The optical afterglow of GRB 030226[1]

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Abstract. We report on optical and near-infrared follow-up observations of the afterglow of GRB 030226 performed with the telescopes at ESO La Silla and Paranal. Our observations started 0.2 days after the burst when the afterglow was at a magnitude of $R \approx 19$. One week later the magnitude of the afterglow had fallen to R=25, and at two weeks after the burst it could no longer be detected ($R > 26$). VLT blue-band spectra show two absorption line systems at redshifts $z = 1.962 \pm 0.001$ and 1.986 ± 0.001, indicating to a metal-rich environment of the burster.

INTRODUCTION

GRB 030226 was discovered by the *HETE-2* satellite on 2003 February 26.15731 UT (3:46 UT). Its duration was longer than 100 seconds, its peak flux and fluence in the 30-400 keV band were $\sim 1.2 \times 10^{-7}$ erg cm^{-2} s^{-1} and 5.7×10^{-6} erg cm^{-2}, respectively (Suzuki et al. 2003). The optical counterpart was detected ~2.5 hours later (Fox et al. 2003) at a magnitude $R \sim 18.5$ (Garnavich et al. 2003) at coordinates (J2000) RA = 11:33:04.9; Dec = +25:53:55.6 (Price et al. 2003), well within the *HETE-2* Wide Field X-ray monitor (WXM) and Soft X-ray Camera (SXC) error boxes.

[1] on behalf of the GRACE collaboration

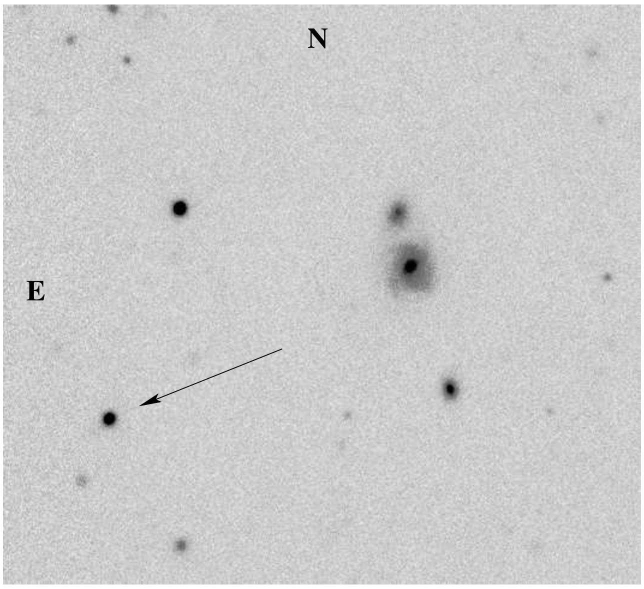

FIGURE 1. *J*-band image of the afterglow of GRB 030226 obtained 5 hrs after the burst with VLT/ISAAC. The field size is approximately $1' \times 1'$. The optical transient ist marked with an arrow.

OBSERVATIONS

Imaging in the near-infrared (NIR) bands started ~4.5 hrs after the burst using VLT/ISAAC at ESO Paranal (Fig. 1). Simultaneously, imaging in the optical was performed using the ESO NTT telescope at La Silla equipped with the multi-purpose instrument EMMI. Further data were obtained in the following nights with the NTT equipped with the SUperb Seeing Imager (SuSI2) and VLT/FORS1.

The early report of the discovery of the GRB afterglow by Fox et al. (2003) allowed for a rapid spectroscopic observation of the optical transient (Greiner et al. 2003). These observations were performed 5 hrs after the burst with VLT Yepun/FORS 2. A 900 s exposure using the 300V grism was obtained when the afterglow was at a magnitude of $B \approx 19.8$. A second spectroscopic run was performed one night later using VLT Antu/FORS 1 equipped with the 600B grism.

RESULTS AND DISCUSSION

In Fig. 2 we display the results of the fits based on our ESO *R*-band data. The best fit using the equation suggested by Beuermann et al. (1999) is $\alpha_1 = 0.70 \pm 0.25$, $\alpha_2 = 2.66 \pm 0.32$, $t_b = 1.04 \pm 0.12$ days, and $n = 1.2 \pm 1.1$ (χ^2/d.o.f.= 3.8), where the symbols have their usual meaning: α_1 is the pre-break slope, α_2 is the post-break slope, t_b is the break time and n characterizes the smoothness of the fit. Potential fluctuations in the light curve are apparent. Kulkarni et al. (2003) also noticed an unusual behavior of the afterglow light curve between 2.3 and 3.3 days after the burst.

GRB 030226 joins the set of bursts with well-observed light curves which allow for

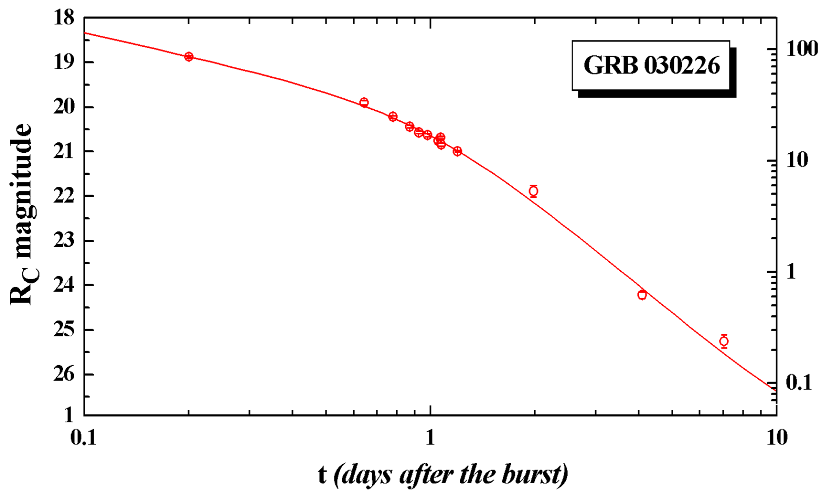

FIGURE 2. The *R*-band light curve of the afterglow of GRB 030226 based on our data obtained at the telescopes at ESO. Note the rapid fading of the afterglow. No host galaxy is apparent in our data down to $R > 26$.

a check of their color evolution and temporal behavior. Our multi-band data allowed us to search for color changes before, during, and after the break in the light curve. Before the break time, based on our multi-color data set on day 0.2, we obtain for the spectral slope β across the optical/NIR bands $\beta = 0.90 \pm 0.03$. Based on the observed spectral energy distribution of the GRB afterglow no evidence for dust in the GRB host galaxy was found. After the break time, on day 4.1, we obtain $\beta = 0.96 \pm 0.09$. In other words, there is no evidence for a change in the spectral slope of the afterglow in the optical/NIR bands before and after the break time. This is in agreement with the prediction of the simplest jet model, according to which the break should be achromatic if it is due the increasing relativistic opening angle when the fireball decelerates (Mészáros & Rees 1999).

The host of GRB 030226 represents another impressive example of a high-z galaxy for which we obtained information about the metal content of its interstellar medium, although the potentially underlying host remained undetectable on our VLT images. The VLT spectra of the optical transient show several absorption lines, but no prominent emission lines. From the absorption lines two redshift systems at z=1.962±0.001 and 1.986±0.001 can be determined (Fig. 3), We find systems of Fe II, Al II, C IV, O I, C II, Si IV, and Si II. Their rest-frame equivalent widths are comparable to those found in other GRB afterglows (e.g., Castro et al. 2003; Masetti et al. 2001; Matheson et al. 2003). We conclude that the interstellar medium close to the burster is possibly enriched with α-group elements. We tentatively identify this as being either a feature of the wind from a Wolf-Rayet star, which was the GRB progenitor, or an interstellar medium shaped by the nucleosynthesis of type II supernovae.

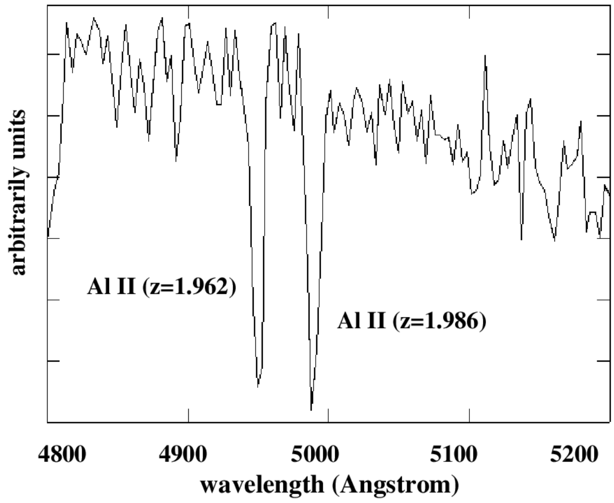

FIGURE 3. Zoom-in of the VLT/FORS2 spectrum of the GRB afterglow obtained 5 hrs after the burst. Shown here are the two pronounced aluminium absorption lines at redshifts z=1.962 and 1.986.

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