X-shooter Science Verification Proposal

Title: X-shooter spectroscopy of the tantalizing double QSO0151+048A+B

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Abstract:

This is a short proposal to secure X-shooter spectroscopy of the enigmatic QSO pair Q0151+048A+B. The purpose of the observation is to determine the systemic redshifts of the two QSOs from their [OIII] and Hα emission lines and to detect extended emission (Lyman-α, [OIII] and Hα) from a huge HI cloud we have previously detected with narrow band imaging at the same redshift as the two QSOs.

Scientific Case:

Q0151+048A+B (also known as PHL1222) is a physical pair of QSOs at redshifts 1.922 (QSO A) and 1.937 (QSO B) separated by 3.3 arcsec on the sky (Williams & Weymann 1976, ApJL, 207, L43; Møller et al. 1998, A&A, 330, 19). In the spectrum of QSO A there is a damped Lyman-α absorber (DLA) at redshift 1.9342 (i.e. slightly larger than that of QSO A). We have previously detected an extended Lyman-α emitter covering 6 arcsec in front of QSO A, presumably related to the DLA (Fynbo et al. 1999, MNRAS, 305, 849). We have observed the system with X-shooter in Comm. 1 using only the UV and visible arms (see Fig. 1). We obtained a 1 hr spectrum covering both QSOs. From this spectrum we have established that there is no absorption in QSO B at the redshift of the DLA and determined the metallicity of the DLA to be very low: [M/H]$= -1.8$. In addition, the velocity broadening is very low, of the order 10 km s^{-1}. This is surprising given that the absorbing cloud is in such a dense environment containing two QSOs within a few tens of kpc.

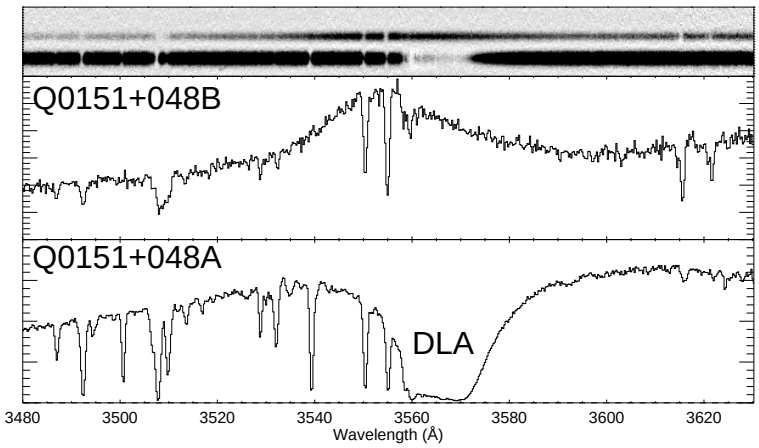

Figure 1: X-shooter spectra obtained in Comm. 1. Here we only show the region around Lyman-α in both spectra. There is a strong DLA in the spectrum of QSO A, but no absorption at all at that redshift in the spectrum of QSO B. In the trough of the DLA there is Lyman-α emission, presumabely from the DLA galaxy counterpart.

We here propose to observe the source again in science verification. We have two goals: *i)* To measure the systemic redshift of both QSOs using the [OIII] and Hα lines. Note that the near-IR arm was not mounted when we obtained the first spectrum. The systemic redshifts are needed to establish the true geometry of the system. The UV lines are typically blueshifted by several 1000 km s^{-1} and are hence not useful for establishing the precise systemic redshifts (Tytler & Fan 1992, ApJS, 79, 1). To reach this goal we need a single 1 hr spectrum aligned with the two QSOs (PA = 41.2^{o} EofN). *ii)* As seen in Fig. 1, there is residual emission in the trough of the DLA (see also Møller et al. 1998 cited above). From narrow band imaging (Fynbo et al. 1999, cited above) we have determined the size of the Lyman-α emitting region to be very large, 6×3 arcsec^2. We have tentative evidence from the Nordic Optical Telescope that there is rotation along the major axis of the emitter. Here we wish to confirm this finding with a 1 hr spectrum aligned with the major axis of the emitter (centred on QSO A with a PA of 98^{o} EofN. This spectrum will also allow us to search for other lines from the emitter, most notably [OIII].

Both targets have emission of the full spectral range of X-shooter from the UV cutoff to K. Therefore, this program is an interesting way to probe how a single observation can secure good data over the full spectral range.

Calibration strategy:

Targets and number of visibility measurements

Target	**RA**	**DEC**	**V** mag	**Mode** (slit/IFU)	**Remarks**
Q0151+048A+B, PA 41.2^{o}	01 53 53.9	+05 02 57	18.0	slit	First priority
Q0151+048A, PA 98^{o}	01 53 53.9	+05 02 57	18.0	slit	Second priority

Time Justification:

We already have a 1 hr X-shooter spectrum covering only the UV and visible arms. From that we clearly detect emission in the DLA trough so 1 hr is sufficient for goal *ii*. The [OIII] emission lines from the QSOs are bright enough that 1 hr should also be sufficient for goal *i*. In total we ask for 2 hr + overhead (about 2.5 hr in total).