X-shooter Science Verification Proposal

Title: Critical test of DLA absorption vs. emission metallicity

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Abstract:

We propose to observe diagnostic line ratios (of redshifted OII, OIII, Hα, Hβ) of a candidate DLA/LBG galaxy at z=2.383 (in the narrow redshift window where this is possible from ground). This will allow the critical test of absorption line metallicity vs emission line metallicity for a DLA galaxy.

The target is 1.4" from the quasar, so technically this would require spectral PSF subtraction (SPSF: Møller 2000, Messenger, 99, 31). We have successfully done this before on ISAAC data (Weatherley et al. 2005, MNRAS,358,985). From an SV perspective this is a critical test how well SPSF subtraction can be done on X-shooter NIR data.

Scientific Case:

Metallicity and evolution of galaxies at high redshifts: DLAs vs. LBGs

A central aspect of the history of the Universe is the formation and evolution of galaxies, and in particular their gradual build-up of metals. The study of galaxies in the early universe is mainly centred around Lyman Break Galaxies (LBGs) while the study of the metals at the same cosmic epoch is based on the study of damped absorbers (DLAs) in the sight-lines towards bright quasars. In order to be able to form a complete picture of galaxy evolution one must find a way to combine the two, and it is a perplexing fact that there is almost no overlap between the two samples. LBG samples are flux limited, and therefore they carry information only about the brightest objects while DLAs are absorption cross-section selected which means they are heavily biased towards the faint end of the luminosity function.

In conclusion: The DLAs and the LBGs are in the mean picked from two opposite ends of the high z galaxy luminosity function and cannot, not even in a statistical sense, currently be combined. The only way to learn how to combine the emission and absorption data of high redshift objects is therefore to perform targeted identification of individual DLA galaxies. Unfortunately identifying DLA galaxies in emission has proven very difficult and to date only very few are know.

A new DLA/LBG candidate was recently discovered during a survey for Lyman-α emitters (LAEs) in the field of the quasar Q2138-4427 (Grove, Fynbo et al., 2009, A&A 497, 689). This quasar has two known DLAs at $z_{abs} = 2.852$ and $z_{abs} = 2.383$. In the narrow band (NB) image we found a faint object close (1.4") to the quasar (See Fig. 1). The object is visible in the NB image only, not in the B-band image, because of the higher contrast against the quasar which is heavily absorbed (1.5 mag) by the DLA in NB.

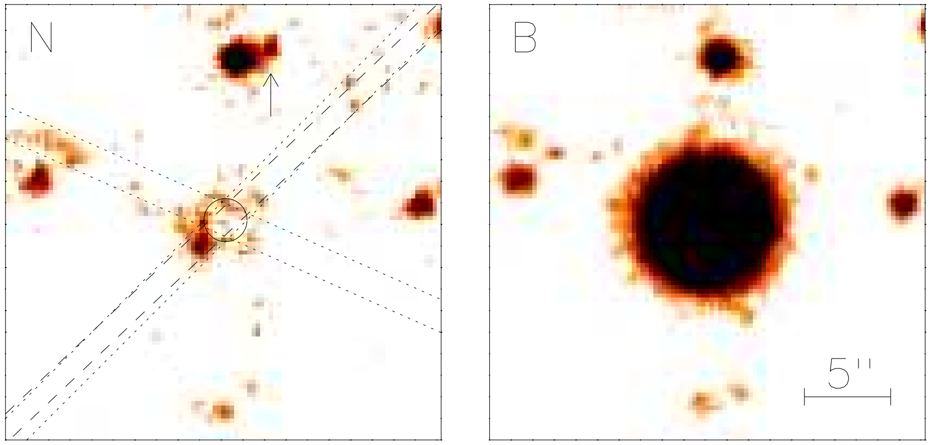

Figure 1: *Right panel:* B-band image of the quasar Q2138-4427. *Left panel:* Narrow band image of the same field but here we have performed PSF-subtraction of the quasar image revealing a B(AB)=25.7 object at a projected distance of 1.4 arcsec. (Figure taken from Grove, Fynbo et al., 2009)

The AB magnitude of the object is 25.7, which is in the range of typical LBGs, and it's projected proximity to the quasar makes it very likely that this galaxy is the host of one of the two DLAs. We have already obtained spectra covering Lyα at the two DLA redshifts but no Lyα emission line was seen (Grove, Fynbo et al, 2009). This is not surprising as only 25% of LBGs have Lyα in emission.

Here we propose: to obtain an X-shooter spectrum aligning the slit with the quasar Q2138-4427 and the nearby candidate LBG/DLA galaxy. The goals of this observation are the following: **(1)** Search for rest-wavelength optical emission lines (OII, OIII, Hα, Hβ) from the candidate to determine it's redshift. **(2)** We suspect that the most likely redshift is that of the lower redshift DLA (2.383). If this is confirmed then all of those diagnostic lines are redshifted into favorable IR wavelengths allowing us access to all of them from ground. This would allow us to determine both the emission line metallicity and the absorption line metallicity (from the quasar spectrum obtained at the same time) and compare them. This critical test of our interpretation of high redshift metallicity data has so far never been possible. Note that there are only very few redshift windows where this test is possible due to the atmospheric absorption in the IR. **(3)** In case we find an emission line redshift different from both DLAs then we can search the quasar spectrum for a corresponding absorption system.

Calibration strategy:

Standard calibrations is all we need. The reduction requires that we are able to decompose the emission lines of the faint neighbour from the continuum of the quasar. We have developed software for this task (spectral PSF subtraction, SPSF: Møller 2000, Messenger, 99, 31). This project will therefore also serve as a demonstration that X-shooter data of close neighbours can be analyzed.

Targets and number of visibility measurements

Target	RA	DEC	V mag	Mode (slit/IFU)	Remarks
Q 2138-4427	21 41 59.8	-44 13 26	18.9	slit	Align slit with faint neighbour

Time Justification:

From Weatherley et al. 2005, MNRAS,358,985 we find OIII 5007 line fluxes of 7.6 and 6.8 (10^{-17} erg/s/cm2) from high redshift galaxies of V(AB) respectively 24.69 and 25.75. Based on this we predict an OIII 5007 line flux in the range 3.0 - 6.8 (10^{-17} erg/s/cm2). The faintest of the lines we target is the OII 3727 (redshifted to 1259.7 nm). Assuming a canonical ratio and using the Xshooter ETC we find that a S/N of 8 is obtained in 5×900 seconds. Adding overheads we request 1.5 hours for the spectrum. Comparison to commissioning data analyzed by us provided a similar exposure time.