NTT Service mode observations of the Lyman-limit Absorber towards Q1205-30

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1 Introduction

The amount of information about the galaxy population at high redshift ($z = 2-4$) has increased tremendously in the last few years. Using the Lyman-break technique several hundred high redshift star forming galaxies, Lyman-break galaxies (LBGs), have been detected and studied with imaging and spectroscopy (Steidel et al., 1996). Using the Hubble Space Telescope detailed morphological studies of the LBGs have been carried out (Dickinson, 1998). It is, however, not yet known how complete the Lyman-break technique is in detecting high redshift galaxies.

An independent route along which to study the galaxy population at high redshift is via the high column density QSO absorption lines systems. The advantage of high column density QSO absorption lines systems is that a wealth of information on the chemical evolution can be and has been obtained by studying the metallicity and dust content of the absorbers from high resolution spectroscopic studies of the background QSOs (e.g. Lu et al., 1996). However, the spectroscopic studies will not tell us anything about the emission properties of the absorbing galaxies.

Only when combining the information obtained from the LBG-studies (e.g. the luminosity function of LBGs), the absorption line statistics for QSO absorption lines systems and the properties of galaxy counterparts of QSO absorption lines systems can we hope to disentangle the observational selection biases which each of the different studies suffer from and obtain a more complete insight into the nature of the high redshift galaxy population.

We are currently undertaking programmes aimed at identifying galaxy counterparts of the two most gas rich subgroups of QSO absorption lines systems, Damped Lyα Absorbers (DLAs) and Lyman-limit systems (LLSs). Three out of the five high redshift DLAs that have been detected in emission at present are at approximately the same redshift as the background QSO. In order to examine whether $z_{abs} \approx z_{em}$ systems indeed are more active emitters (e.g. due to photoionisation by the QSO or induced star formation) we choose to study Q1205-30, since the spectrum of Q1205-30 published by Lanzetta et al. (1991) shows the presence of a strong LLS at the emission redshift of the QSO, which is $z_{em} = 3.036$.

Table 1: Journal of observations, NTT, 1998

Filter	Combined seeing (arcsec)	Exposure Time (sec)
CS 4906/20	1.4	64000
B	1.3	3600
I	0.96	5600

In this paper we report on preliminary results of our analysis of the data obtained during NTT service observation in January, February and March 1998.

2 Locating Q1205-30

The coordinates of Q1205-30 have not been published (in the paper by Lanzetta et al. (1991) the reference to Q1205-30 is 'Hazard and McMahon, unpublished'). As the coordinates could not be obtained through private communication, we had to 'rediscover' Q1205-30. We found that one way in which this could be accomplished was by obtaining a prism plate of the area around RA 12h05m, DEC -30^o from the UK-prism survey. After careful visual inspection of a copy of the plate UJ9085P we found a point source with an emission line consistent with being Lyα at $z \approx 3.0$ and measured its approximate coordinates from the plate. By examining the corresponding field in the Digital Sky Survey we measured the precise position of Q1205-30 to be RA 12 05 35.72, DEC -30 14 25.8 (1950).

3 Observations and data Reduction

We have applied a narrow/broad band filter technique in several earlier studies of galaxy counter parts of DLAs (e.g. Møller & Warren, 1993, Fynbo, Møller & Warren, 1999). This method is extremely well suited towards service observations since it requires many long integrations of the same field on the sky during dark time. We hence submitted a proposal for and obtained NTT service mode time to image the field of Q1205-30 using a special 20Å (fwhm) narrow filter centred at 4906Å, which is the wavelength of redshifted Lyα, and in standard B and I filters. The data were obtained during January, February and March, 1998. The total integration times in each filter and the seeing in each of the combined frames are given in Table 1.

Also observed were two standard star fields from Landolt (1992) and the three spectrophotometric standard stars Eggr99, Feige 56 and L970.

The individual reduced images in each of the three filters were combined using the code described in Møller and Warren (1993), which optimizes the signal-to-noise for faint objects. We reach 5σ limiting magnitudes of 26.0 in B(AB), 25.1 in I(AB) and 25.1 in the narrow band. At $z = 3.036$ a narrow band

AB magnitude of 25.1 corresponds to a Lyα flux of $1.0 \times 10^{-17} ergs^{-1} cm^{-2}$.

4 Results

4.1 The neighborhood of Q1205-30

Fig.1 shows the result of the subtraction of the point-spread function (PSF) of Q1205-30 in the I-band. Seen is a red galaxy 3 arcsec east of the QSO, a fainter blue galaxy 2 arcsec west of the QSO and most importantly excess emission in the narrow band north of the QSO (green fuzz).

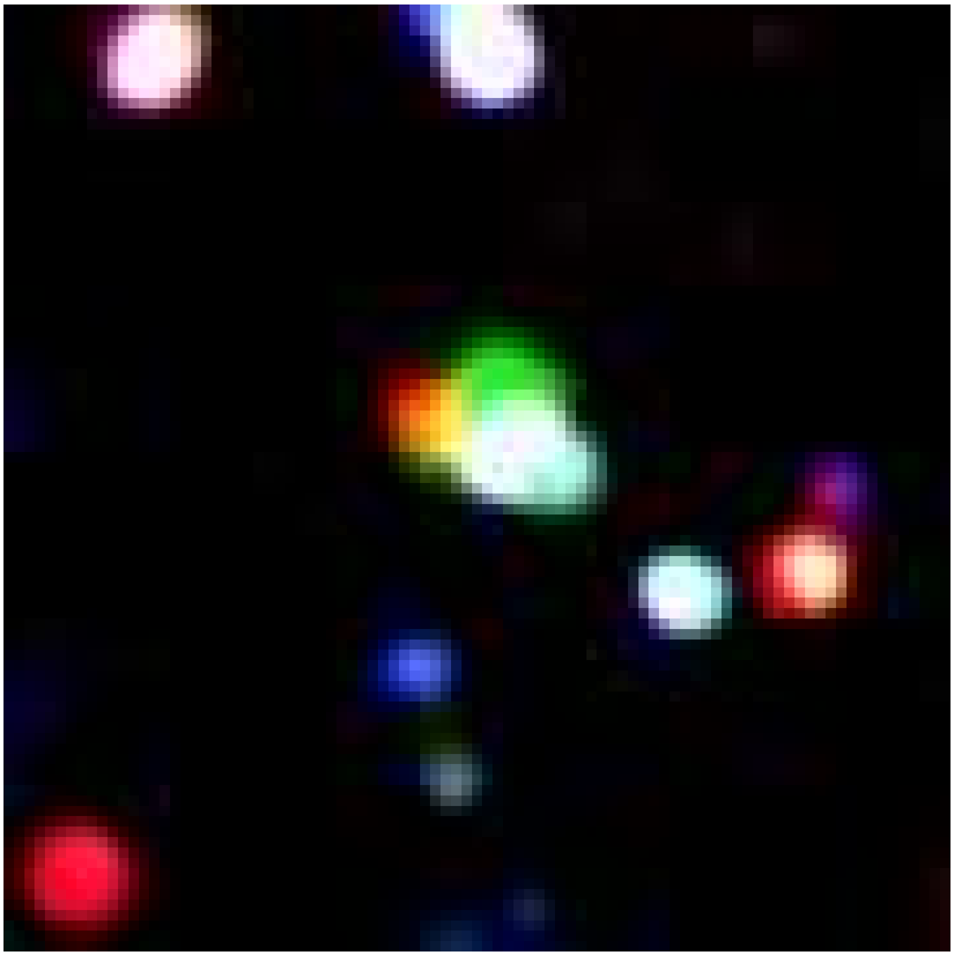

Figure 1: A composite colour image showing a 90x90 pixels, 32x32 arcsec^2, region surrounding Q1205-30. The colour coding is red (I-band), blue (B-band) and green (narrow-band). 95% of the QSO-flux has been subtracted in each filter in order to show excess emission close to the QSO line of sight. North is up and east is to the left.

4.2 Lyα emitters in the field

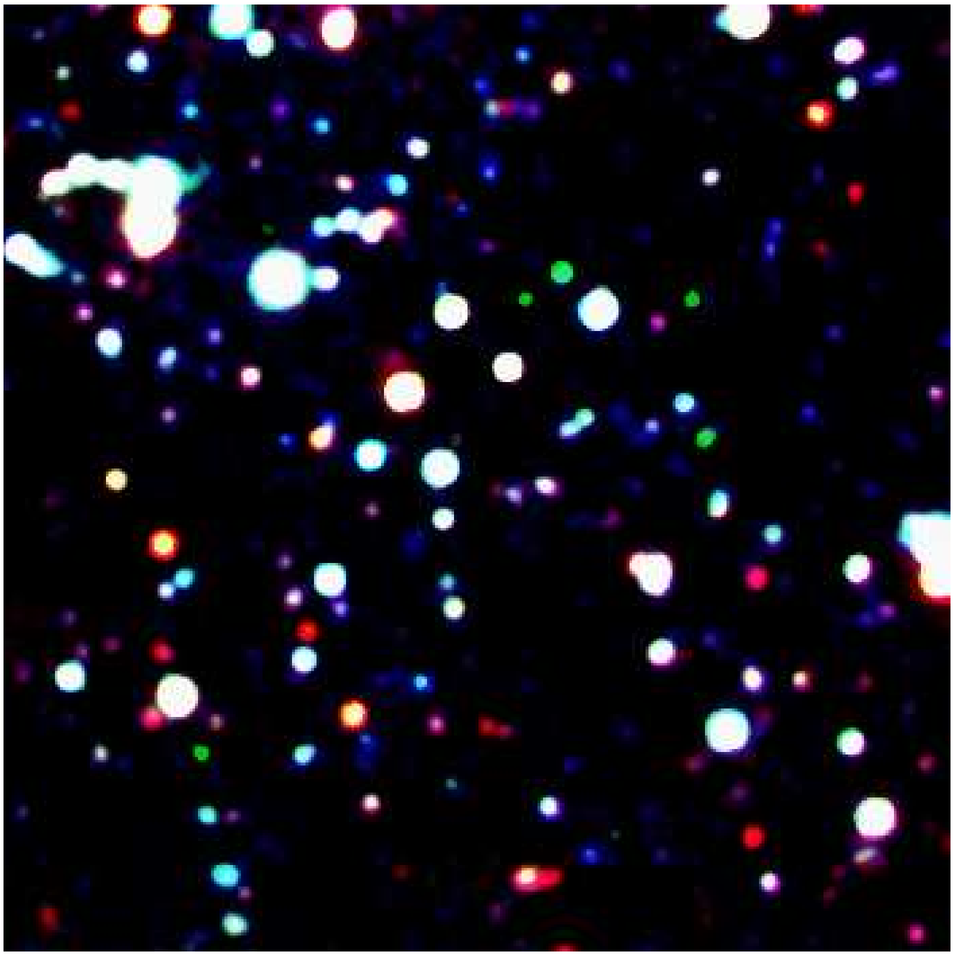

Figure 2: A composite colour image showing a 350x350 pixels, 123x123 arcsec^2, region containing a group of 5 candidate Lyα emission line galaxies 70-150 arcsec west of Q1205-30. The colour coding is red (I-band), blue (B-band) and green (narrow-band). North is up and east is to the left. The emission line galaxies are the green objects north west of the centre and in the lower east corner. Q1205-30 is located about 120 arcsec east and outside this frame.

In order to pick out galaxies in the field associated with the QSO/absorber system with Lyα line emission we performed photometry in the three bands using the photometry package SExtractor (Bertin & Arnout, 1996). 473 galaxies were detected with a signal–to–noise ratio (SN) > 5 in the narrow band. Fig. 3 shows the two-colour diagram $n(AB) - B(AB)$ *versus* $n(AB) - I(AB)$ for these objects. Five galaxies with strong excess emission in the narrow band filter compared to the B-band filter were found at separations from 80 to 150 arcsec west of Q1205-30. These five galaxies are shown in Fig. 2. The Lyα fluxes range from $1.1 \times 10^{-17} ergs^{-1}cm^{-2}$ to $4.0 \times 10^{-17} ergs^{-1}cm^{-2}$. Q1205-30 has a slight excess emission in the narrow band filter compared to B. The weakness of this excess emission is the result of the blue wing of the Lyα emission line of the QSO being absorbed partly by the Lyman limit absorber.

5 Future work

We need to perform spectroscopic follow-up observations in order to confirm the redshifts of the candidate emission line galaxies and the three sources close to the QSO line of sight.

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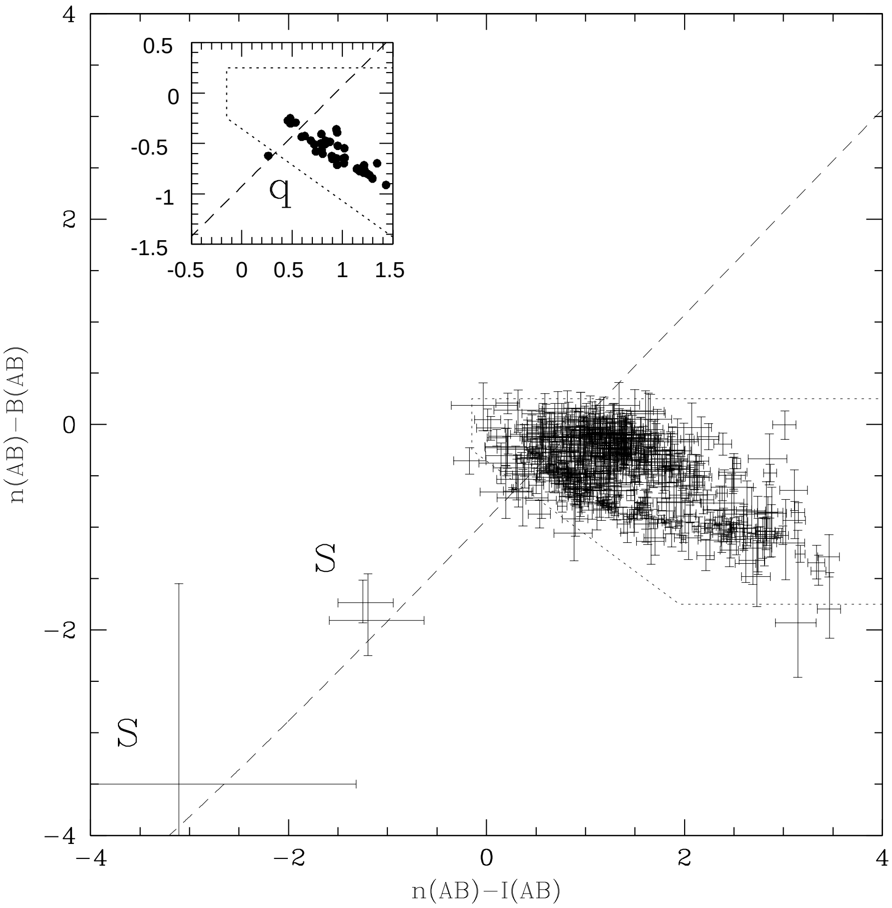

Figure 3: Two-colour diagram $n(AB) - B(AB)$ *versus* $n(AB) - I(AB)$ for objects detected with SN in the narrow–band frame > 5. The dashed line is a line of constant $B - I$ in the continuum (chosen to be that of Q1205-30), but with a spectral feature in the narrow filter ranging from a strong absorption line in the upper right hand corner to a strong emission line in the lower left hand corner. Three of the five candidate emission line galaxies are seen in the lower left corner. The remaining two are detected in neither B nor I. The dotted lines confine the expected region of objects with no special features in the narrow filter. The inserted diagram shows a blow up of the region of the plot containing Q1205-30 (marked q) and objects with SN$>$ 30.