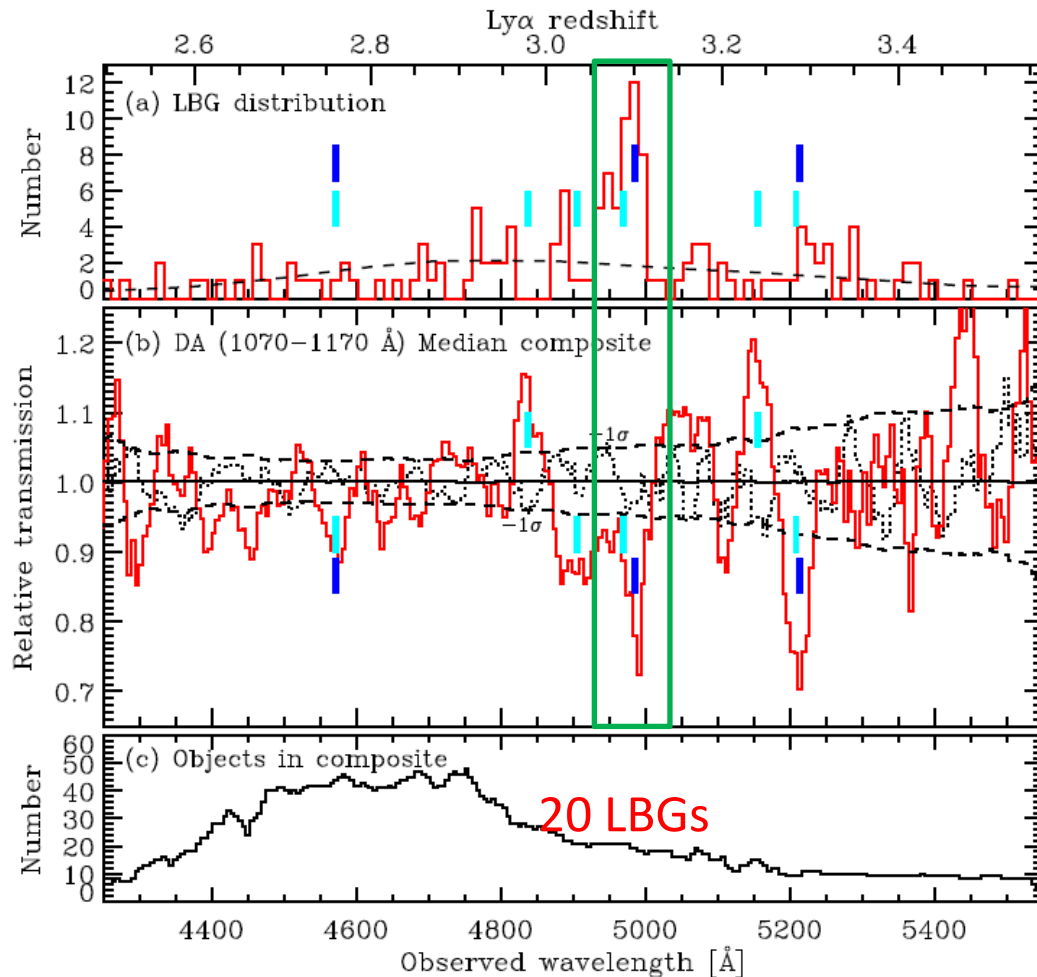
Galaxy-QSO absorption lines correlation analysis



Transmission over $dz=0.02$

IGM-galaxy: Hayashino et al. in prep.

HI enhancement at $z=3.1$ proto-cluster in SSA22

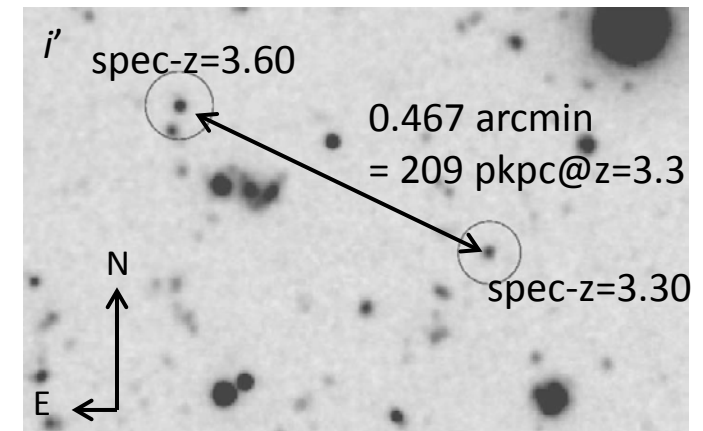
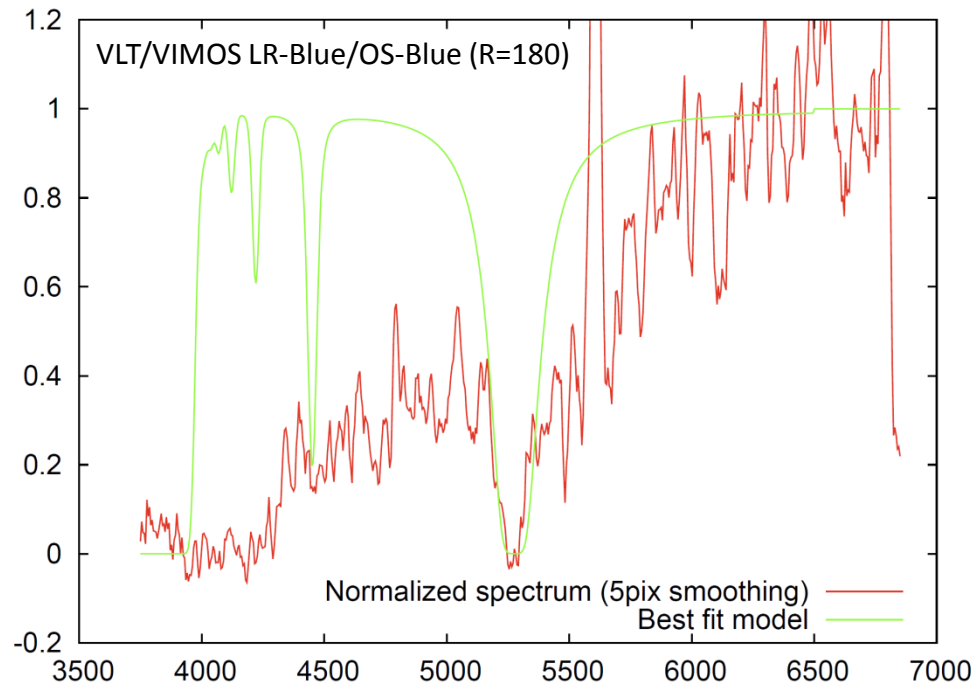


“galDLA”: DLA in a galaxy spectrum

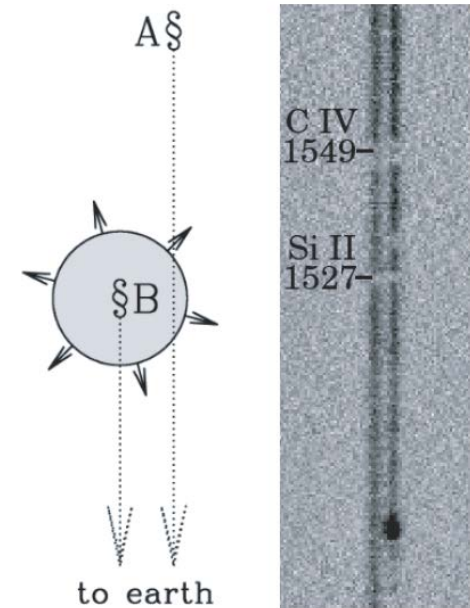
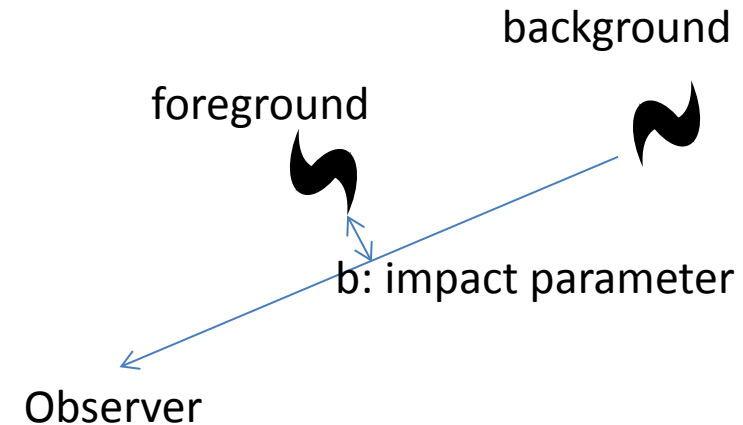
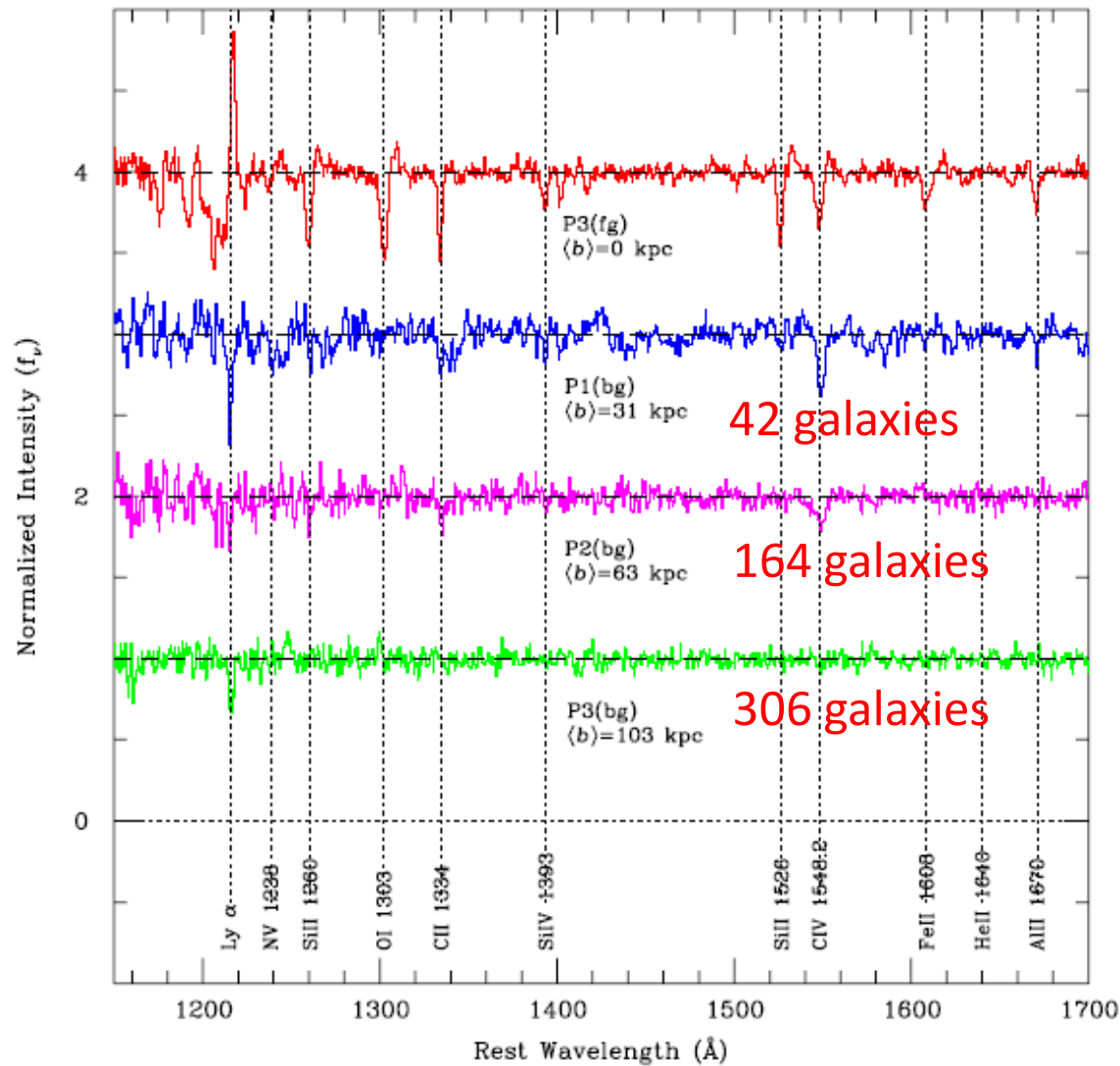
Mawatari et al. in prep.

- Extremely strong DLA ($>5e21 \text{ cm}^{-2}$)

$z=3.34$ $\log_{10}(N_{\text{H I}}/\text{cm}^{-2})=22.19+0.20-0.16$ ($b=10-100 \text{ km/s}$)

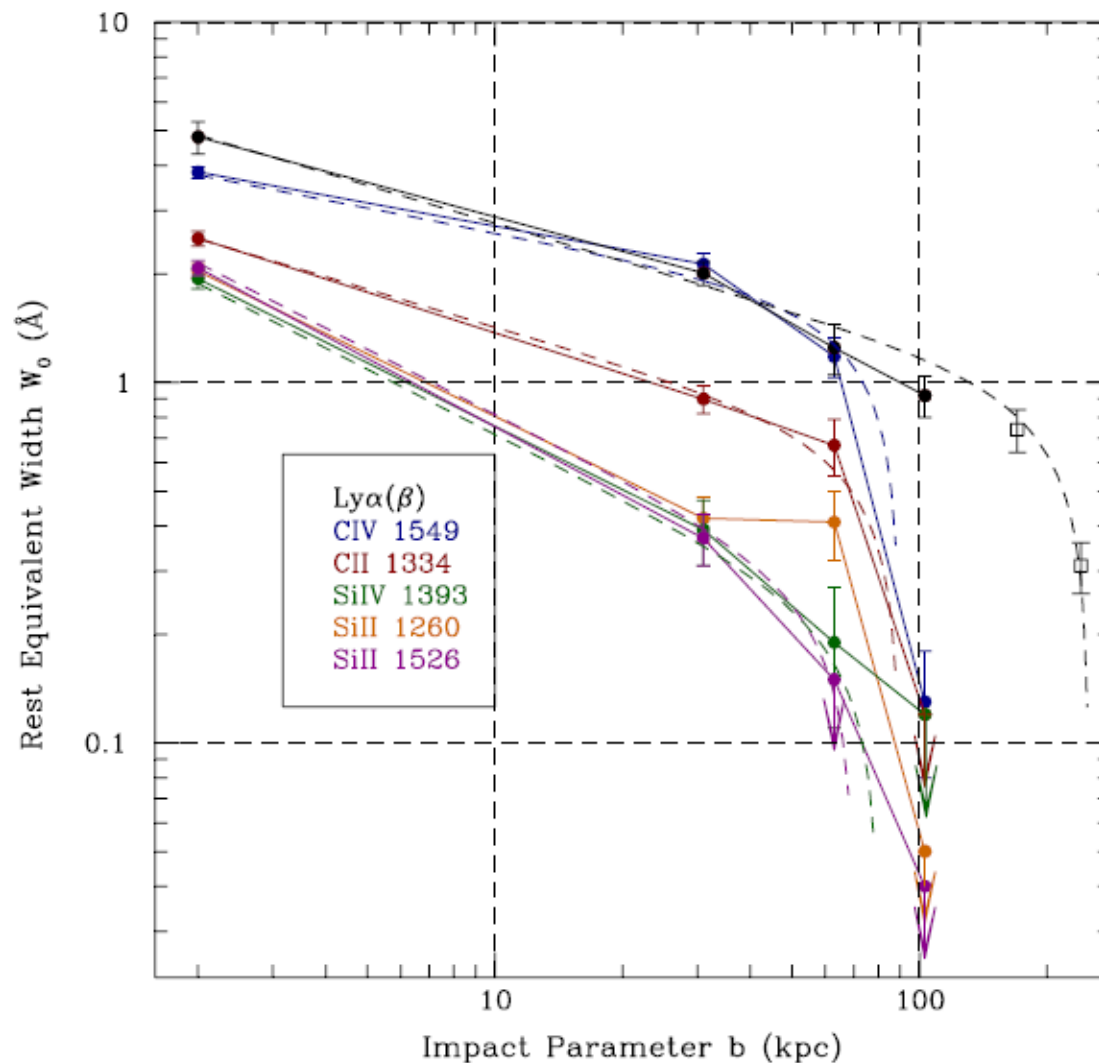


CGM: Steidel et al. (2010)

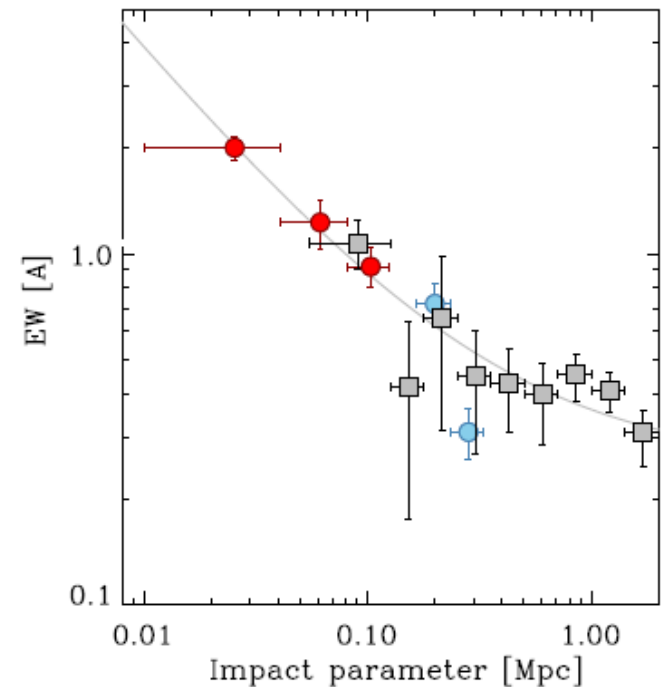
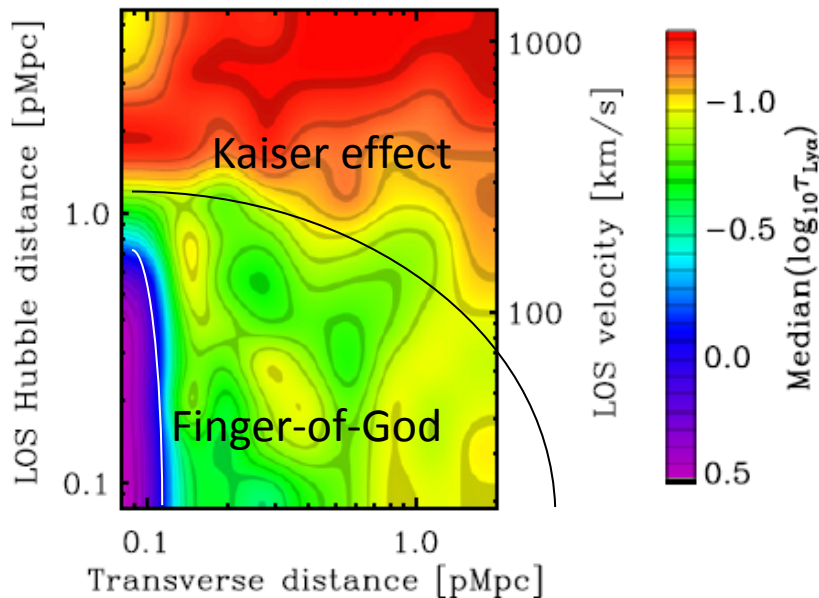
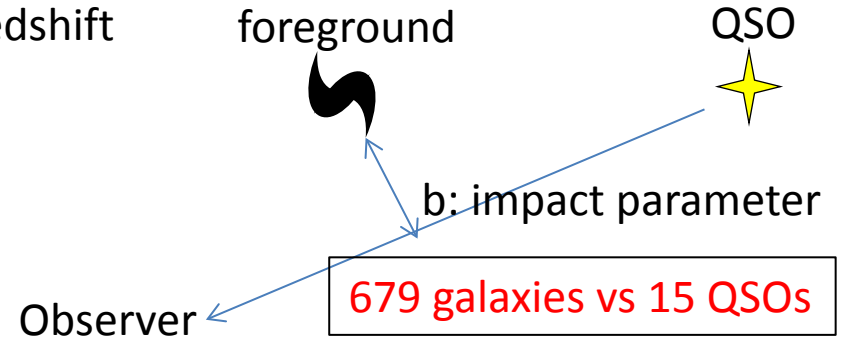
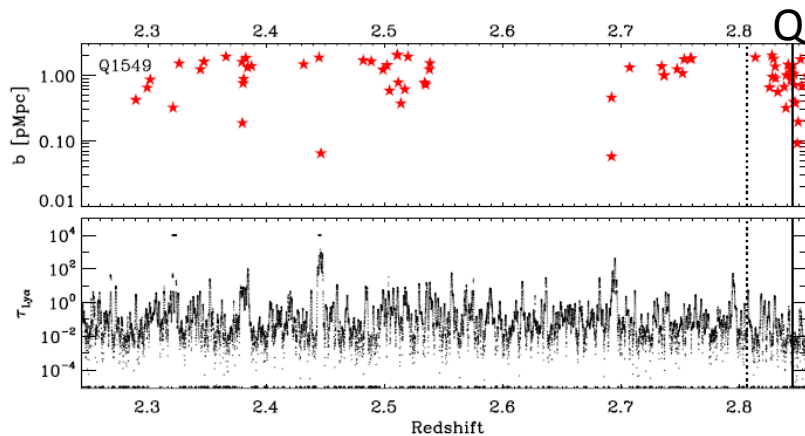


Adelberger +05

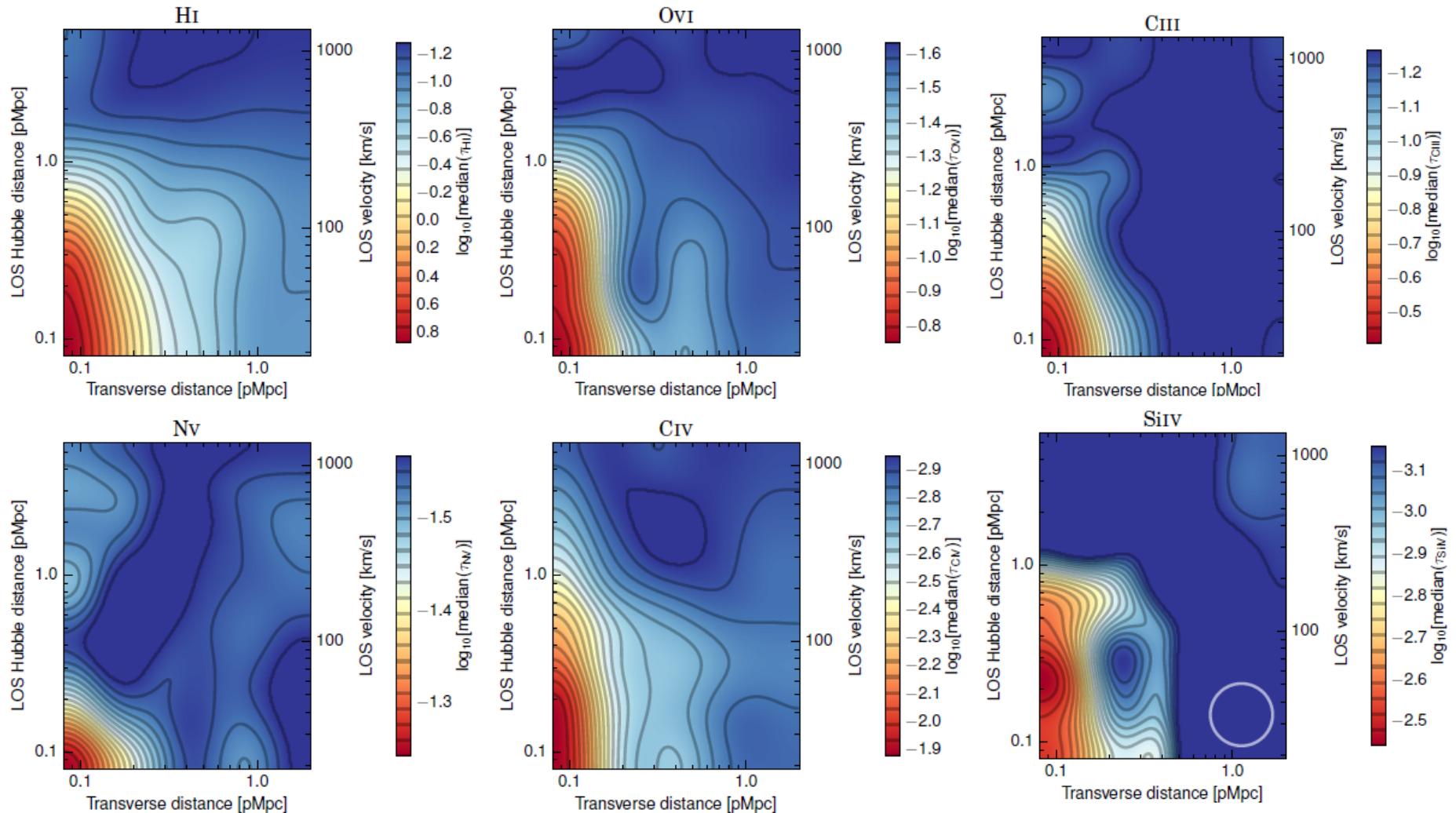
CGM: Steidel et al. (2010)



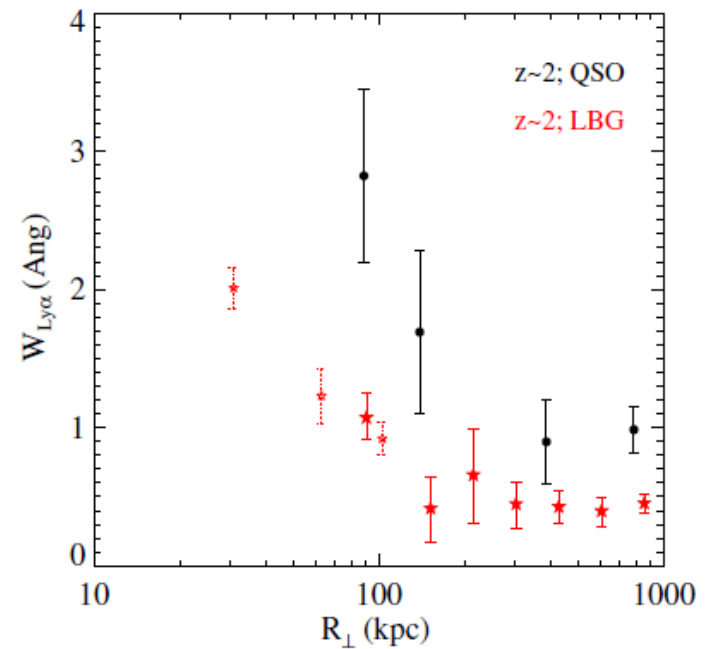
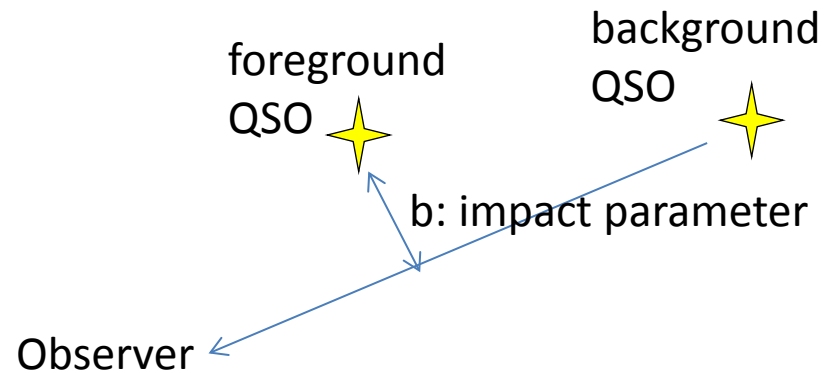
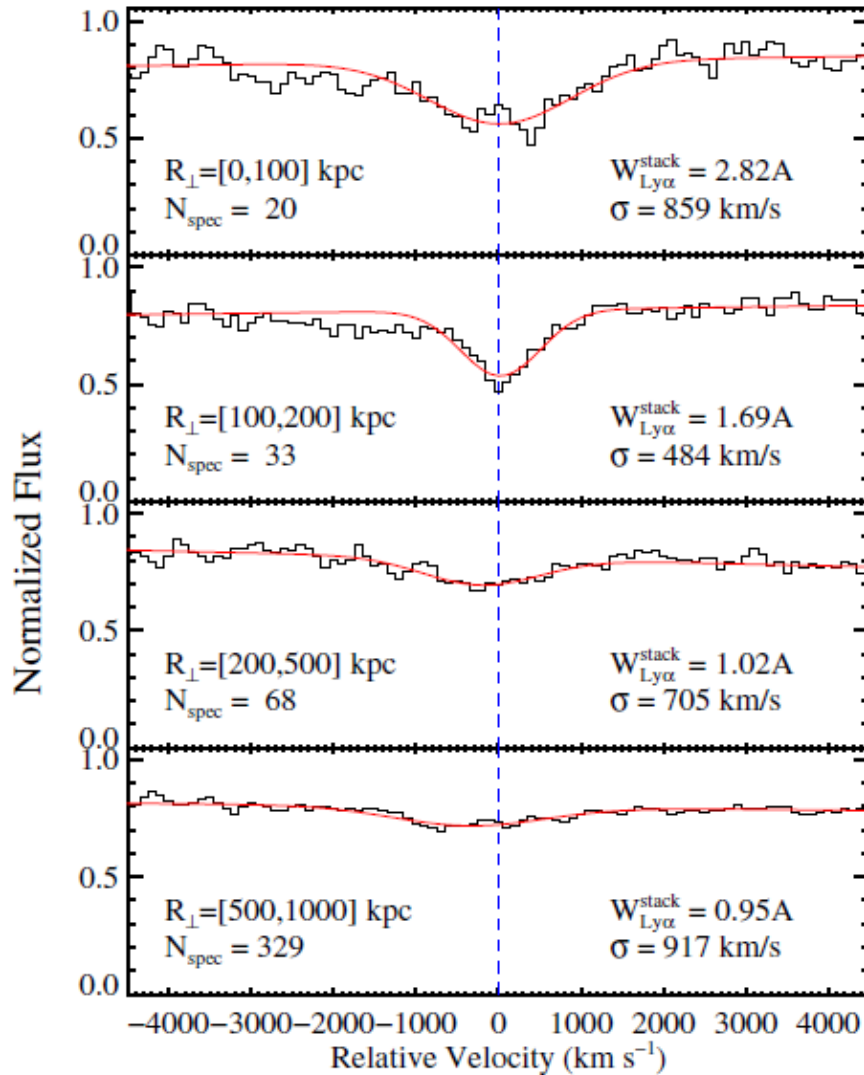
CGM: Rakic et al. (2012)



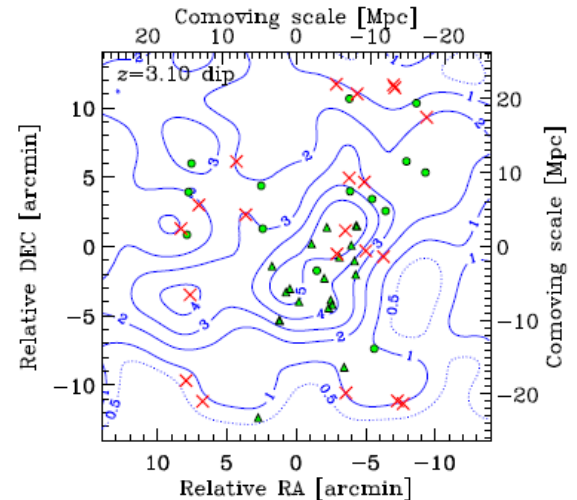
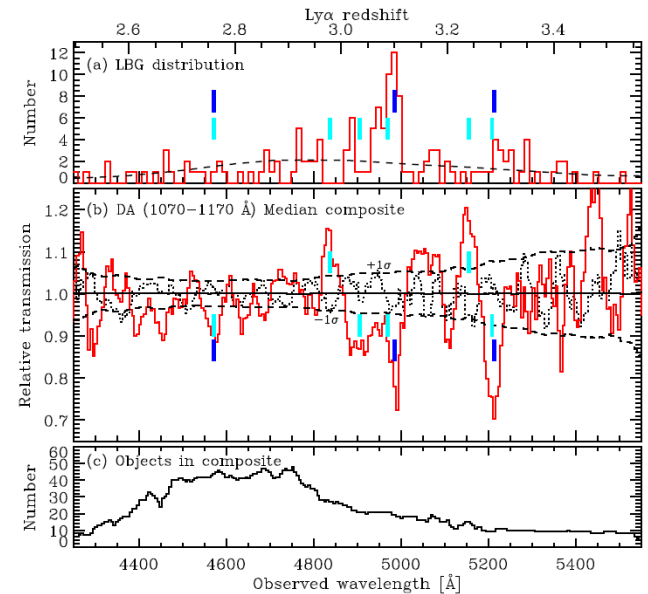
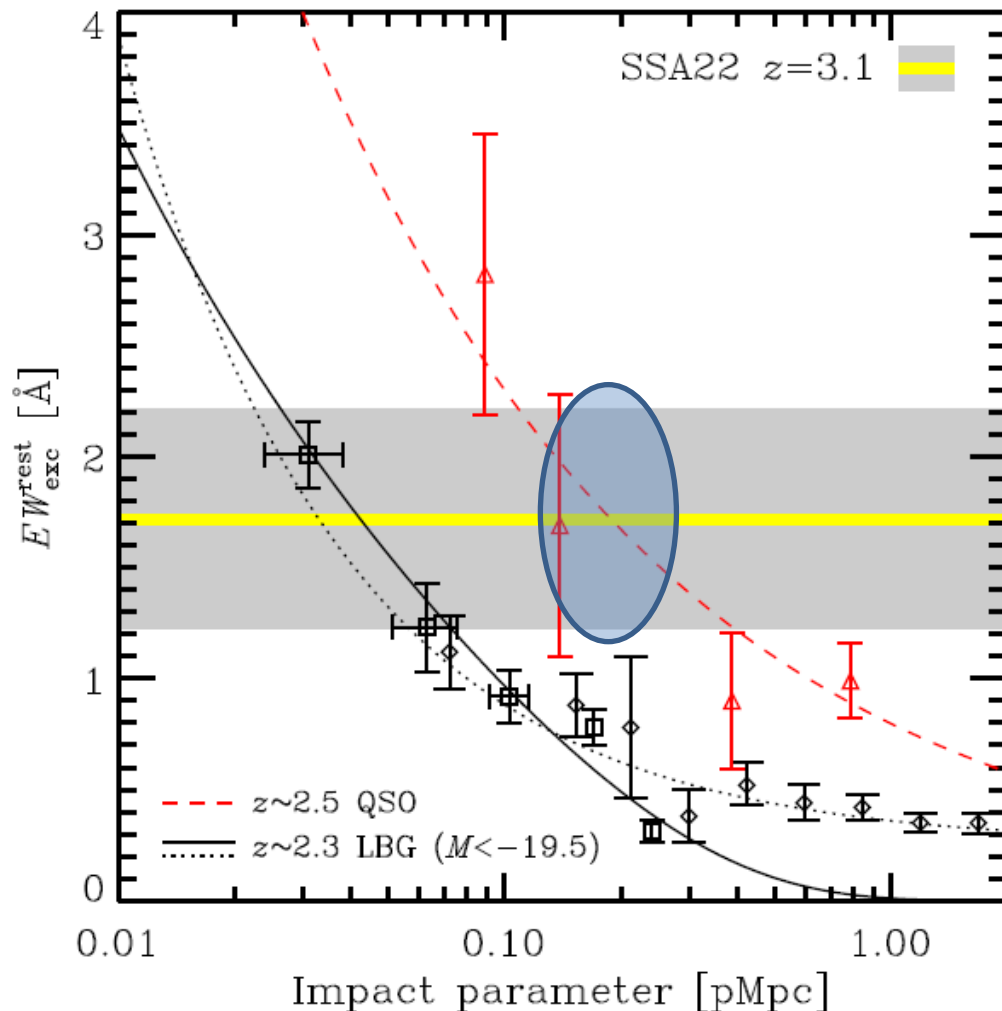
CGM: Turner et al. (2014)



CGM: Prochaska et al. (2013)



Intra-proto-cluster medium?

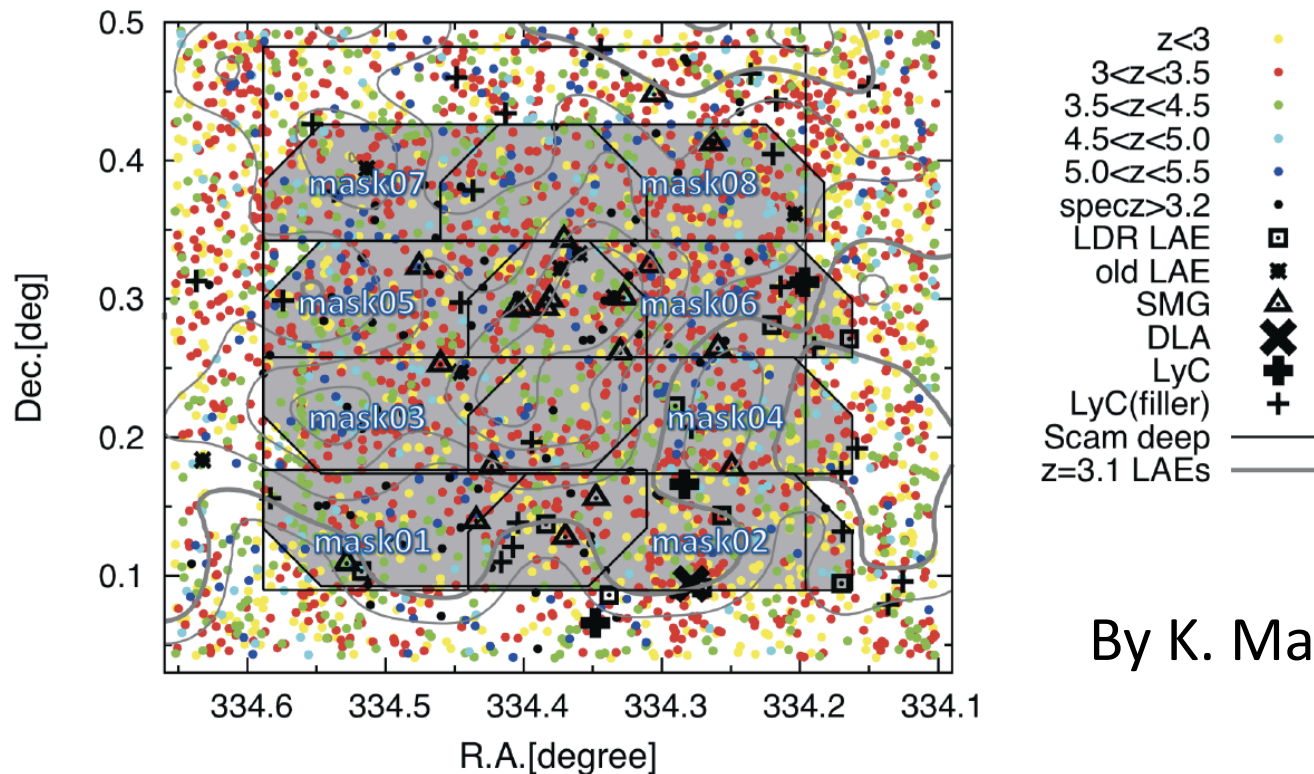


SSA22 HIT with DEIMOS

HIT=HI Tomography

- 5 nights (Subaru 2/UC 3) → ~700 slits

Sky distribution: All targets (to be updated)



By K. Mawatari

CGM/IGM survey with Subaru/PFS

- LBG ($2 < z < 3$, $m < 25_{AB}$) spectroscopy
 - 10 h on-source, Blue (450-550), $S/N > 2$ (3pix binning)
 - Target surface density $\sim 2/\text{arcmin}^2$ ($m < 25$)
 - 3 visits/FoV $\rightarrow \sim 5$ nights/FoV
 - $\sim 6,000$ spectra/FoV $\rightarrow > 10$ times larger sample
 - NIR arm is highly useful to detect optical nebular lines (but $\lambda < 1.25 \mu\text{m}$)
 $\rightarrow$ Accurate systemic redshift for CGM analysis
- Science goals
 - High spatial resolution (~ 1 cMpc) HI tomography
 - HI (& metal)-galaxies (& dark matter) cross-correlation: Cosmic Web
 - CGM survey
 - HI cold accretion
 - Metal enrichment in CGM/IGM
 - CGM as a function of luminosity and environment
 - “galDLA” survey
 - DLA and counterpart galaxies
 - Metal line systems and galaxies

Future prospects

- Galaxy spectra
 - IGM HI tomography
 - Galaxy-HI (dark matter) cross-correlation
 - CGM survey
 - Galaxy-IGM interaction: cold accretion, outflow, metal enrichment, etc.
 - “galDLA” survey
 - Extremely faint galaxy population?
- Subaru/PFS
 - An order of magnitude larger sample
- TMT
 - Higher spectral resolution and S/N

Appendix: HSC NB Intensive Proposal

- 20 nights / 2 years (S16A—S17B) for COSMOS & SXDS
 - NB387
 - NB527
 - NB718
 - IB945
 - NB973
- Science goals: Reionization of hydrogen and helium
 - Measuring hydrogen ionization degree at $z \sim 7$
 - Measuring Lyman continuum escape fraction (emissivity) of galaxies
 - Measuring faint-AGN luminosity function at $z \sim 5$ and their Lyman continuum emissivity