X-shooter Science Verification Proposal

Line properties of Lyα blobs at high redshift

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Abstract:

Lyα blobs are some of the most intriguing objects found in the high redshift Universe. It is still, ten years after the first discovery, unclear what powers these enormous clouds of ionised gas. With new, excellent instruments such as X-shooter, this question is about to be solved. We propose using three hours of X-shooter science verification time to study the line properties of one of these enigmatic objects at high redshift ($z \sim 2.3$), in order to prove the feasibility of observing restframe optical lines from high redshift galaxies, and to further our understanding of what powers Lyα blobs.

Scientific Case:

Introduction: Lyα blobs

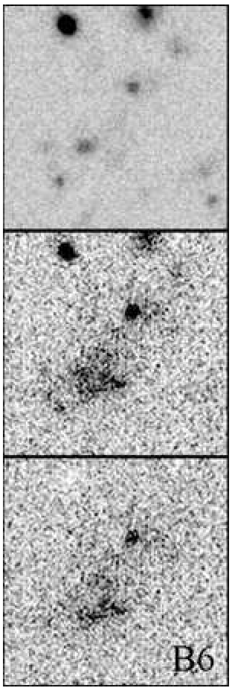
Since the first discovery of a high redshift Lyα blob (Steidel et al. 2000), several tens of these enigmatic sources have been detected and many possible emission mechanisms proposed. Lyα blobs are clouds of ionised gas, emitting strongly in the Lyα line, with line luminosities up to 10^{44} erg s^{-1} cm^{-2}, and observed sizes up to 150 kpc. Some are found around radio galaxies (Miley & de Breuck 2008), some harbour Lyman-break galaxies or bright infrared galaxies (Matsuda et al. 2004, Dey et al. 2005) and one has even been found without a visible counter-part (Nilsson et al. 2006). The mechanisms proposed to explain the luminous Lyα clouds include extreme star formation, the so-called "super-wind" scenario (Ohyama et al. 2003, Mori et al. 2004), ionisation by obscured/un-obscured AGN (Weidinger et al. 2005) or heating by infalling gas onto a dark matter halo (Fardal et al. 2001, Nilsson et al. 2006). It is still unclear how these blobs are powered, as well as how often they occur and during what phase of galaxy formation.

Lyα blob B6

In Palunas et al. (2004), narrow-band imaging of the field around the J2143-4423 cluster was presented. In this field, several large Lyα blobs were found, and several compact Lyα emitters. One of the blobs found was blob B6, as proposed to observe here, see also Figure 1. This blob is of medium size in their sample, it has a major axis of $8''$, or about 64 kpc. It was also observed with Spitzer-MIPS at 24μm, as presented in Colbert et al. (2006). The detection revealed that blob B6 has a total Far-IR luminosity of 5.2×10^{12} L$_{\odot}$, consistent with ULIRG luminosities, indicating that it contains a dusty starburst galaxy, or an obscured AGN. Blob B6 has been spectroscopically confirmed, with Lyα spectroscopy, to have a redshift of $z = 2.367$. This makes it excellently suited for follow-up observations with X-shooter, as many of the diagnostic restframe optical emission lines are observable in the near-IR.

Immediate objective

We propose with this science verification program to observe the Lyα blob B6, in order to verify the capability of X-shooter to observe restframe optical emission lines of $z \sim 2$ galaxies, and in order to study the line properties of a Lyα blob. In Figure 1, the sky transmission and OH emission lines are shown in the near-IR, with the location of the emission lines we wish to observe overlaid. It is clear that with the observations proposed here, we will be able to observe the forbidden oxygen lines and potentially the Hα and Hβ lines, if either are present. Using the observations of these lines, we can study the radiative transfer processes occurring by comparing the Lyα and Hα measurements and we can measure metallicites from the oxygen lines. We will further learn about the degree of ionisation in the Lyα cloud, and separate which power mechanism described above is the dominant one for this blob. With the resolution of X-shooter we will also be able to model the Lyα line; revealing clues of e.g. the dust optical depth, HI column densities and intrinsic Lyα EWs (Tapken et al., 2007).



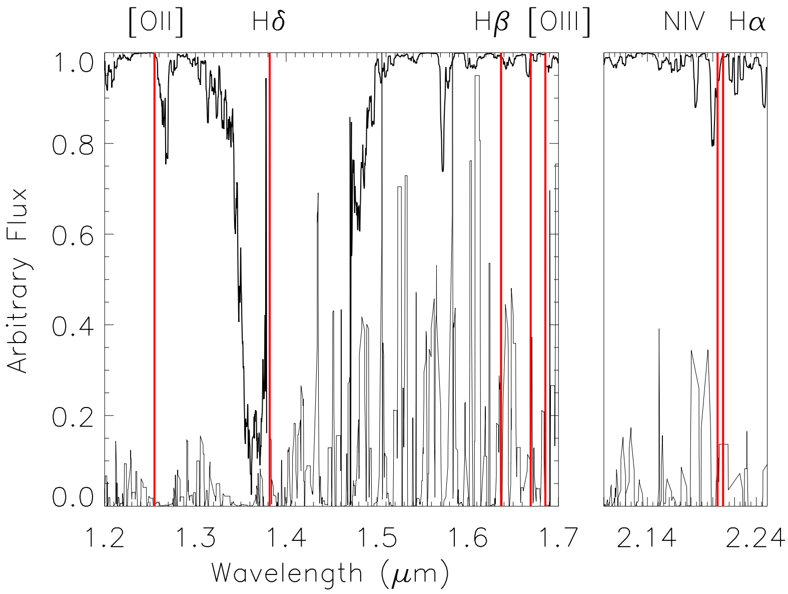


Figure 1: **Left** Imaging thumb-nails of blob B6. Top image is B band, middle image is narrow-band and bottom image is the continuum-subtracted narrow-band (Lyα). Each image is $30'' \times 30''$. From Palunas et al. 2004. **Right** Plot of the OH sky emission lines (bottom) and the sky transmission (top) in the near-IR. Red thick lines mark the position of several restframe optical emission lines, such as [OII], Hβ, [OIII] and Hα for the redshift of the blob B6. The oxygen lines, as well as Hα should be observable if present.

Targets and observing mode

Target	RA	DEC	B mag	Mode (slit/IFU)	Remarks
Blob B6	21 42 42.63	−44 30 09.0	24.02	slit	also detected with Spitzer, major axis 8″

Time Justification:

For the exposure calculations we have used the X-shooter ETC (v.3.2.8). The blob has a Lyα flux, as measured in the narrow-band image, of 1.4×10^{-15} erg s^{-1} cm^{-2}, resulting in a surface brightness of $\sim 3 \times 10^{-17}$ erg s^{-1} cm^{-2}. To observe the Lyα line alone, in the UVB arm, one observing hour (including overheads) under normal conditions (3 days from new moon, airmass 1.2, seeing $1''$) gives an integrated detection of $> 8\sigma$. The ratio of Hα to Lyα can range from $\sim$ 0.1 to 1, depending on the Lyα attenuation. The Hα fluxes will thus be larger than $\sim 3 \times 10^{-18}$ erg s^{-1} cm^{-2}. To detect this line with $> 5\sigma$, three observing hours are needed. The Hβ line has typically one third of the Hα flux, and will also reach 5σ in three hours. The oxygen lines, [OII] and [OIII], are difficult to estimate, as we do not know their intrinsic line strengths. A good assumption is that they will not be fainter than Hβ and thus clearly detected in three observing hours. To summarise, all the lines we expect to be observable should be securely detected in three hours of observing time, and we hence ask for three hours of science verification time on the target blob B6.