Probing the star formation rate of damped Lyman-α systems

Michele Fumagalli[1], John M. O'Meara[2] and J. Xavier Prochaska[1,3]

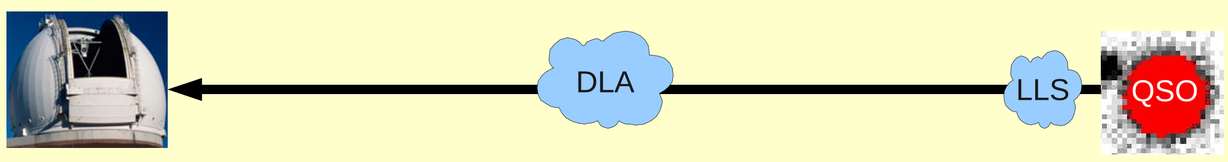
1- Department of Astronomy and Astrophysics, University of California, Santa Cruz (Email: mfumagalli@ucolick.org);
2-Department of Chemistry and Physics, Saint Michael's College; 3- UCO/Lick Observatory.

Abstract

•Bright quasars in the background of damped Lyman-α systems prevent the imaging of these objects.
•Intervening Lyman limit systems act as natural blocking filters to image the rest-frame FUV emission from damped Lyman-α systems without contamination from the quasar.
•This technique permits to understand the nature of damped Lyman-α systems.
•We present preliminary results from an ongoing imaging survey aimed to study the star formation rate, the size and the morphology of these objects.

Introduction

The major challenge in observing damped Lyman-α system (DLA) counterparts comes from the bright background quasar (QSO). We image DLAs using the technique first proposed by O'Meara et al. [1]. We target DLAs in QSOs with intervening Lyman limit systems (LLSs) at redshift $z_{LLS} > z_{DLA}$. The LLS serves as a blocking filter to absorb any emission from the background quasar at the rest-frame ultraviolet wavelengths of the foreground DLA. (See Fig. 1).



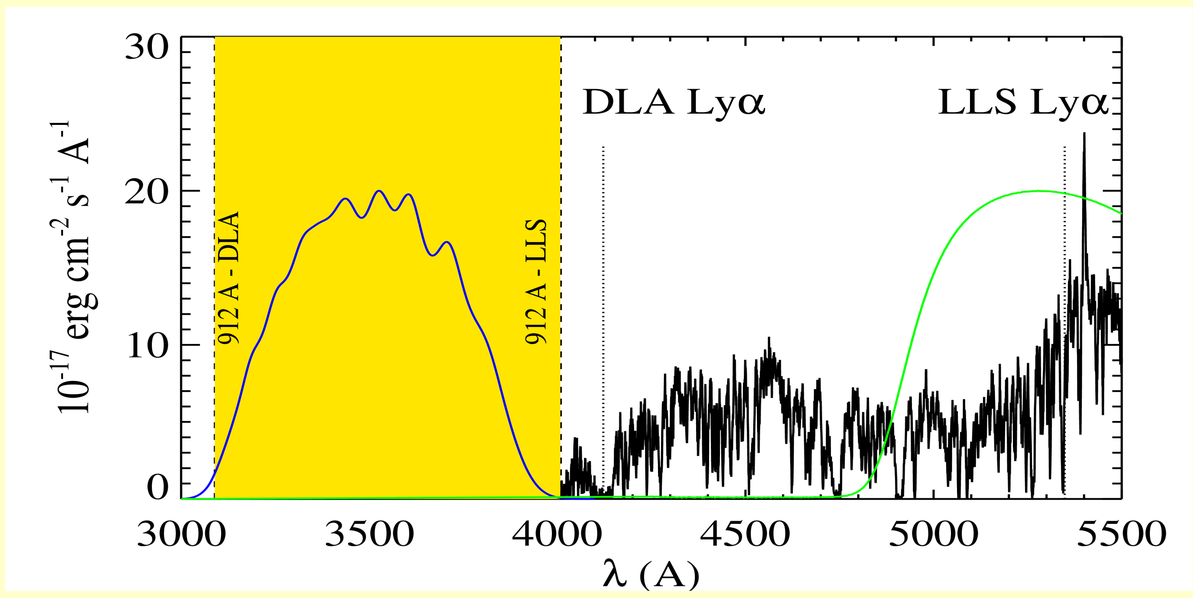


Figure 1: LRIS spectrum of QSO J0956+3444. The rest frame FUV emission from the DLA is observed in the region enclosed in between the dashed lines. In that window, the light from the QSO has been completely absorbed by the LLS. The blue curve shows the LRIS-Keck u' band filter, while the green one shows the V band filter.

Survey status and candidates detections

Ongoing ground based (LRIS@Keck) and space (WFC3@HST) observations will provide images for ~40 DLAs (z~2-3). Two fields are shown in Fig 2. We identify the best DLA candidates using SPH simulations [2] and HI observations [3] to compute the probability distribution of the impact parameter as a function of the absorber column density. (Fig. 3).

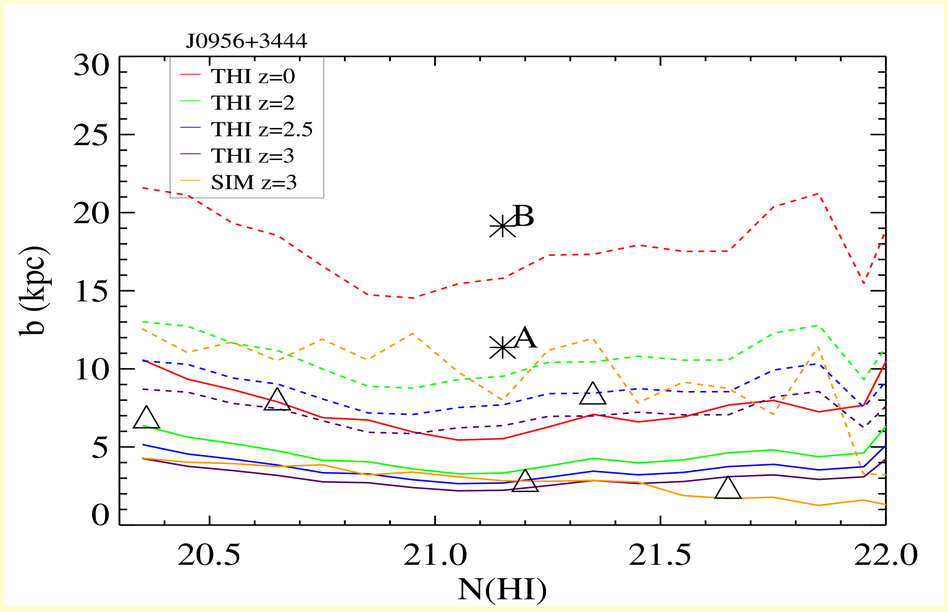


Figure 3: DLA J0956+3444 candidates. The 50% (solid lines) and 90% (dashed lines) of the impact parameter distribution are used to identify DLAs. SPH simulations are in yellow. Models at different redshifts from observed HI maps are in red (z=0), green (z=2), blue (z=2.5), and violet (z=3). Triangles are confirmed DLAs, while asterisks are our targets.

REFERENCES:

[1] O'Meara, J., et al., 2006, ApJ, 642, L9
[2] Pontzen, A., et al., 2008, MNRAS, 390, 1349
[3] Walter, F., at al., 2008, AJ, 136, 2563
[4] Bouwens, R., et al., 2004, ApJ, 611, L1

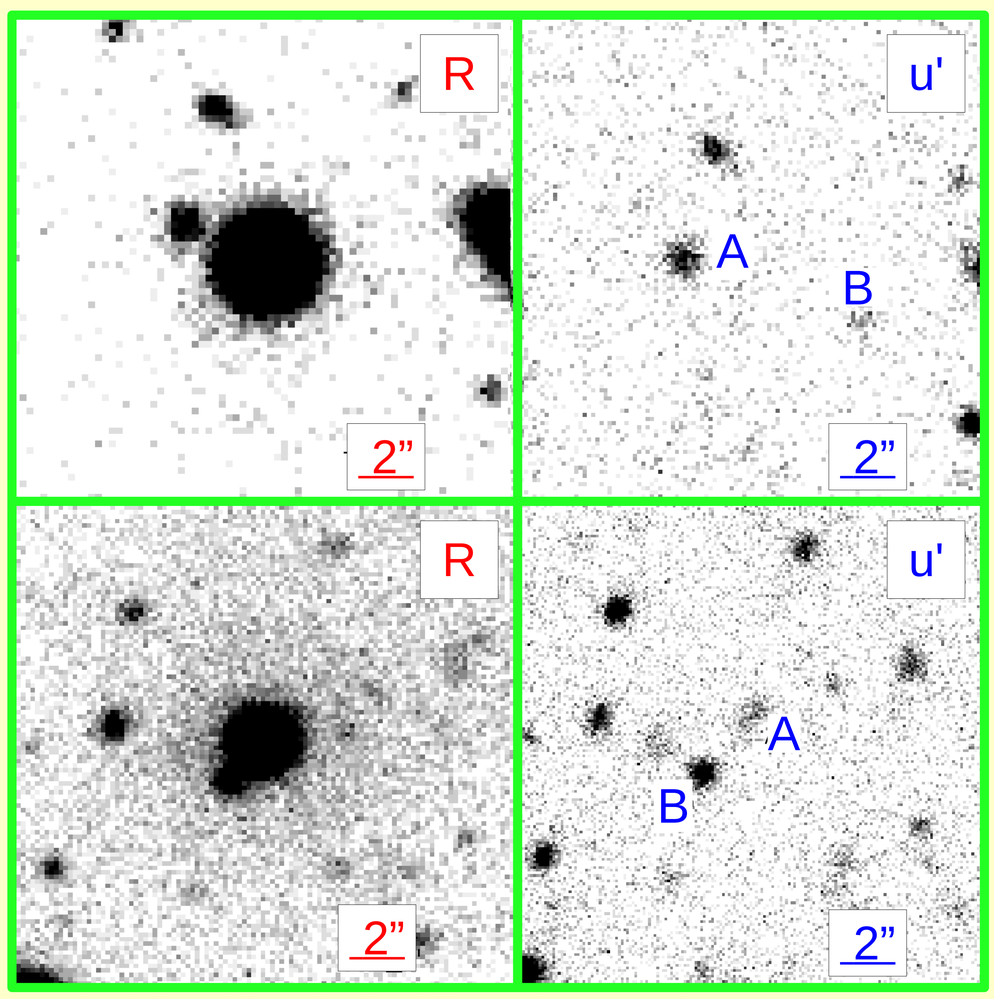


Figure 2: R band filter (left) and u' band filter (right) images for DLA J2114-0055 (top) and DLA J0956+3444 (bottom). Due to the intervening LLS, the light of the quasar is completely absorbed in the u' band images (centered in the R band). This allows the detection of faint galaxies even at very low impact parameters.

Preliminary results

u' band images provide the star formation rate (SFR) and estimates of size and morphology of DLAs. Fig. 4 shows a comparison between Lyman break galaxies (LBGs) [4] and our DLA candidates. High resolution HST observations are needed to avoid a bias in the size determination, as revealed by a set of simulated images in different seeing conditions.

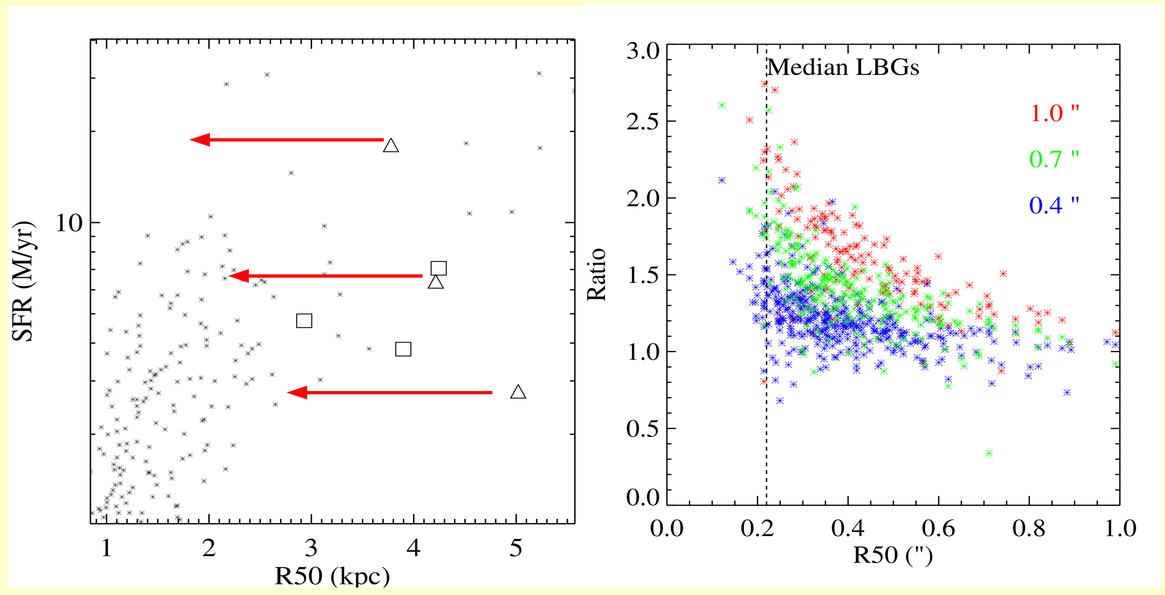


Figure 4: (Left panel). Comparison of star formation rate and size of LBGs (asterisks) and DLA candidates (triangle and squares). The arrows indicates the size once corrected for seeing effects. (Right panel). Comparison of R50 in simulated images with different seeing. Ground based observations may overestimated the size up to a factor of 2.

Future work

With our sample we will:

•study the size and morphology to understand DLAs nature;
•probe the evolution of the star formation in gas rich objects;
•explore the connection between SFR and HI column density;
•compare observations with cosmological simulations;
•compare DLAs with LBGs and other high redshift populations.