“Damped Lyman Alpha Systems” by Wolfe, Arthur M., Gawiser, E. and Prochaska, Jason X.

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Galaxy Formation Seminar
Outline

• What is a Damped Lyα system?

• How do you observe them?

• What is their nature?

• What do they contribute to galaxy formation?
What is a Damped Lyα system?: QSO Spectrum

QSO PSS0209+0517’s spectrum. Fig. 1 from Wolfe et al. 2005

Wolfe, AM et al. 2005
What is a Damped Lyα system?: Voigt Profile & the Damped Lyα Line

Two DLAs with their best fit Voigt profile. Fig. 2 from Wolfe et al. 2005
How do you observe them?:
Simple Observational Technique

- $W_r \approx 10 \cdot \sqrt{N(\text{H}[I]) / 2 \cdot 10^{20} \text{cm}^{-2}}$ Å

- $W_r > 5$ Å, Limits selection to systems which fully absorb all QSO emission. Corresponds to $N(\text{H}[I]) \geq 5 \cdot 10^{19} \text{cm}^{-2}$

- Search is done throughout $z = [z_{\text{min}}, z_{\text{max}}]$. Min. $z$ was chosen to be where $\sigma(W_r) < 1$ Å. Max. $z$ was chosen 3000 km*s^-1 below $z_{\text{em}}$. 
What is their nature?:

Properties

• By definition they are selected to have large amounts of H[I] gas, but they lack H$_2$ gas.

• DLAs are metal-poor objects with $[\text{M/H}] \geq -2.6$ and $<\text{[M/H]}>=-1.11$

• The log$_{10}(\text{SFR/Area})$ for a uniform disk is -1.95.

• DLAs have counterparts in other wavelengths, but any observations are plagued by the brightness of the background QSO.
What do they contribute to galaxy formation?:
Cosmic Neutral Gas Measurements

- It has been shown that DLAs are good tracers of significant portion of H[I] in the universe from $1.6<z<5$
What do they contribute to galaxy formation?:
Cosmic Neutral Gas Measurements

Evolution of DLA Metallicity Through Redshift.

- Evolution is toward Solar metallicity at present-day, but DLAs have metallicities which are sub-solar at low redshift.
- The DLA minimum metallicity is -2.6.
What do they contribute to galaxy formation?:

Cosmic Neutral Gas Measurements

- DLAs provide the fuel for “future” star formation at galaxies at $2<z<5$.

- DLAs are thought to be the progenitors of the disk component of present-day galaxies. Though the evolution in metallicity towards present-day is sub-solar.
What do they contribute to galaxy formation?:

Lack of Statistics & Understanding

• The calculation of a typical dark-matter halo mass is difficult because of statistics. Increased statistics can give the clustering and power spectrum for the H[I] distribution and improve estimates for b(z).

• There are indications that the luminosity function of DLAs overlaps with the LBGs luminosity function, but a lack of statistics creates an incomplete picture.
Conclusions

• DLAs are systems composed of H[I] which are detected by their absorption feature in QSO spectra.

• They are H[I] gas rich, while being H$_2$ poor and therefore is a great tracer of the hydrogen gas needed to fuel stars at later times.

• DLAs have low metallicities and contain a significant proportion of the H[I] gas found at 2<$z<$5.

• They may be the progenitors of the disk* component of present-day galaxies.