

History of Star Formation from the Cosmic Evolution of

$$\omega_{\text{HI}}$$

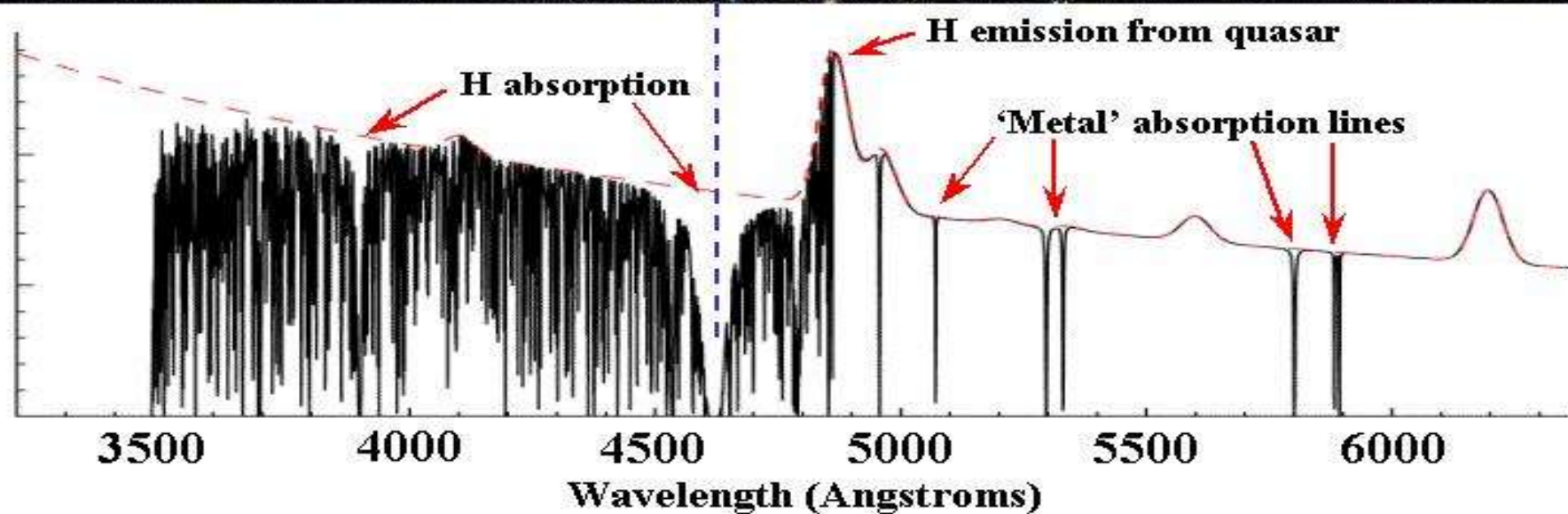
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Germany)

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What are Quasar Absorbers?



Hydrogen lines:

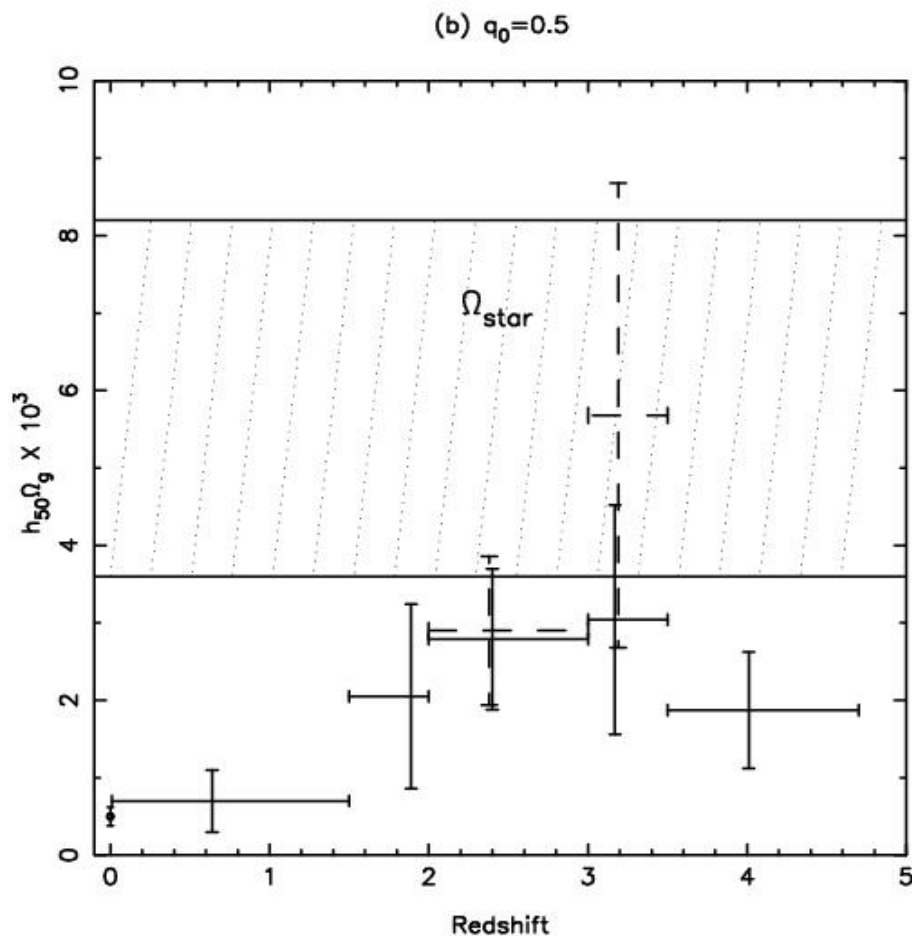
Lyman Limit Systems (**LLS**): $N(\text{HI}) > 10^{17} \text{ cm}^{-2}$

Damped Lyman- α (**DLA**): $N(\text{HI}) > 10^{20.3} \text{ cm}^{-2}$

Damped Lyman- Systems: advantages & limitations

- Seen at **all z**
 - Selected **regardless of luminosity, morphology, SF**
 - **Physical properties** well constrained: N (HI), metals, molecules, etc.
 - Major component of **neutral gas**
 - Tracers of **global metallicity**
- ...
 - **Nature** not known
 - **1D** only
 - ...
 - ...

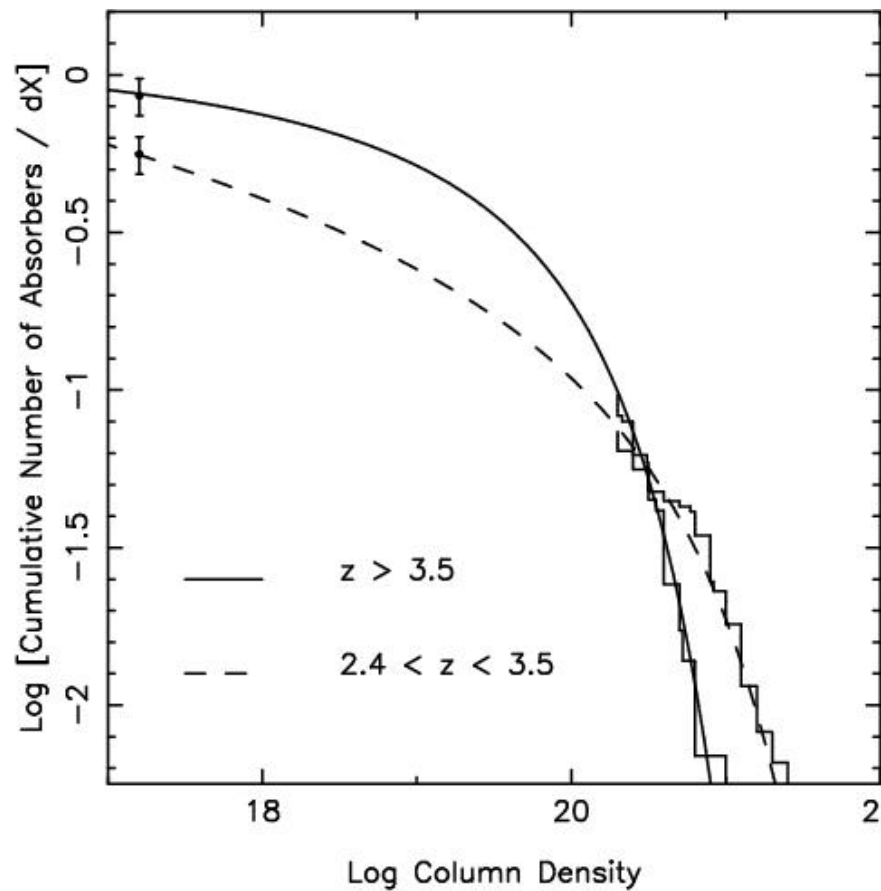
Where did we stand?



- Select galaxies on **HI cross-section**
- Stars form from **HI gas**

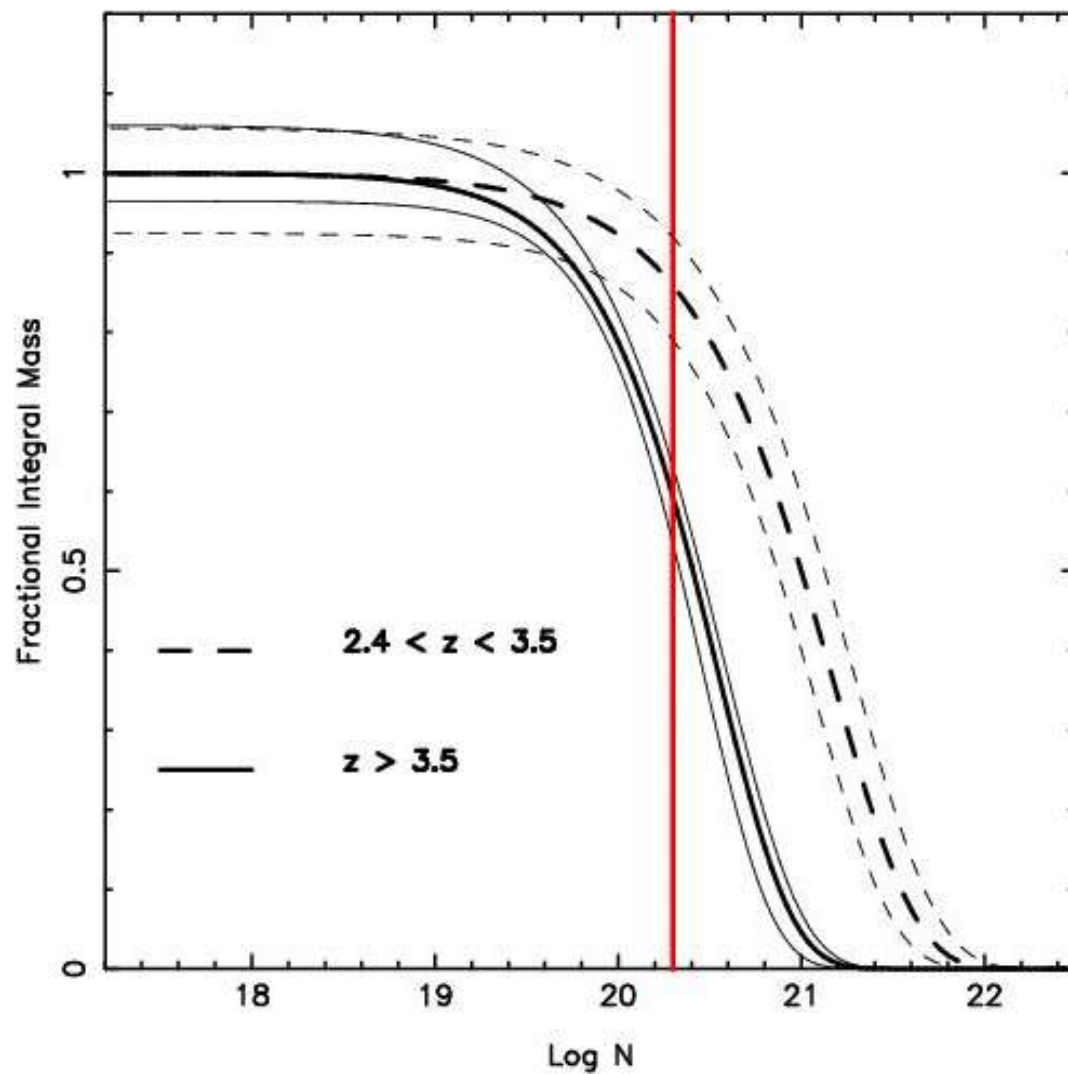
– (Storrie-Lombardi et al., 1996, *MNRAS*, 283, L79)

Column Density Distribution



$$\Omega_{\text{DLA}} = \frac{H_0 \mu m_{\text{H}}}{c \rho_{\text{crit}}} \int_{N_{\text{min}}}^{\infty} N_{\text{H}} f_{N_{\text{H}}} dN_{\text{H}} \quad (1)$$

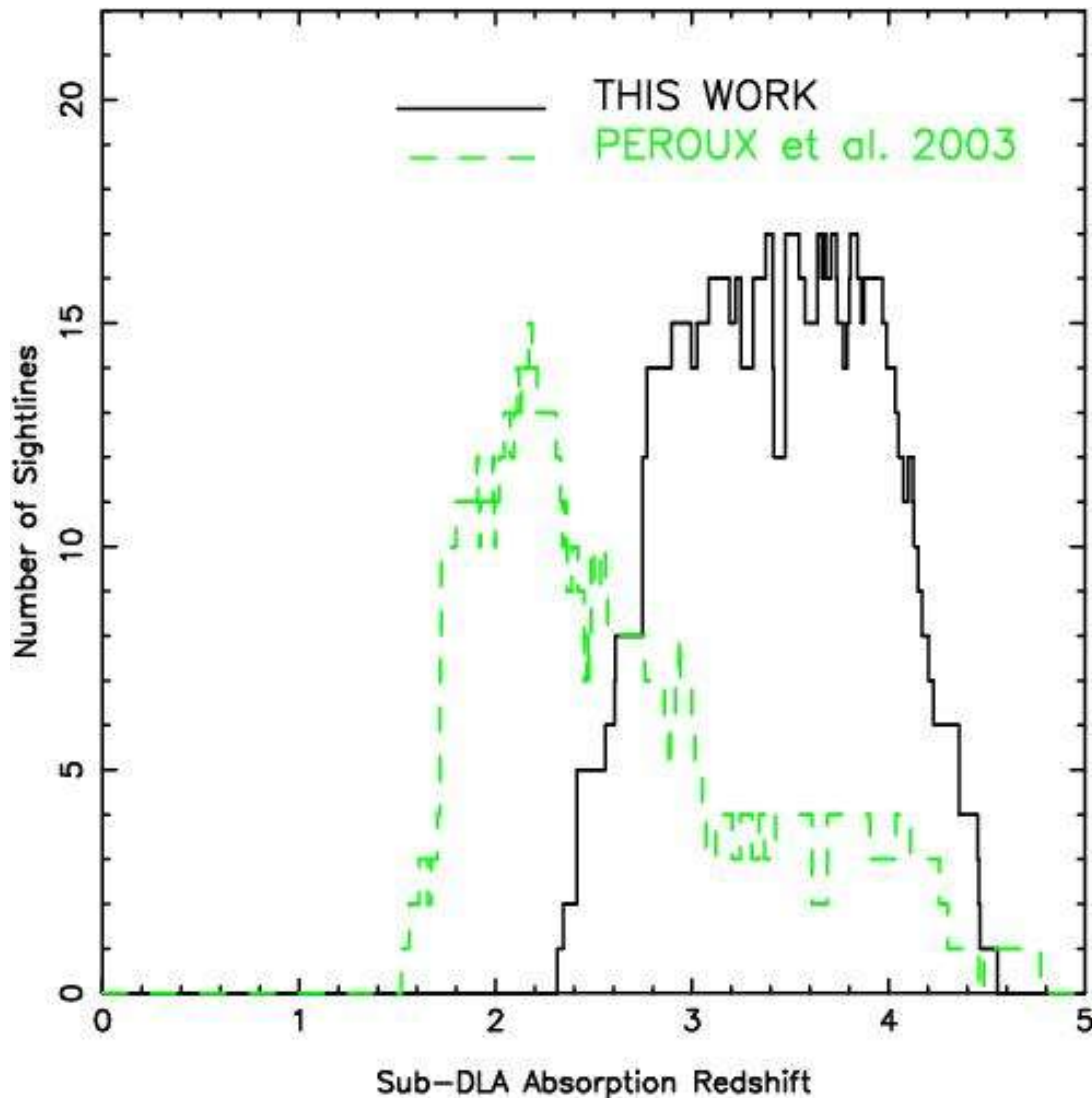
Newly Defined Absorbers



- **Sub-DLA with $N(\text{HI}) > 10^{19} \text{ cm}^{-2}$**

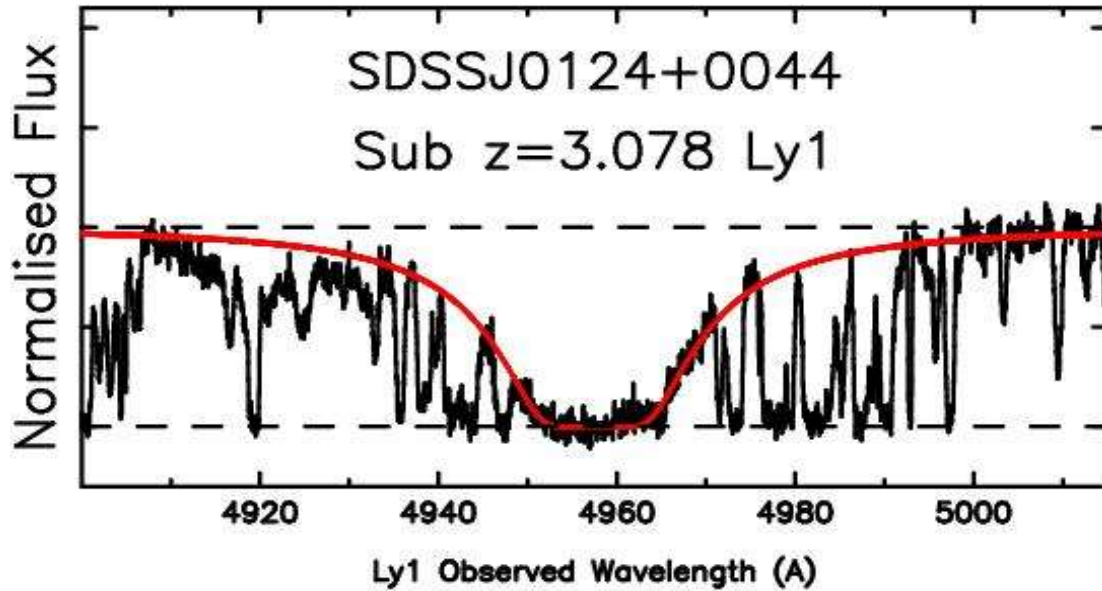
(Péroux et al. 2003a, MNRAS, 346, 1103)

Survey's Sensitivity

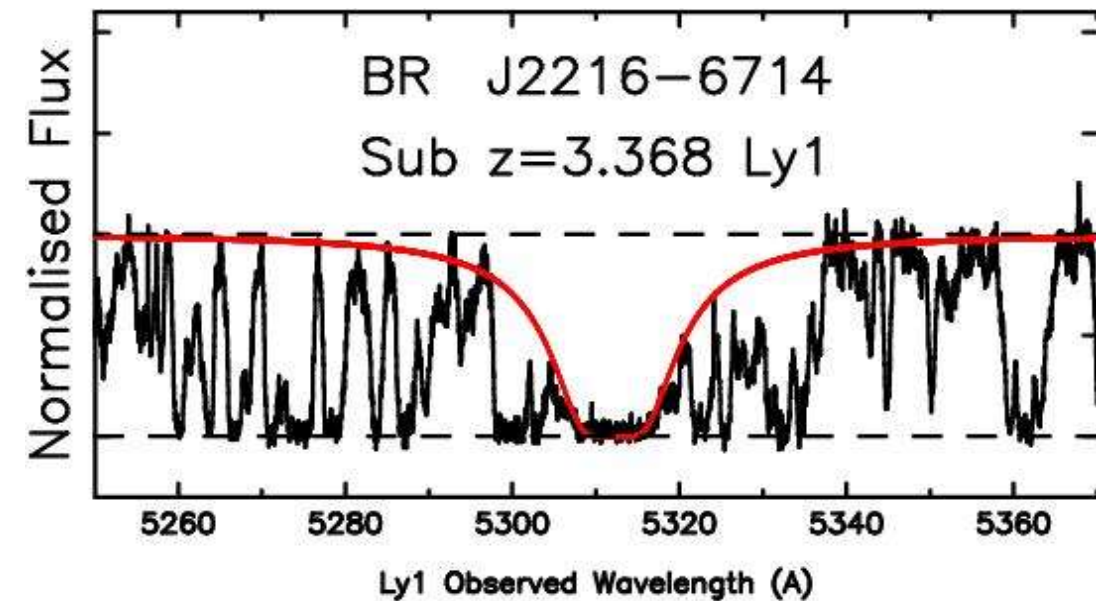


- ESO archive sample:
22 VLT/UVES quasar spectra
- new $z > 4$ data:
17 VLT/UVES quasar spectra
- (*Péroux et al. 2003b*, *MNRAS*, 345, 480)

Voigt Profile Examples

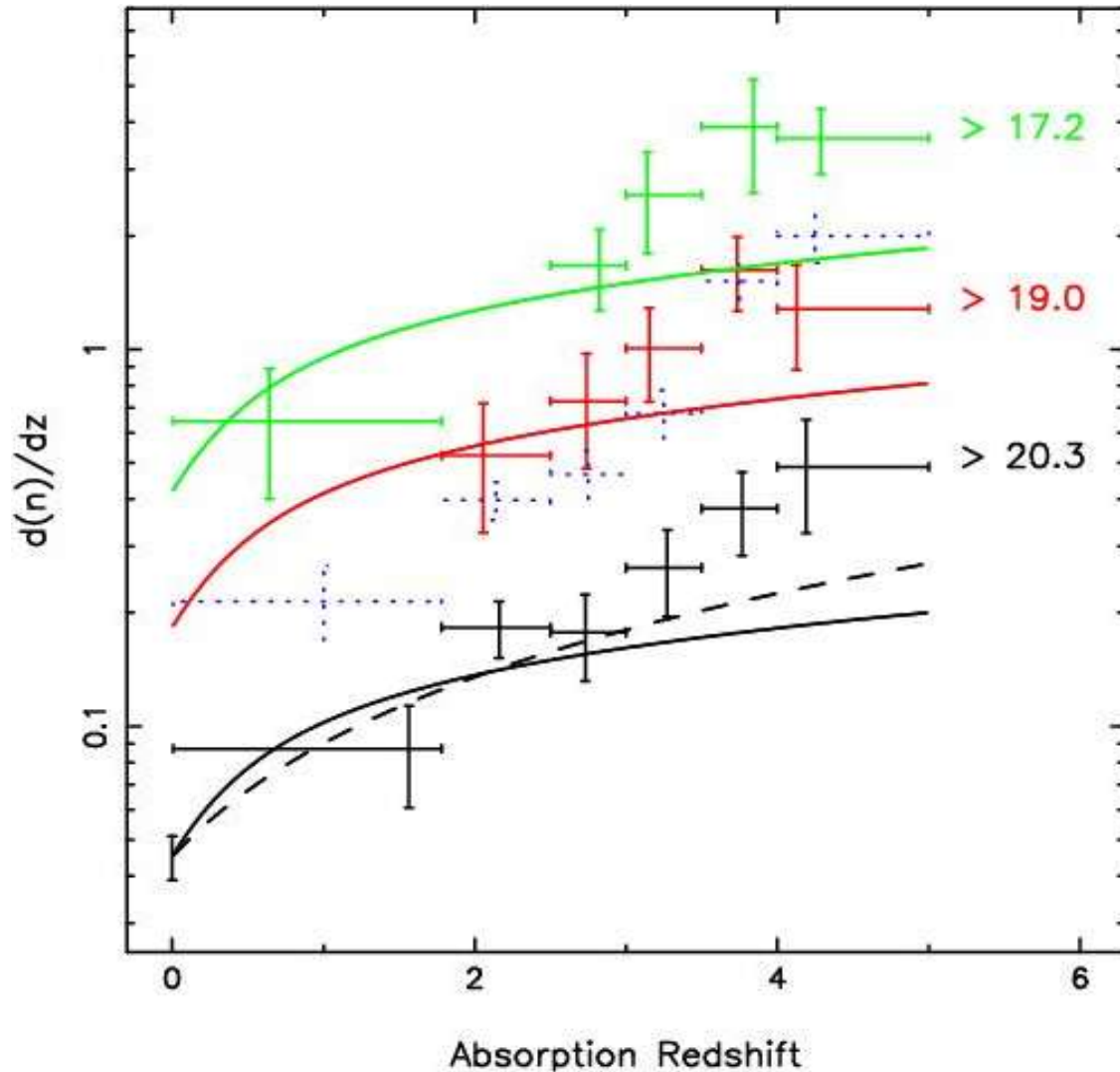


- $\log N(\text{HI}) = 20.21$



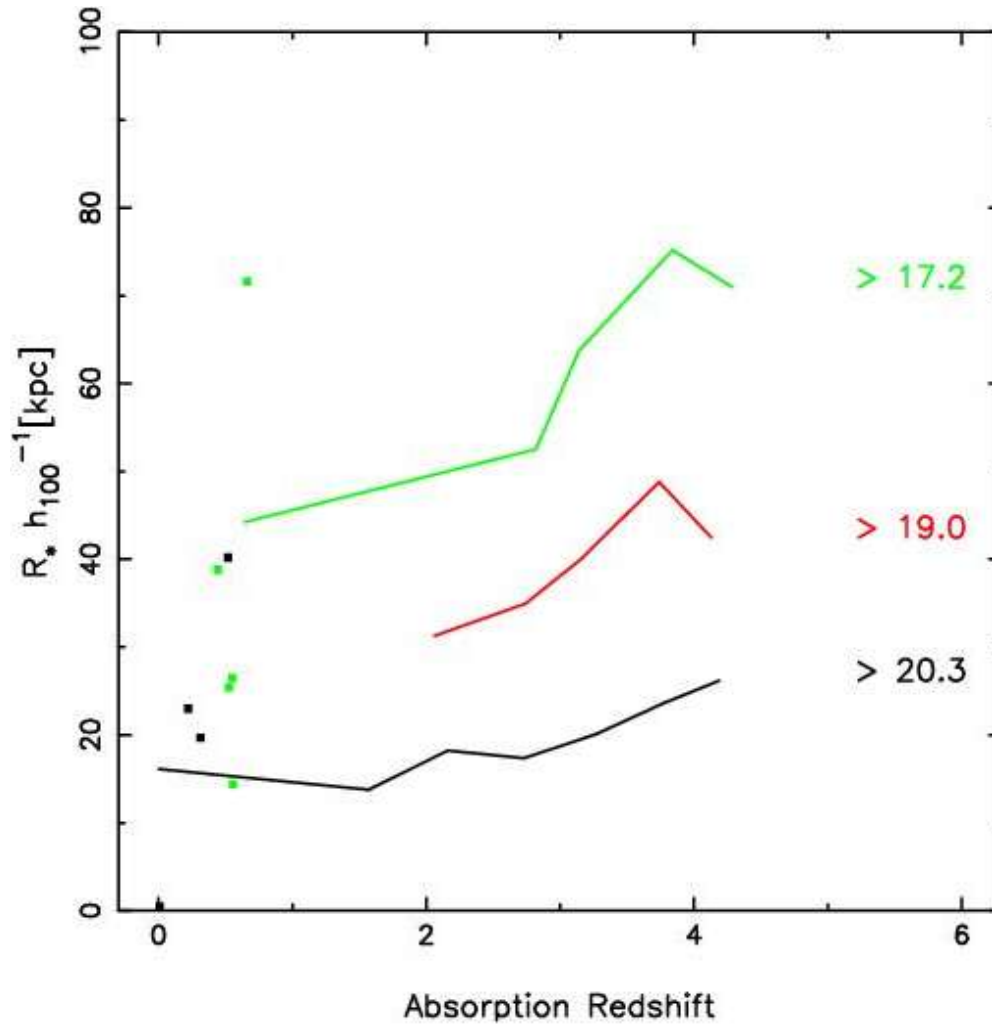
- $\text{Log } N(\text{HI}) = 19.80$

Number Density



- Solid lines: **no evolution curves**
- $d(n)/dz$ evolves from $z=5$ to $z \sim 3$

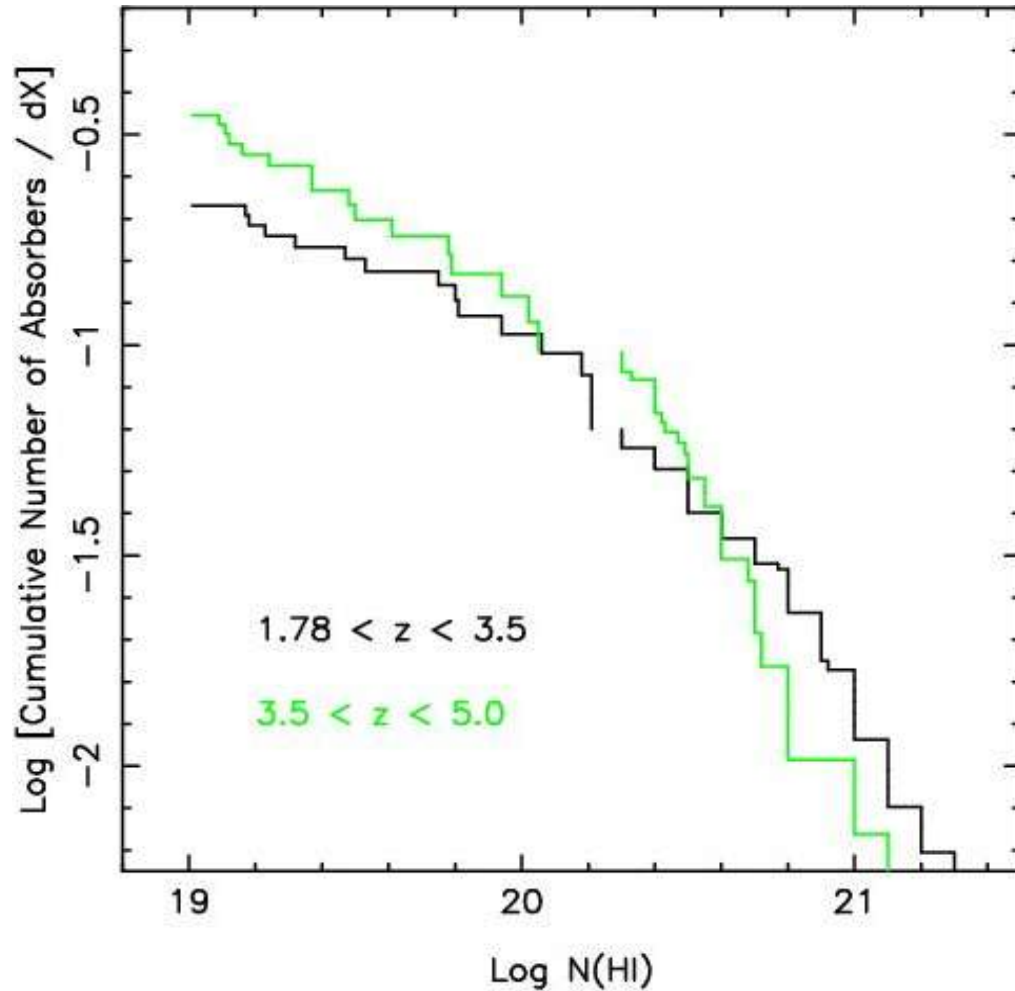
Absorber Sizes



- Same parent population
- **Schechter** luminosity function

$$R_* = 76/91 h_{100}^{-1} \frac{n(z)^{1/2}}{(1+z)} \left[\frac{H(z)}{H_0} \right]^{1/2} [\text{kpc}]$$

Cumulative Number

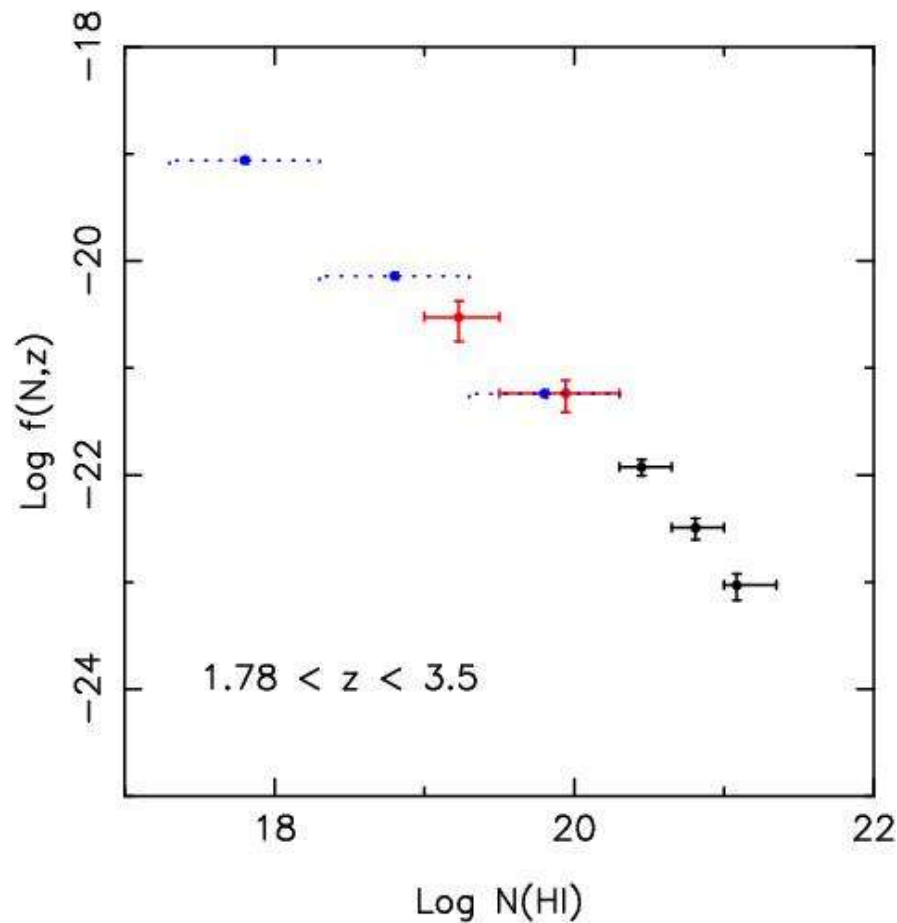


- Sub-DLAs/ DLAs surveys are independent

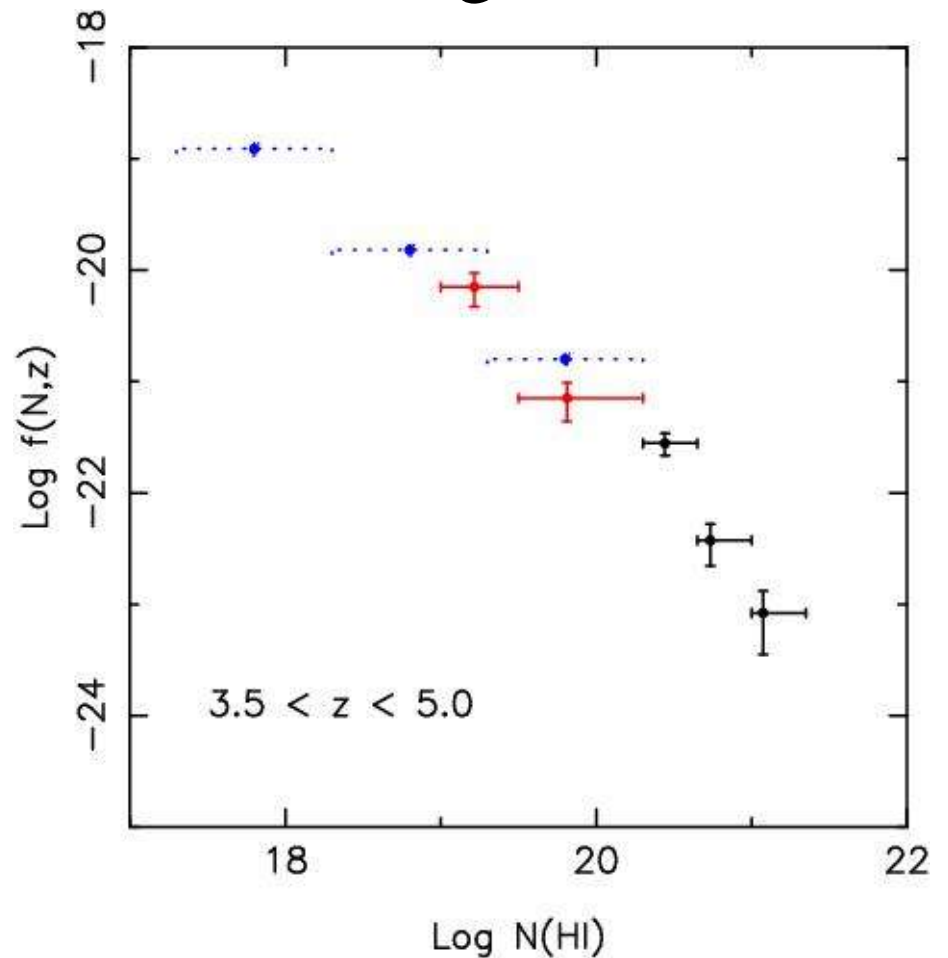
– (*Péroux et al. 2005, MNRAS, submitted*)

Differential N(HI) Distribution

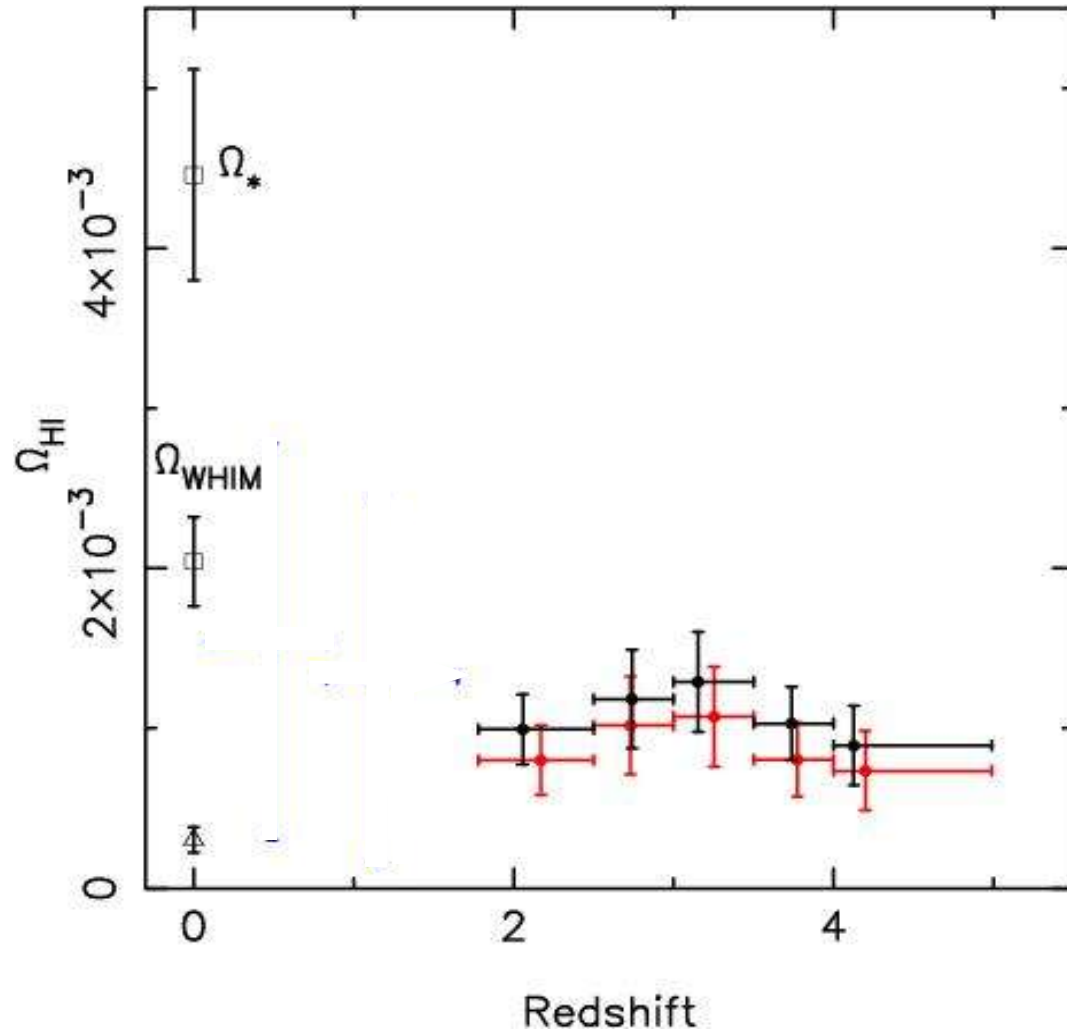
low z



high z

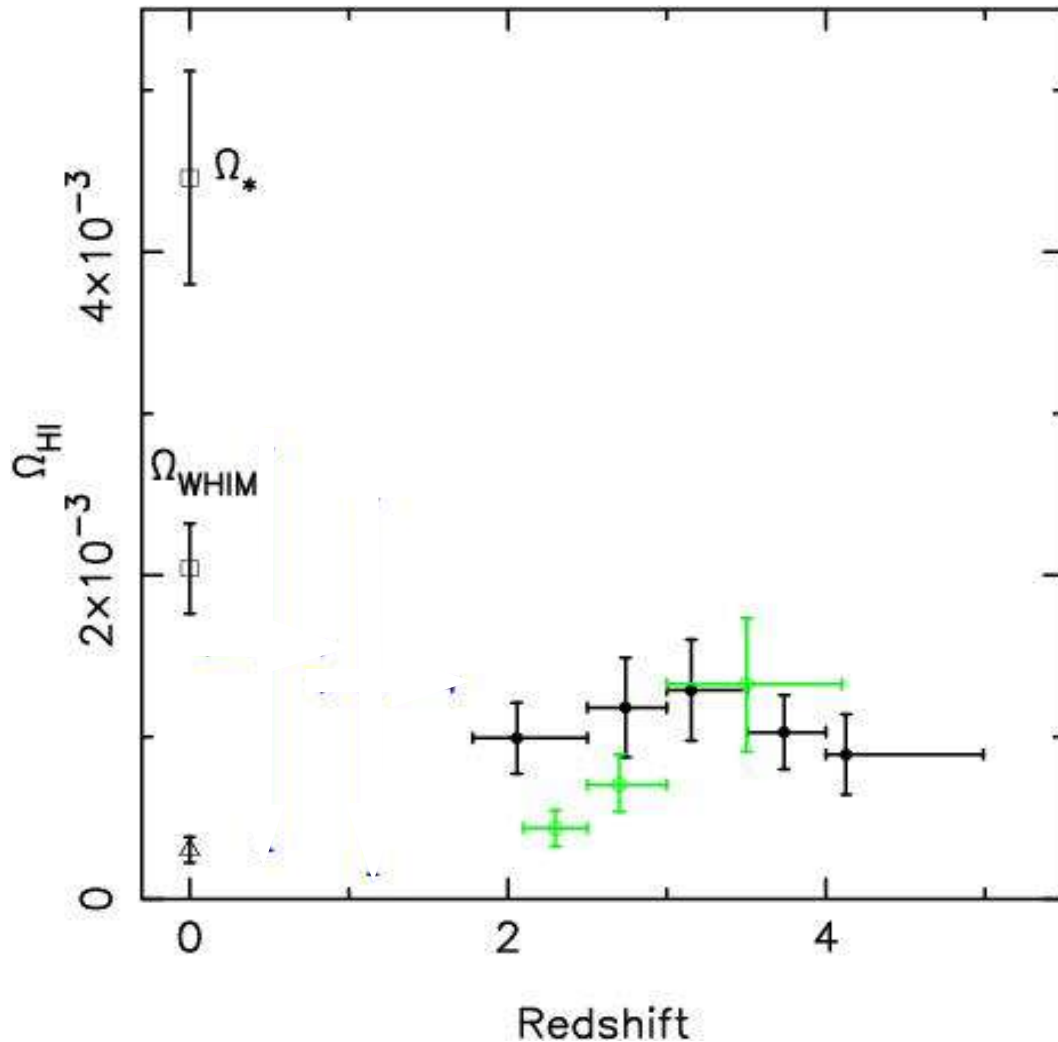


Neutral Gas Mass



Sub-DLA contribute
at all redshifts from
 $z=5$ to $z=2$

Neutral Gas Mass



- Sloan:
homogeneous
sample
-> why different
evolution?

*(Prochaska & Herbert-Fort,
2004, PASP, 116, 622)*

Finding DLAs at $z < 2$

More challenging:

- rare
- cosmology means that dz per quasar is smaller
- Ly α ($\lambda_{\text{rest}} = 1216 \text{ \AA}$) moves below atmospheric cut-off
=> requires UV observations

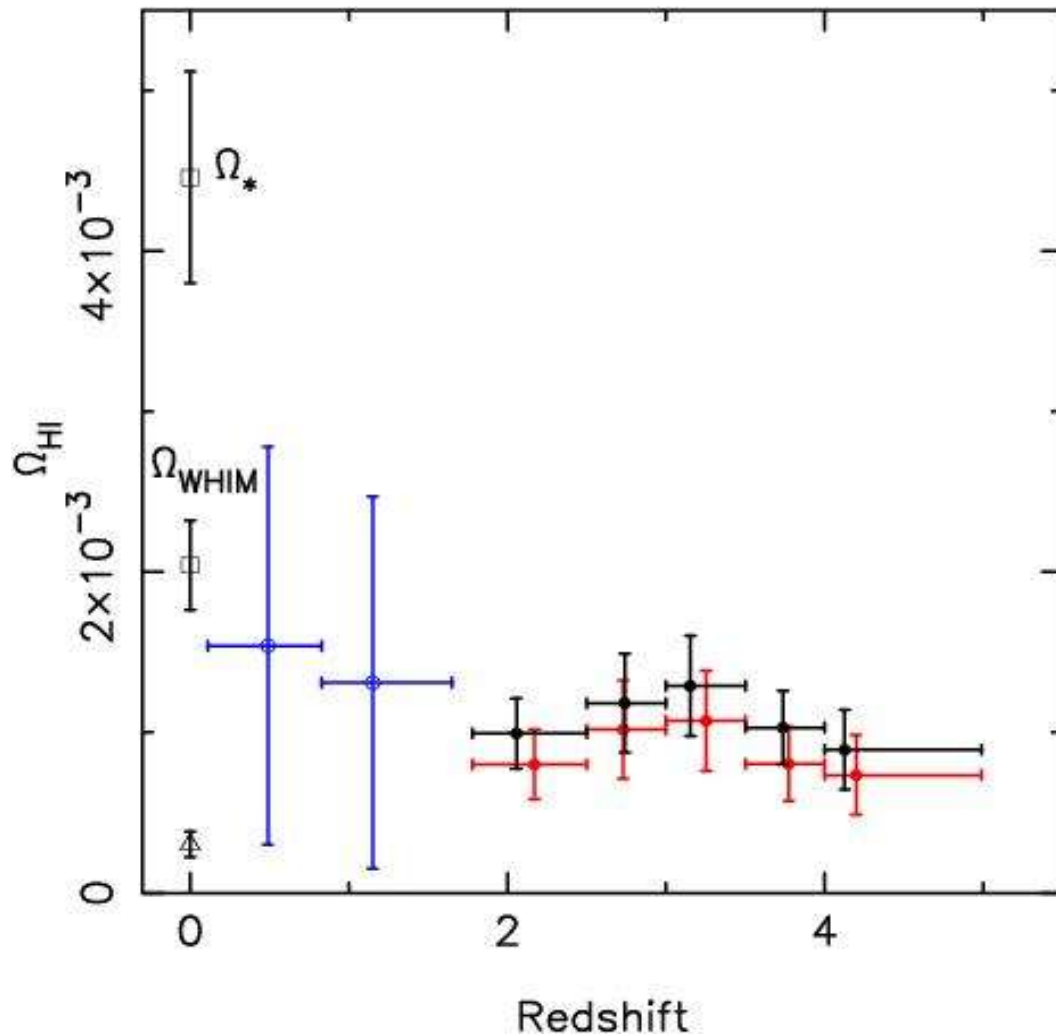
MgII- selection Method

- **Empirically:** all DLA systems have a MgII ($\lambda_{rest} \sim 2803 \text{ \AA}$) associated with them
- **BUT** not all MgII are DLAs

=> Use a sample of **MgII** selected in the optical to search for DLAs at corresponding redshift

(Rao & Turnshek, 2000, ApJS, 130, 1)

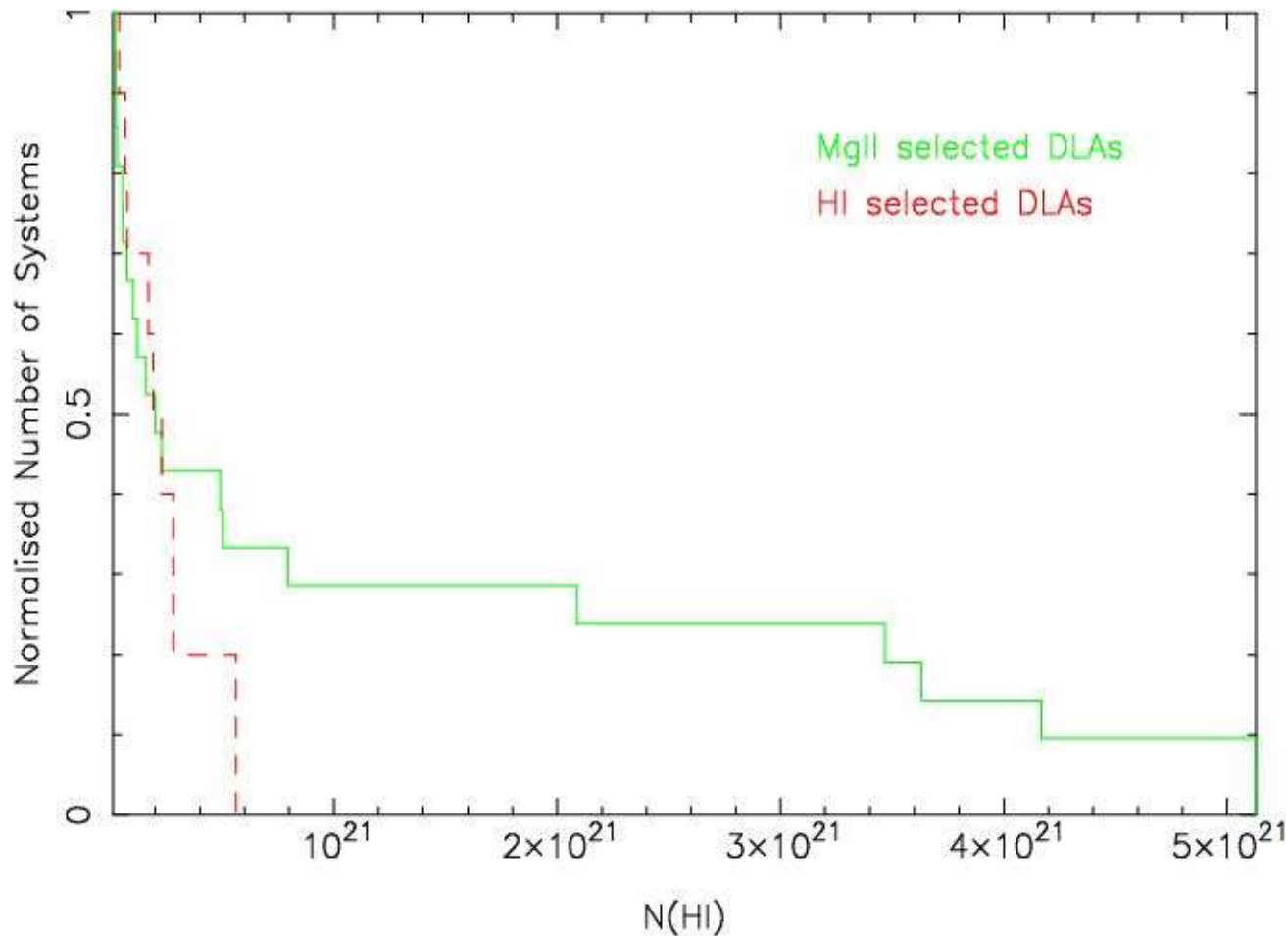
Neutral Gas Mass



MgII- selection
method yields
high values of
 ω_{HI}

$\Rightarrow \omega_{\text{HI}}(z < 2)$
poorly
constrained

N(HI) distributions



HST/ TNG data

Compare

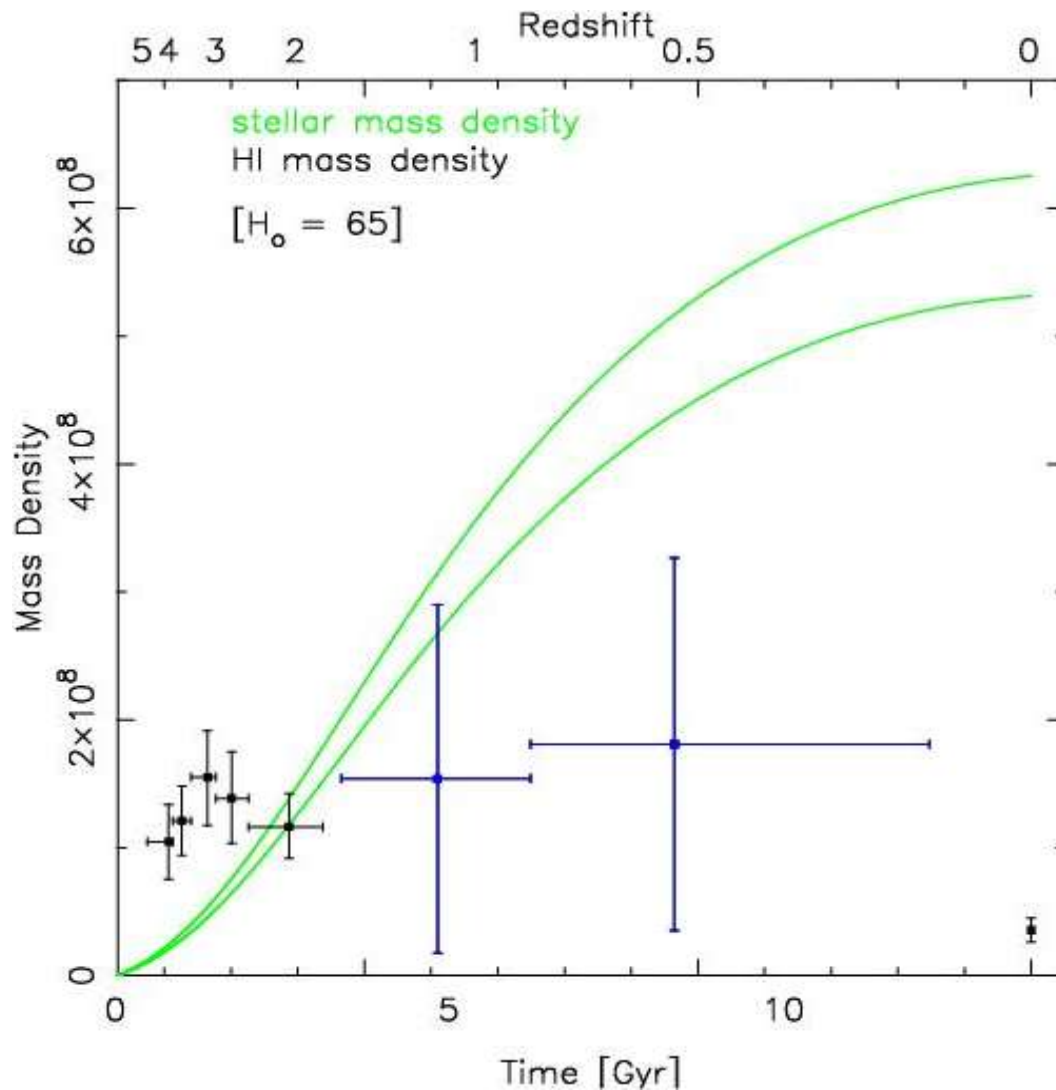
HI-selected &

MgII-selected

DLAs at $z < 2$

(Péroux, Deharveng, Le Brun &
Cristiani, 2004, MNRAS, 352, 129)

Where do we stand?



- $\omega_{\text{HI}}(z=4) < \omega_{*}(z=0)$
- $\omega_{\text{HI}} \sim \text{cte}$ at $2 < z < 5$
- $\omega_{\text{HI}}(z > 0) > \omega_{\text{HI}}(z=0)$
- $\omega_{\text{HI}}(z < 2)$ poorly constrained

Conclusion

- HI gas is an indirect tracer of **star formation history**
- ω_{HI} is about constant from $z=5-2$
- ω_{HI} at $z < 2$ is methodology dependent

