# The optical afterglow and host galaxy of GRB 000926

Johan P.U. Fynbo[1], Javier Gorosabel[2], Palle Møller[1], Jens Hjorth[3], Michael I. Andersen[4], Mathias P. Egholm[5], Brian L. Jensen[3], Holger Pedersen[3], Bjarne Thomsen[5], and Michael Weidinger[5]

[1] ESO, Garching, Germany
[2] DSRI, Copenhagen, Denmark
[3] Copenhagen Observatory, Denmark
[4] Division of Astronomy, Oulu University, Finland
[5] IFA, Århus, Denmark

**Abstract.** In this paper we illustrate with the case of GRB 000926 how Gamma Ray Bursts (GRBs) can be used as cosmological lighthouses to identify and study star forming galaxies at high redshifts. The optical afterglow of the burst was located with optical imaging at the Nordic Optical Telescope 20.7 hours after the burst. Rapid follow-up spectroscopy allowed the determination of the redshift of the burst and a measurement of the host galaxy HI-column density in front of the burst. With late-time narrow band Ly$\alpha$ as well as broad band imaging, we have studied the emission from the host galaxy and found that it is a strong Ly$\alpha$ emitter in a state of active star formation.

## 1 Introduction

Although the nature of the "central engines" of GRBs still are a subject of intense debate it is now well established that the majority of the long duration GRBs occur in star forming galaxies at cosmological redshifts (see Van Paradijs, Kouveliotou & Wijers 2000 for a review).

In this paper we focus on GRB 000926. This long duration burst was detected on September 26.9927 (UT) 2000 by three instruments (Ulysses, Konus and NEAR) in the Interplanetary Network (IPN, e.g. Klebsabel et al. 1982; Hurley et al. 2000), and localized to a 35 arcmin$^2$ error box which was circulated via the GRB Coordinates Network (GCN)[1] 20.3 hours after the burst (Hurley 2000). GRB 000926 was well studied over a wide range of the electromagnetic spectrum (Fynbo et al. 2001; Price et al. 2000, Piro et al. 2001; Harrison et al. 2001).

## 2 Identification of the afterglow

Optical follow-up observations started at the Nordic Optical Telescope 17 minutes after the release of the IPN error box coordinates (Hurley 2000). In the main panel of Fig. 1, we show an R–band image of the Optical Afterglow (OA). The OA is marked with an arrow. The three small panels show the fading of the afterglow during the following days.

[1] `http://gcn.gsfc.nasa.gov/gcn/`

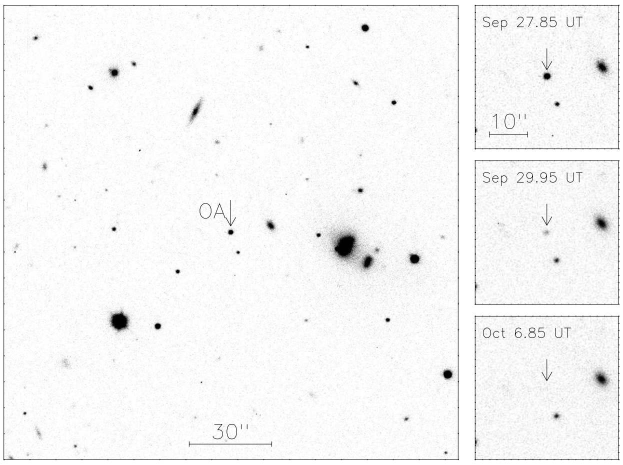


**Fig. 1.** *Left panel*: The R–band image of the OA taken 17 minutes after the release of the IPN error box coordinates. The OA is marked with an arrow. *Right panels*: Three smaller R–band images at three epochs showing the decline of the OA.

## 3 Spectroscopy

Optical spectra of the afterglow were obtained 21.7 hours and 44.4 hours after the burst. The combined spectrum is shown in Fig. 2. Seen are a number of strong metal absorption lines from which a redshift of z=2.0377 is determined. We detect no lines from intervening absorbers. In the blue end of the spectrum there is a damped absorption line due to neutral hydrogen from which we infer a HI column density of around $2\times10^{21}$ cm$^{-2}$. The equivalent widths of the metal absorption lines are stronger than for any known Damped Ly$\alpha$ Absorber at similar redshifts (Møller et al. in preparation).

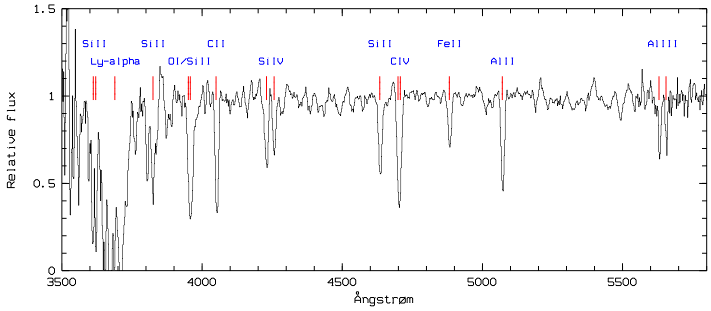


**Fig. 2.** The spectrum of GRB 000926 showing strong metal absorption lines as well as a damped Ly$\alpha$ absorption line at z=2.0377.

## 4 The host galaxy

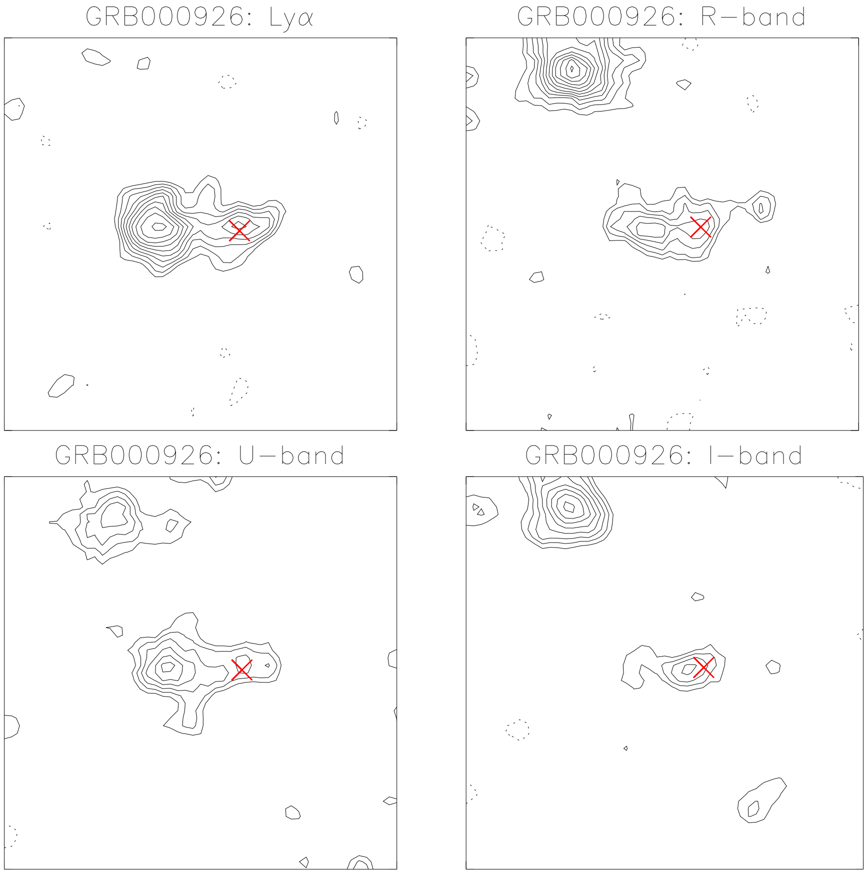


**Fig. 3.** The host galaxy of GRB 000926 as imaged in Ly$\alpha$, U, R and I. The R-band image is taken from Fynbo et al. (2001). East is to the left and north is up. The size of the images is $10{\times}10$ arcsec$^2$. The position of the optical afterglow is indicated with an $\times$. The GRB occurred in the redder and fainter western part of the Ly$\alpha$ emitting region.

With deep R–band imaging obtained 1 month after the burst we detect the host galaxy as an extended object consisting of several compact knots. In order to study the host galaxy further, we obtained a special narrow (fwhm 45Å) band filter designed to cover Ly$\alpha$ at the GRB redshift. In May 2000 we obtained 12 hours of imaging in the narrow filter as well as 7 hours of imaging in the U filter and 3 hours of imaging in the I filter at the Nordic Optical Telescope. We detect the host galaxy in all bands (Fig. 3). The host galaxy is a relatively strong Ly$\alpha$ emitter (we detect one brighter Ly$\alpha$ emitter in the field). About 65% of the Ly$\alpha$ emission comes from the eastern knot of the host and the remaining 35% from the western knot in which the GRB occured. Although the signal-to-noise ratio is low, the western knot seems to be brightest in the I-band, and it must hence be redder than the other components. This indicates either more extinction or the presence of an older stellar population.

## 5 Summary

GRB 000926 occurred in a star forming galaxy at a redshift of z=2.0377. The optical spectrum of the afterglow shows strong metal absorption as well as a damped Ly$\alpha$ absorption from metal enriched gas in the host galaxy of the burst. The galaxy is a strong Ly$\alpha$ emitter consisting of at least two compact knots. The GRB occurred in the western and reddest of the knots.

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