Prospects for the Cosmic Origins Spectrograph and the IGM/galaxy relationship

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Overview

What are are we trying to measure?

Why is it interesting?

What we know so far.

How the Cosmic Origins Spectrograph will improve our understanding.

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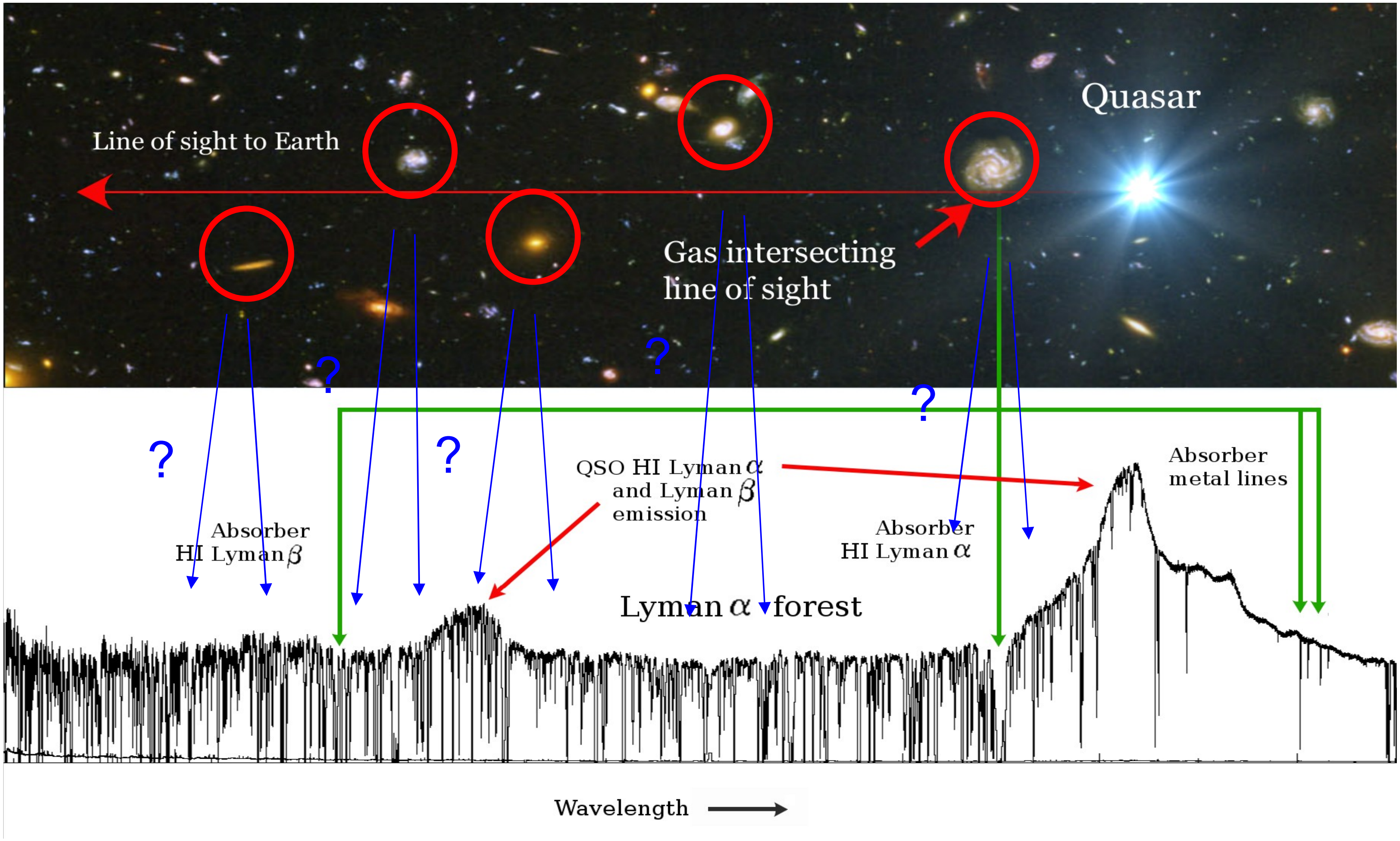
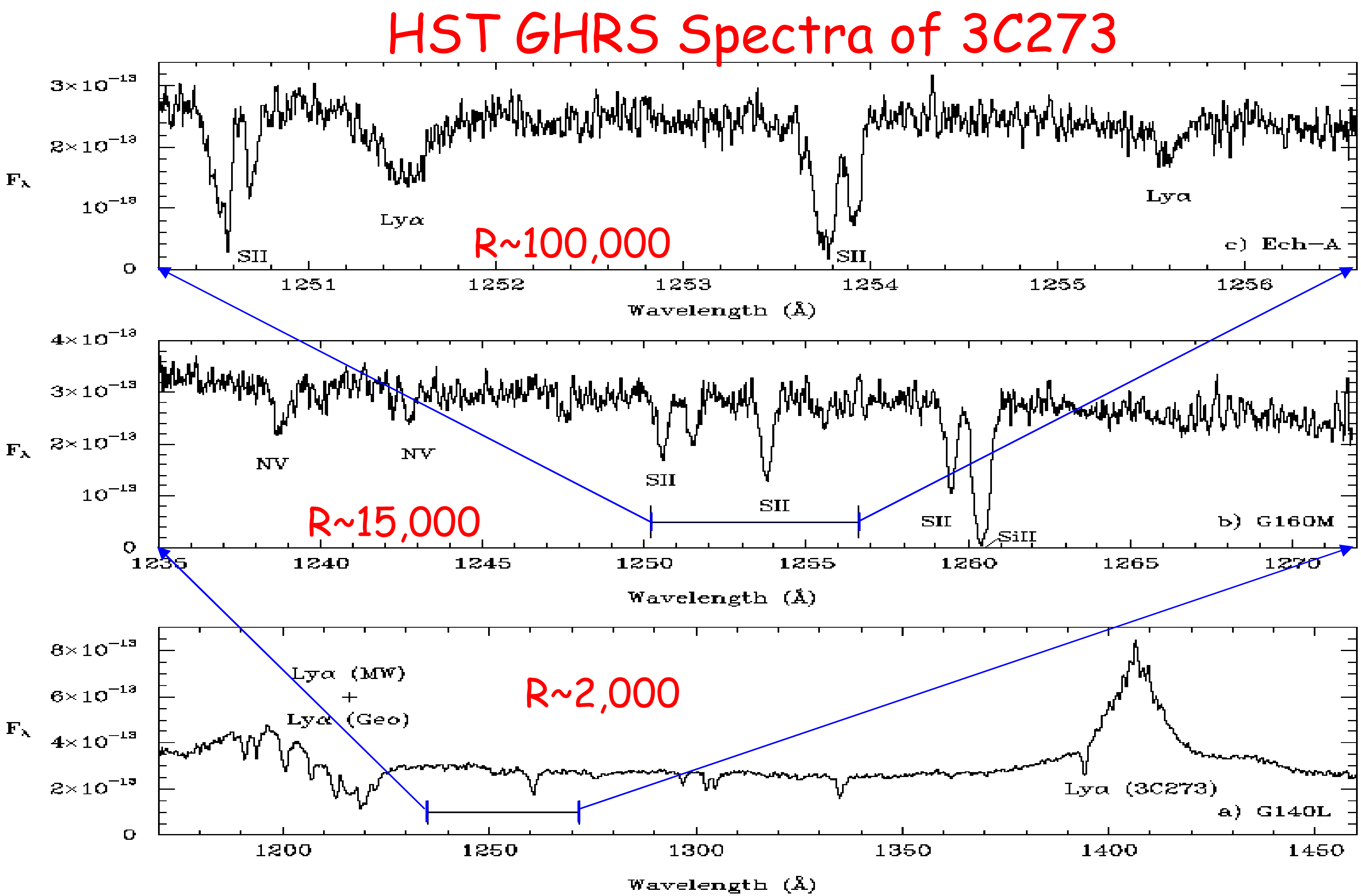
The IGM via QSO absorption lines



Ly-α Savannah



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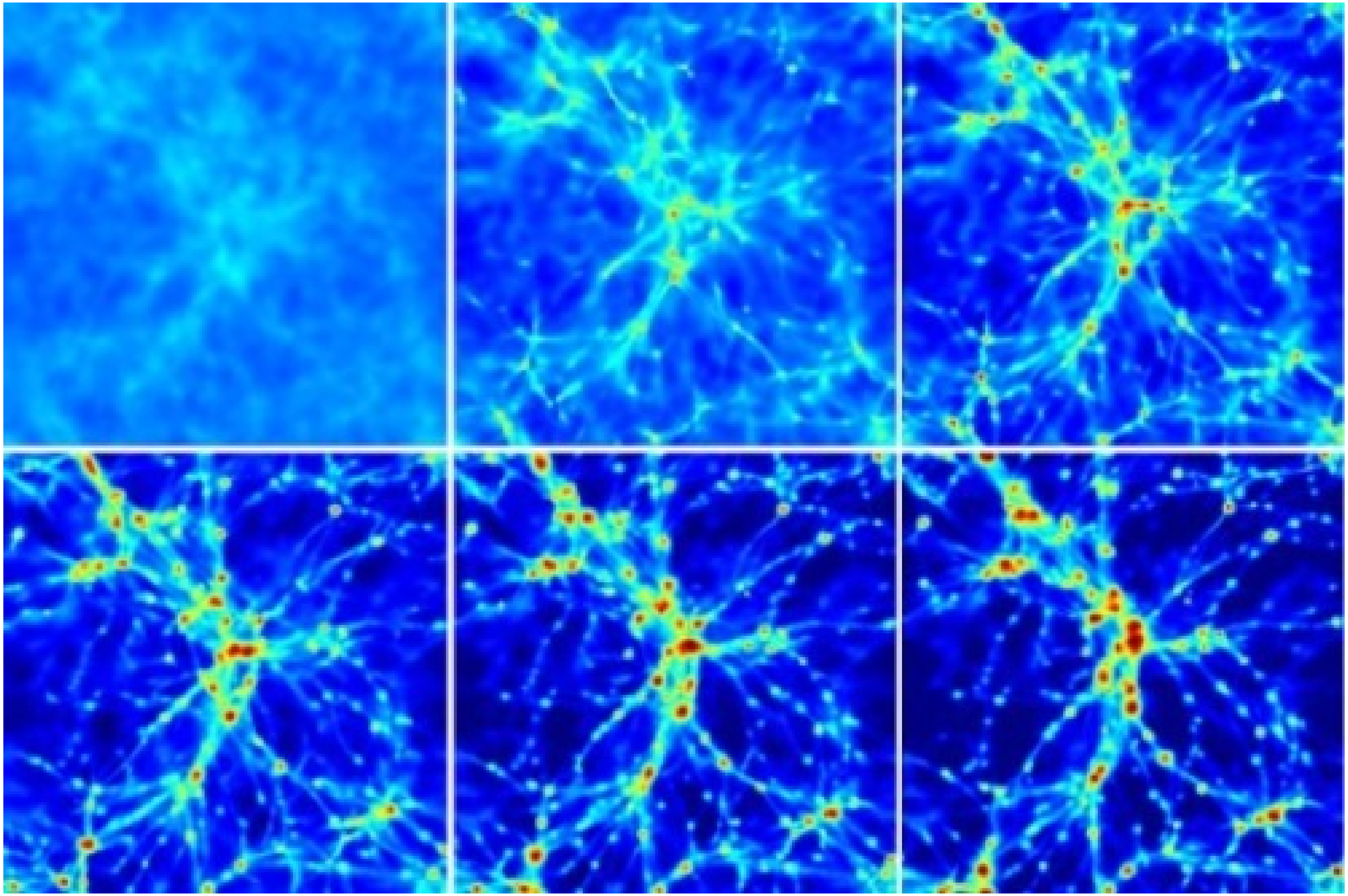
Structure formation: simulations



Snapshots from a simulation showing the formation of a galaxy cluster. Courtesy of Craig Booth

Problems with simulations

Compared to observations, they predict:

- too many faint galaxies at low redshift.
- too high a fraction of blue galaxies.

Possible solution: "feedback" to suppress star formation. This involves the interaction between galaxies and the IGM.

These models need testing...

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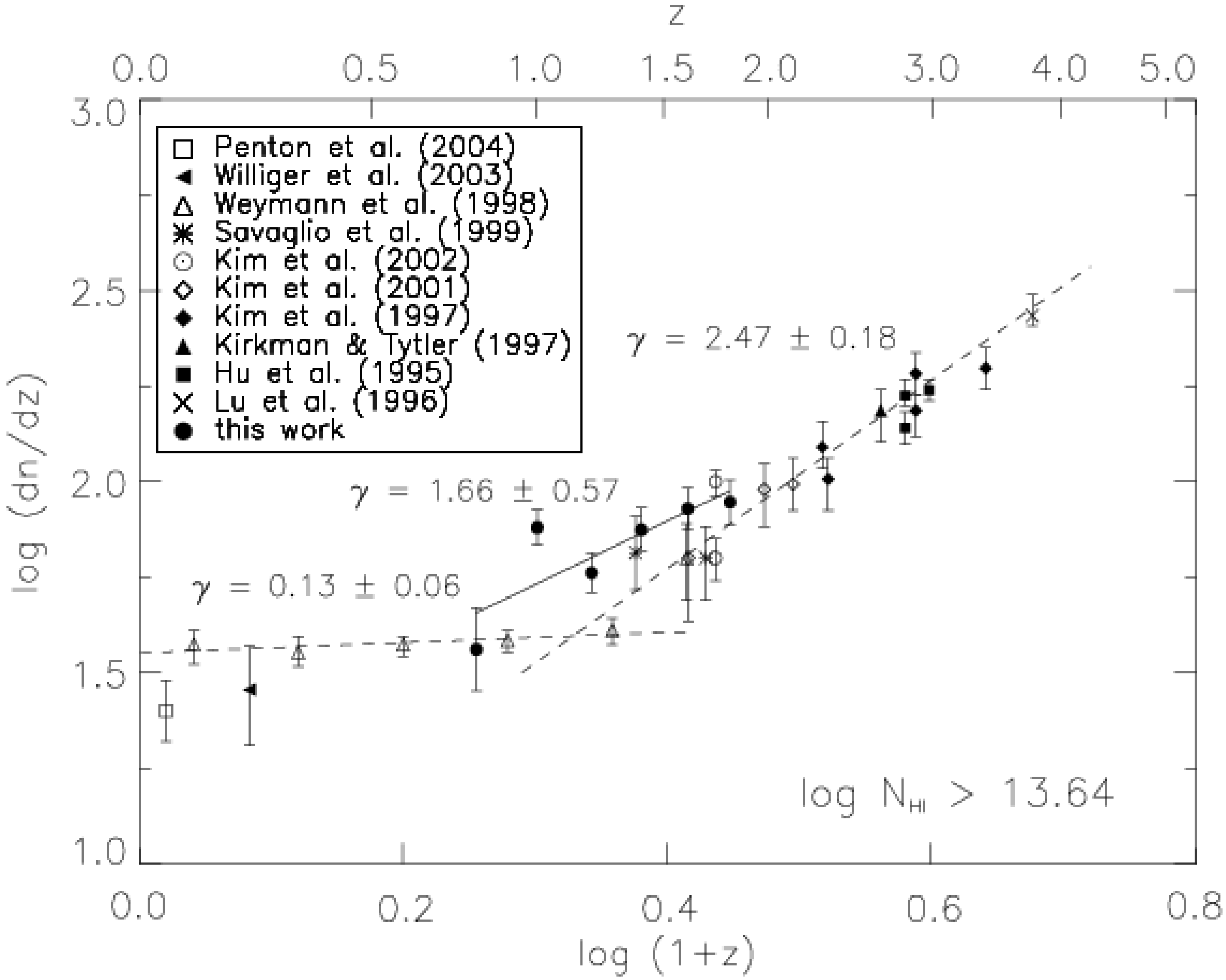
What we know so far: absorbers



Evolution of number density of absorbers with redshift

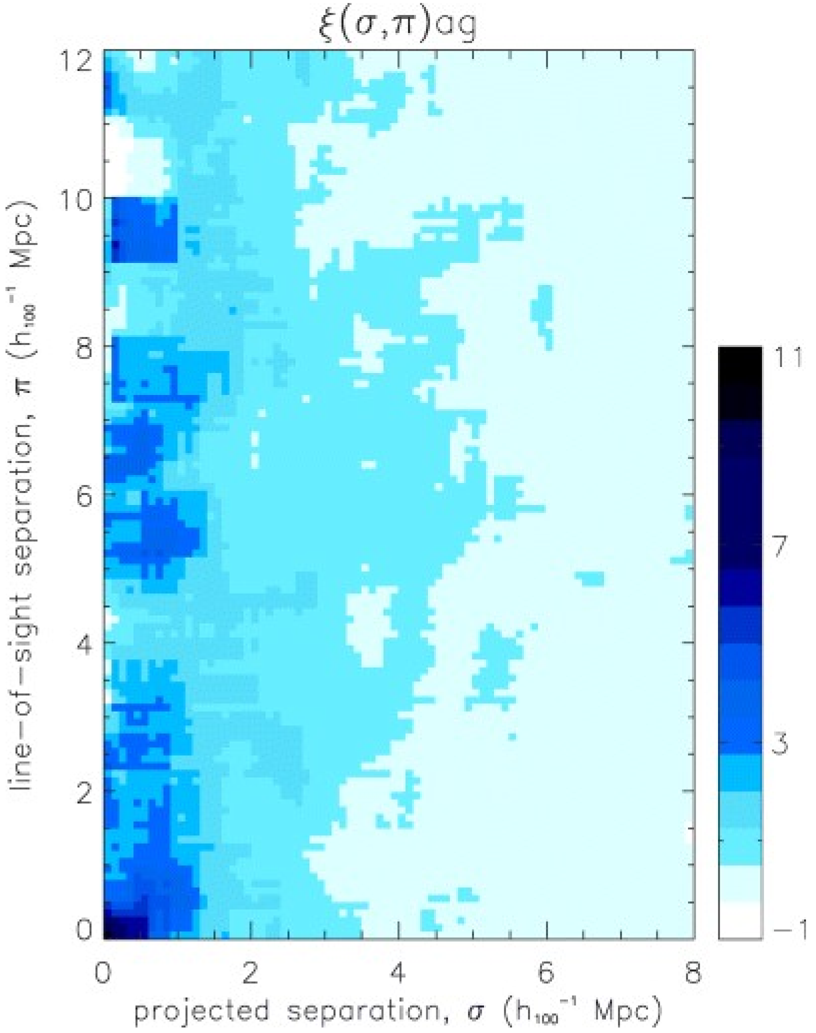
Janknecht et al., 2006.

The IGM contains a large fraction baryons down to low redshifts.

Lehner et al 2007: present a study of the Ly-α forest at $z \leq 0.4$, from which they conclude that:

- There is a significant population of broad (b > 40 km/s) Ly-α absorbers at $z < 0.4$. The fraction of broad to narrow absorbers is higher at $z \leq 0.4$ than at $1.5 \leq z \leq 3.6$, implying that a larger fraction of the low-redshift universe is hotter and/or more kinematically disturbed.
- At least 20% of the total baryons in the universe are located in the highly ionized gas traced by broad Ly-α absorbers.
- The cool photoionized low-z intergalactic medium probed by narrow Ly-α absorbers contains about 30% of the baryons.

Clustering Relative to Galaxies
(Ryan-Weber 2006)



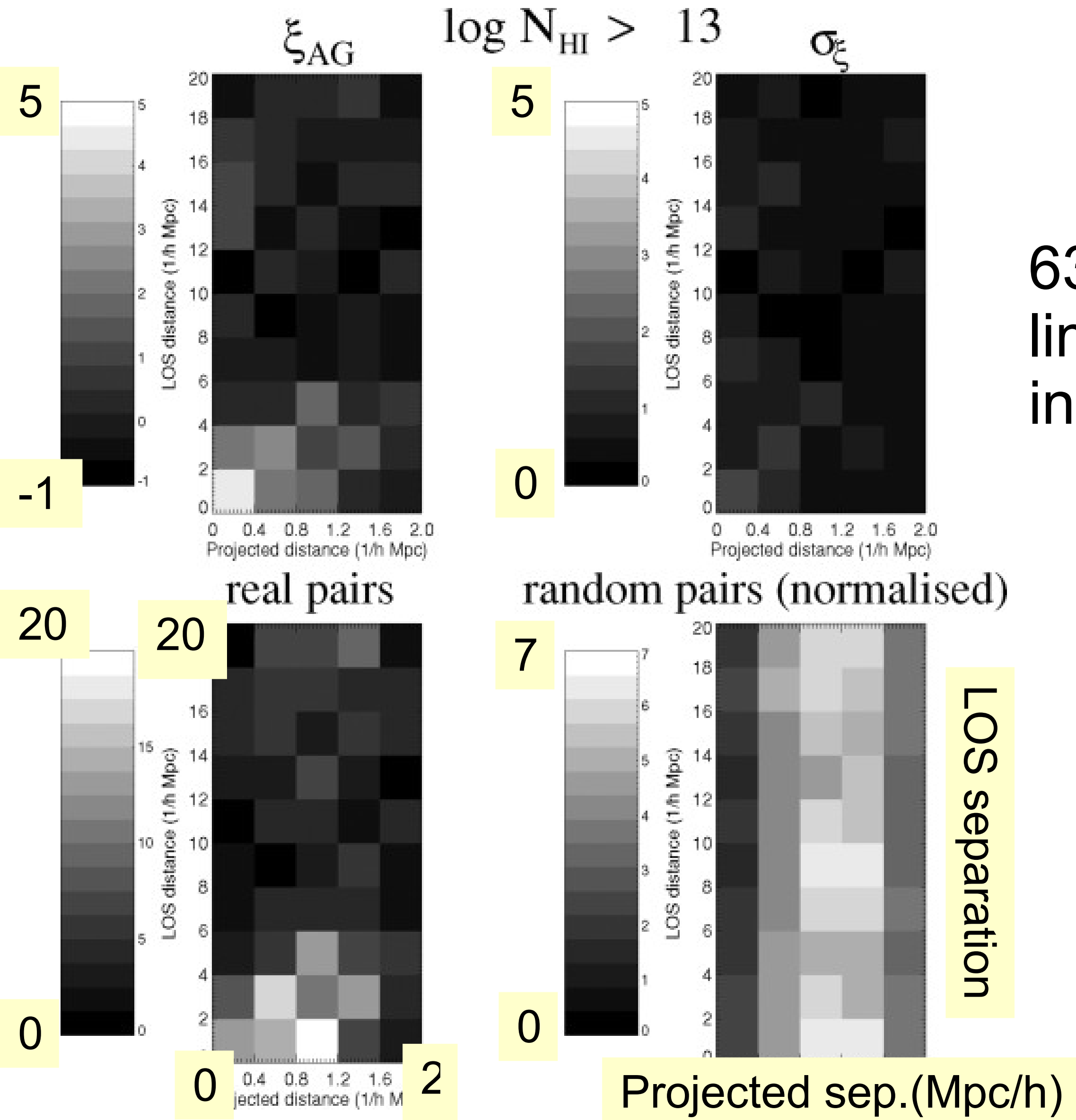
$z = 0$

5317 galaxies detected in 21cm HI. 129 Ly-α absorbers in 27 QSO sight-lines observed.

The absorber–galaxy cross-correlation function. The function is calculated with a resolution of $\delta\sigma = \delta\pi = 0.1\ h_{100}^{-1}$ Mpc and is smoothed with a boxcar width of 9 pixels in this diagram. The smoothing level of 9 pixels is used to emphasize features on > 1 h_{100}^{-1} Mpc scales. Jackknife realizations show typical pixel variations of the order $\xi_{ag} < 0.5$.

Clustering Relative to Galaxies

(Morris and Jannuzi 2006, Wilman et al 2007)



0 < z < 1

636 galaxies (magnitude limited) and 406 absorbers in 16 lines of sight.

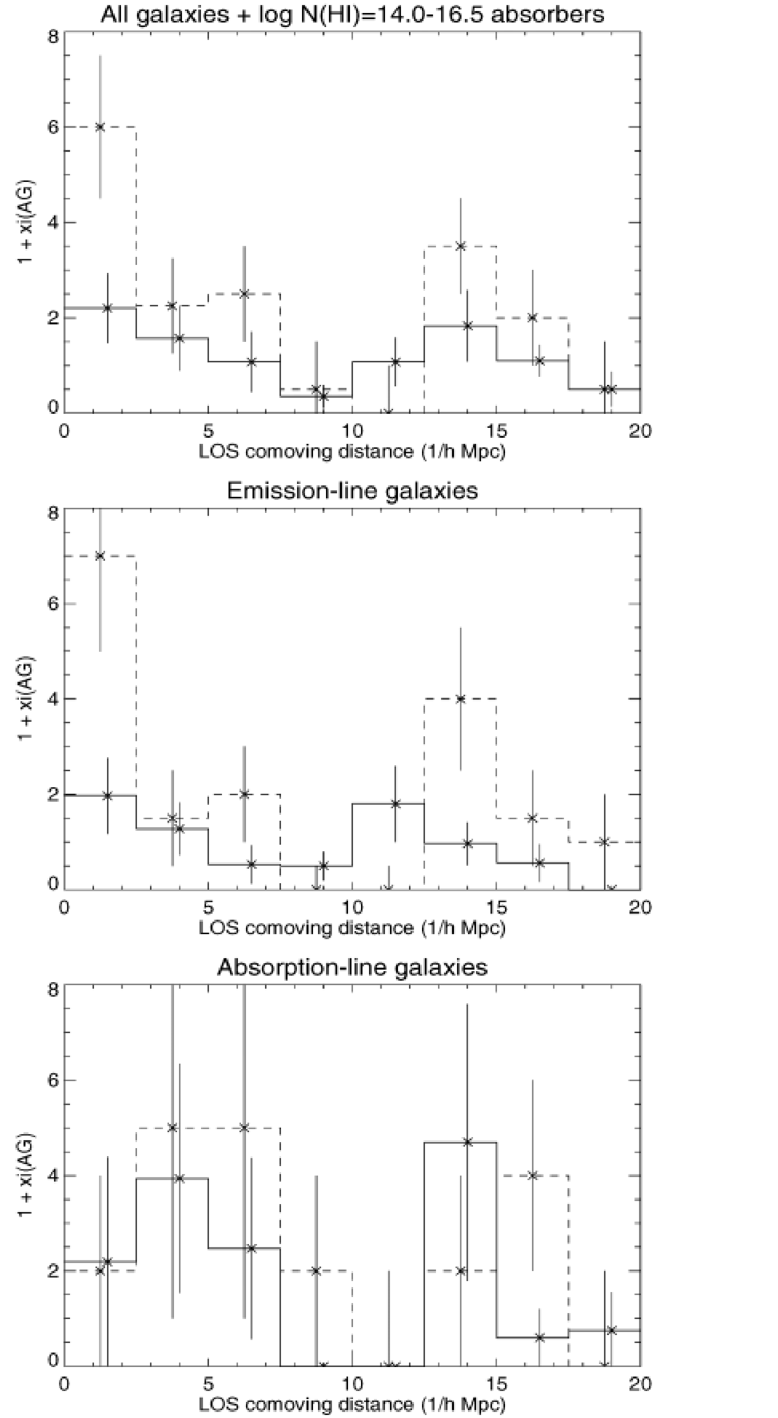
The absorber–galaxy two-point correlation function (top left), ξ_{AG}, determined using the real and random absorber–galaxy pair counts (lower left and right, respectively). Also shown is the uncertainty on ξ_{AG} derived using jackknife resampling equation (6) (top right).

Clustering Relative to Galaxies

(Chen et al. 2005)

Emission line galaxies (more star formation and thus more gaseous) cluster more strongly with absorbers than absorption line galaxies?

A comparison of Wilman et al. (2007) ξ_{AG} measurements with those of Chen et al. (2005) (dashed lines) for different galaxy sub-samples and absorption lines with $10^{14} < N_{HI} < 10^{16.5}$ cm^2 (upper panel: all galaxies; middle panel: emission-line galaxies and lower panel: absorption-line galaxies). $1 + \xi_{AG}$ is plotted as a function of comoving LOS distance for galaxies within 1 h^{-1} Mpc of the LOS.



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Low- vs mid-redshift

- Guaranteed time observations for COS will observe many low redshift (z < 0.5) QSOs, but higher redshifts are also important. The star formation rate decreases by a factor of 10 from z=1 to z=0.
- With multi-object spectrographs on 8m telescopes, we can routinely observe ~4 galaxies per square arcminute up to z~1. (1 arcmin ~ 0.5 Mpc at z=0.5)
- What happens as we approach the dn/dz power law transition?

Cosmic Origins Spectrograph

- Choose fields which already have deep galaxy surveys, find brights QSOs in these fields. (VVDS, GDDS, Deep2, zCOSMOS...)
- Choose fields which already have deep imaging for photo-z correlation (alone or for MOS target selection).
- Better throughput than STIS gives higher S/N per resolution element, allowing us to look at the correlation function dependence on N and b.