

# X-shooter Science Verification Proposal

## ”The IGM-Galaxies Connection in the Deep-02h VVDS Field”

Investigators	Institute	EMAIL
Celine PEROUX	Observatoire Astronomique de Marseille-Provence	celine.peroux@gmail.com
Laurence TRESSE	Observatoire Astronomique de Marseille-Provence	laurence.tresse@oamp.fr
Olivier ILBERT	Observatoire Astronomique de Marseille-Provence	olivier.ilbert@oamp.fr
Olivier LE FEVRE	Observatoire Astronomique de Marseille-Provence	olivier.lefevre@oamp.fr

### **Abstract:**

Understanding galaxy formation is one of the major goals of modern cosmology. The next challenge is to understand the physical processes of the formation of galaxies and structures and their interactions with the tenuous medium in between galaxies: the Intergalactic Medium (IGM). The IGM forms and connects galaxies, fuels them throughout time, and may be profoundly changed by their feedback of energy, matter, and chemical elements. We propose to obtain X-Shooter spectra of 5 quasars within the Deep-02h VVDS Field in order to cross-correlate their Ly- $\alpha$  1215 Å, CIV 1548-1550 Å and MgII 2796-2803 Å absorbers with the 7972 foreground galaxies with secure spectroscopic redshifts.

### **Scientific Case:**

The Intergalactic Medium (IGM) is known to be the major reservoir of baryons at high-redshifts. Thanks to large samples of  $z\sim 3$  galaxies, it is now possible to study observationally their connection with this ionised gas reservoir. Several interactions have been identified ranging from accretion of the gas for star formation within the galaxies to galactic winds polluting the IGM with metals up to low overdensities (i.e. Ryan-Weber et al. 2009, MNRAS, 395, 1476).

Recently, Adelberger et al. (2005, ApJ, 629, 636) have used Lyman-Break techniques to select  $z\sim 3$  galaxies in the field of quasars. They thus have been able to study the cross-correlations of Lyman- $\alpha$  and CIV absorbers seen in the spectra of background quasars with the galaxy population in the field. They found that CIV is detected in most of the galaxies haloes up to a hundred of kpc. Similarly, they find that Ly- $\alpha$  is associated with galaxies up to distances as high as 10 Mpc. More surprisingly, their observations hint to a decrease of this cross-correlation at small distances ( $<4$  Mpc).

The CFHTLS-D1-02h equatorial field has been extensively observed by the magnitude-selected VVDS Deep spectroscopic VIMOS survey (Le Fèvre et al. 2005, AA, 439, 84) yielding reliable spectroscopic identifications for several thousands objects between  $z = 0$  and  $z = 5$ . It is a pure  $I$ -band limited dataset for which the 2D spectra have been observed and redshifts accurately measured with spectral features such as the Lyman break, the Ly $\alpha$  emission, the FUV absorption lines, etc (Tresse et al. 2007, A&A, 472, 403). Spectroscopic redshifts are reliable at a  $\delta(z)=0.005$  level. The selection function is well-controlled through the whole redshift baseline up to  $z\sim 5$ , as well as the incompleteness using the most recent photometric redshifts over this field which include the new deep JHK WIRCAM imaging and thus enable reliable photometric redshifts with  $\Delta(z)=0.03 \times (1+z)$  (Ilbert, et al. 2006, A&A, 453, 809). Here, we propose to make use of the UV to IR coverage of X-Shooter to look for absorbers in the spectra of some

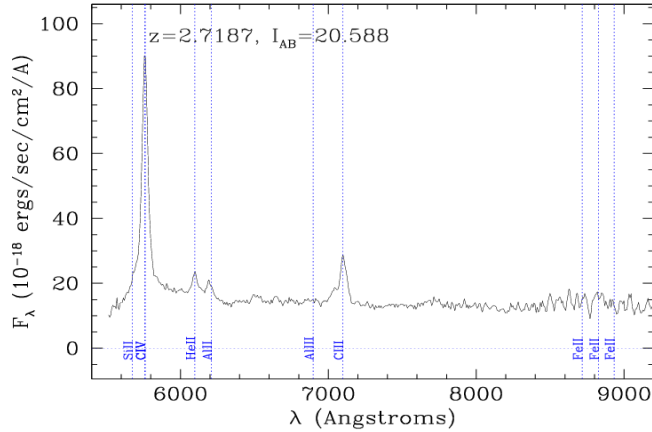


Figure 1: VVDS spectrum of quasar 020268754. The emission lines of CIV and CIII are clearly visible even at this modest resolution. We propose here to get a X-Shooter spectrum of five quasars such as this one in order to have higher-resolution Ly- $\alpha$ , CIV and MgII absorbers coverage with which to study the IGM-Galaxies connection.

of the quasars in the field.

### Calibration strategy:

We do not foresee in special calibration other than the standard ones. Because the targets are point like, nodding along the slit will be used for sky subtraction in the IR without lost on the total exposure time.

### Targets and number of visibility measurements

We have selected five of the quasars with  $z > 2$  and AB mag  $R < 21.0$  in order to look for Ly- $\alpha$ , CIV and MgII absorbers. The emission redshift of these objects range from  $z_{em} = 2.13$  to 3.28. An example of a VVDS quasar spectrum is shown in **Figure 1**. In the same field, there are 7972 galaxies with secure spectroscopic redshifts at  $z < 3.28$ . The Deep-02h VVDS Field covers a  $0.62 \text{ deg}^2$  effective area, i.e. roughly  $450 \times 450 \text{ Mpc}^2$  at the redshift of the quasars.

These objects are visible at the end of the night during the August X-Shooter SV run.

Target	RA	DEC	V mag	Mode (slit/IFU)	Remarks
VVDS020268754	+02 26 09.62	-04 24 37.73	20.60	slit	$z_{\text{em}}=2.7187, T_{\text{exp}} = 1\text{hr}$
VVDS020188089	+02 25 25.68	-04 35 09.45	20.94	slit	$z_{\text{em}}=2.1384, T_{\text{exp}} = 1\text{hr}$
VVDS020180665 <sup>a</sup>	+02 26 45.45	-04 36 15.42	19.32	slit	$z_{\text{em}}=3.2619, T_{\text{exp}} = 0.5\text{hr}$
VVDS020465339 <sup>b</sup>	+02 27 06.44	-04 19 24.29	21.31	slit	$z_{\text{em}}=3.2852, T_{\text{exp}} = 2\text{hr}$
VVDS020208084	+02 27 29.24	-04 32 27.50	19.10	slit	$z_{\text{em}}=2.2900, T_{\text{exp}} = 0.5\text{hr}$

<sup>a</sup> follow-up FORS 3800 to 6500 Å spectrum available from Gavignaud et al. 2006 (A&A, 457, 79).

<sup>b</sup> this object was included in our selection since  $R < 21.0$ , but has a V mag slightly fainter.

**Time Justification:**

We aim for a SNR of about 20 and a resolution of  $R=8800$  in the VIS arm of X-Shooter in order to securely detect the absorbers down to rest equivalent width  $\text{EW}(\text{CIV})=0.06 \text{ \AA}$  at  $5\text{-}\sigma$ . We estimated the exposure times using the X-Shooter E.T.C. version 3.2.8, with the following parameters: i) slit width (UVB)=1.0 arcsecs, slit width (VIS) = 0.9 arcsecs, slit width (NIR) = 0.9 arcsecs; ii) point source; iii) seeing=1.00 arcsecs and iv) airmass=1.6.

The exposure time for each object are provided in the target table. We therefore request a total of 5 hrs with X-Shooter to study 5 quasar spectra. We emphasize that some of our scientific objectives could be achieved at lower significance with a smaller number of quasar spectra. **Indeed, this proposal could provide a high scientific return for a relatively small investment in terms of telescope time.**