X-shooter Science Verification Proposal

Hide and seek – disappearing Lyα in a GRB host?

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Abstract:

GRB host galaxies are often intense emitters of Lyα photons. It is not rare to detect Lyα emission (from the host) in afterglow spectra. One nice example is provided by GRB 060714 at $z = 2.711$: an afterglow spectrum taken 8.5 hr after the GRB showed bright Lyα with flux 1.7×10^{-17} erg cm^{-2} s^{-1} (luminosity $L = 10^{42}$ erg s^{-1}). Surprisingly, in a late-time spectrum of the host (1.7 yr after the GRB) there is no Lyα down to a 3σ flux limit of 1.1×10^{-18} erg cm^{-2} s^{-1}, which is a factor of 15 lower than our previous measurement. If confirmed, such variability would be puzzling to explain, and would indicate a profound influence of the GRB on the galaxy environment. A possible reason to fake the "disappearance" of the line could be a complex spatial geometry of the emitting region, which may have been included by the slit in the first spectrum but not in the second. We propose here a snapshot (1 hr) observation with the X-shooter IFU of this system to look for the "disappeared" Lyα emission and to study its spatial distribution.

Scientific Case:

Gamma-ray bursts (GRBs) release a huge amount of energy in the form of electromagnetic radiation (up to 10^{54} erg if isotropic), and hence their impact on the surrounding medium can be profound. Variability of absorption lines in afterglow spectra has been detected, the material being located up to a few kpc away from the GRB explosion site. However, up to date no variation in the emission line fluxes have been detected. Line emission likely originates from a large number of regions separated hundreds of light-years from each other. By causality arguments, it takes order of hundreds of years for the GRB radiation to affect these regions. Variability is thus not expected unless the emitting region is very compact.

It was thus a big surprise to detect an apparent strong variation of the Lyα line flux in the host of GRB 060714: the line intensity dropped by at least a factor of 15 comparing spectra taken 8.5 hr and 1.7 yr after the GRB explosion.

Before claiming such an extraordinary fact, several checks are in order. The line observed in the early afterglow spectrum was significant at 7σ level, and it was seen in individual exposures, both in the 2D and 1D spectra. Reduction was carried out independently by two of us. The late-time spectrum was taken with a more sensitive CCD, and had a similar exposure time and sky conditions. We thus expect comparable or even better detection limits. We carefully checked that the slit position was correct; indeed, continuum from the host is detected in the spectrum, indicating no obvious blunders. Furthermore, other objects falling serendipitously in the slit are detected at the right place. The reason for the line variability seems to be a physical one.

In the two spectra, the slit position angles were different (the two slits being almost orthogonal). If the geometry of the line-emitting region is complex, then it could be possible that the slit of the first spectrum was encompassing the emitting region, while in the second spectrum this region was not covered. Indeed, it is not uncommon that the Lyα emission is more extended than the continuum.

We thus propose to observe the host of GRB 060714 with the X-shooter IFU. The available field of view is enough to cover the outskirts of this galaxy (which in broad-band imaging appears almost point-like).

We will be able to detect, if any, Lyα emission wherever it is located, and to study its spatial distribution. In case of no emission, we will have solid grounds to claim the disappearence of the line.

Calibration strategy:

Standard calibration is adequate.

Targets and number of visibility measurements

Target	**RA**	**DEC**	**R** mag	**Mode** (slit/IFU)	**Remarks**
GRB 060714	15:11:26.43	-06:33:58.3	26.6	IFU	

Time Justification:

The targetted line was detected in a Tektronix/FORS1+300V afterglow spectrum with 1.5 hr exposure time. It was non-detected in the E2V/FORS1+300V host spectra (again, 1.5 hr exposure time). X-shooter has a better efficiency than the 300V grism, as well as better resolution (which lowers the line background). We thus expect to reach a meaningful limit with 1 hr exposure. The ETC confirms that we can reach a limiting flux of $\sim 2 \times 10^{-18}$ erg cm^{-2} s^{-1} (at S/N = 3), which is enough to establish variability of the line.