Optical afterglow observations of GRB 021004 and GRB 030226

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Abstract. We present our multi-band optical afterglow observations of the long duration GRB 021004 and GRB 030226 in combination with other published data to study the nature of the bursts. Optical afterglow light-curves of both the GRBs exhibit signatures of collimated outflow. Observed superimposed variability in the case of GRB 021004, in the form of bumps and wiggles, suggest density fluctuations in the ambient medium. The derived temporal and spectral flux decay indices of GRB 030226 afterglow show an inconsistency with the theoretically predicted values.

Keywords: Optical, observations, afterglows

OBSERVATIONS

Optical photometric observations of GRB 021004 and GRB 030226 afterglows in *BVRI* and *UBVRI* passbands respectively [2, 3] were carried out using the 1.04-m Telescope of the ARIES, Naini Tal and the 2.01-m Telescope at the Indian Astronomical Observatory, Hanle, India. Published photometric data for both the GRBs in literature were also used after putting them on the same photometric scale to reproduce the afterglow light-curves (LCs). We used our photometric calibration for both the GRBs to correct for inconsistencies between different published photometries. For both the GRB fields we have long temporal coverage and our data fill in the gaps (see Figure 1) in the LCs. The results from our analysis of these two afterglows are briefly described below.

DISCUSSIONS AND RESULTS

GRB 021004

Modeled *UBVRI* afterglow LCs of GRB 021004 are shown in Figure 1 (left panel) over-plotted on the observed data. The *ISM* jet model gives a reasonably good fit with a fitted jet-break time t_j around 8 days after the burst. Using this value of t_j, the output γ–ray energy is estimated to be $\sim 1.3\times10^{51}$ erg. Also, our model explains the early re-brightening (around 0.1 day after the burst) in terms of the passage of the synchrotron peak frequency through optical bands. Due to dense temporal coverage, superimposed variabilities in the GRB 021004 optical afterglow LCs is clearly visible in form of bumps and wiggles. Such deviations from the smooth power-law decay are not expected from

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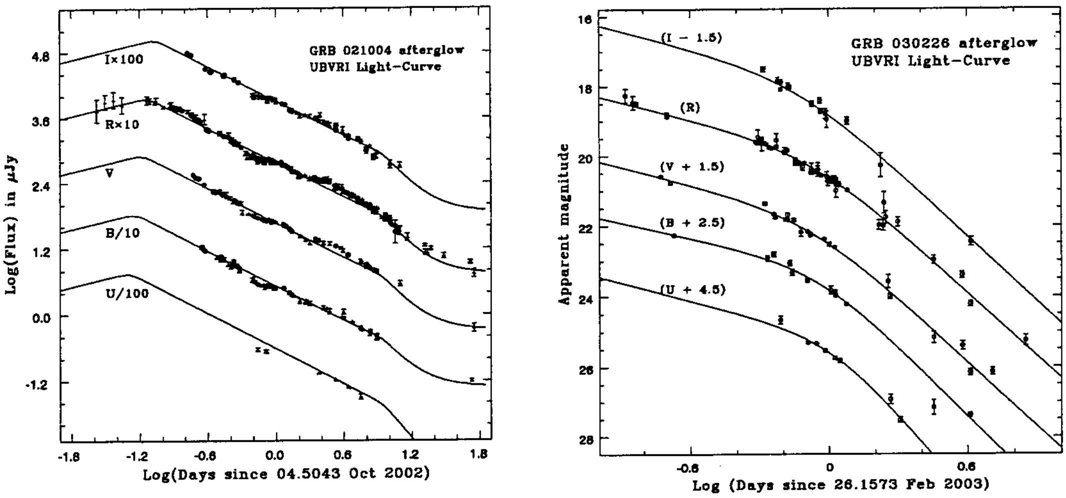

FIGURE 1. *UBVRI* afterglow LCs of GRB 021004 (left) and GRB 030226 (right). Solid circles are our observed data points. The solid lines are the modeled LCs over-plotted on the observed afterglow data points. Vertical offsets have been used to avoid the overlapping.

the simple fireball synchrotron model. These near achromatic variabilities might arise due to density fluctuations in the ambient medium.

GRB 030226

Our *UBVRI* photometric data is used along with other published data to study the nature of GRB 030226 afterglow LCs (see Figure 1). The broken power-law fit to the multi-band *BVR* data [3] gives an average value of early time temporal flux decay index α_1 = 0.67±0.02, late time temporal flux decay index α_2 = 2.5±0.03 and t_j = 0.86±0.03 day. Constructed spectral energy distribution around 0.83 day after the burst, using the de-reddened *BVRIK* magnitudes, gives a spectral index $\beta = -0.82 \pm 0.02$. The determined β is consistent with the measured α_2, if cooling frequency ν_c lies above the optical band [1]. However, this predicts an α_1 around 1.2, much steeper than the observed value of 0.67±0.02. The data are therefore not consistent with the predictions of *ISM* jet model with ν_c lying below optical bands. The derived value of t_j in the case of GRB 030226, yields an estimated output γ−ray energy around 0.8×10^{51} erg, assuming particle density n around 1 cm^{-3}.

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