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# THE SHORT-TIME VARIABILITY OF GRB021004

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The gamma-ray burst (GRB) GRB021004 was detected by the FREGATE, WXM, and SXC instruments on board the *High Energy Transient Explorer II (HETE-II)* at 12:06:13.57 UT on 2002 October 4 (Shirasaki et al., 2002). At 48 seconds after the detection, the WXM localized coordinate was informed via the GRB Coordinates Network (GCN), and optical follow-up observations started immediately. The optical afterglow was identified as a object at R.A. $00^{\rm h}26^{\rm m}54\overset{\rm s}{.}674$ Dec. $+18^\circ55'41\overset{''}{.}59$ (J2000), determined by Henden & Levine (2002) with brightness of $\sim$15 mag at 9.45 minutes after the burst (Fox, 2002). The optical spectra of the afterglow showed two MgII absorption systems which revealed $z = 1.38$ and 1.60 (Fox et al., 2002; Eracleous et al., 2002; Anupama et al., 2002) and the multi-component Lyman$\alpha$ systems revealed $z \sim 2.3$ (Chornock & Filippenko, 2002; Sahu et al., 2002; Salamanca et al., 2002; Savaglio et al., 2002; Castro-Tirado et al., 2002). GRB021004 is the first case of the particularly observed the variability of magnitudes and colors from early time. In this paper we present the results of the $VRcIc$ time-resolved photometry from 0.078 to 0.336 days after the burst.

We started the observation of GRB021004 at 13:56:48 UT on 2002 October 4, using the Bisei Astronomical Observatory (BAO) 1.01-m telescope. At first an hour, we imaged the 12-field mosaic for covering the entire WXM error box in $R_c$ band, and after identified the afterglow potion by Fox (2002), pointed the telescope to center of the afterglow and repeated $Rc$ band exposures during 30 min. After that, for 4.5 hours until the sunrise, the $VR_cI_c$ multicolor observation was continued. The electric cooled CCD camera CV-16IIE (assembled by MUTOH Industries Ltd. and Koheishya, Japan) was attached to the bend-cassegrain focus. The detector is a Kodak KAF-1602E with 1536$\times$1024 pixels and a pixel size of 9 $\mu$m. The field of view is 7.8$\times$5.2 arc minutes and the 3$\times$3 pixels were read out as one pixel corresponded to a 0.9 arc seconds square. The instrumental gain is 4.43 e-/ADU and the noise included the read-out and dark is 37.1 e-. The exposure time for the object was set to 60 seconds. The object frames were dark-subtracted and flat-fielded. The several images were stacked for improving $S/N$. The photometric procedure was made with APPHOT in IRAF. The reference star for magnitude calibration was used R.A. $00^h26^m58^s\!.77$ Dec. $+18°56'56''\!.1$ (J2000), $V = 16^m\!.258 \pm 0^m\!.006$, $R_c = 15^m\!.538 \pm 0^m\!.016$, $I_c = 14^m\!.896 \pm 0^m\!.028$ (Henden, 2002).

The $VR_cI_c$ light curves of the optical afterglow of GRB021004 obtained by our observation and the unfiltered data of Uemura (2003) are shown in Figure 1. These are obviously deviation from simple power-law decay, whose decay index seems to change steeper between 0.1 and 0.2 days. The colors ($V - R_c = 0^m\!.46 \pm 0f^m\!.12, R_c - I_c = 0^m\!.52 \pm 0^m\!.10$) did not change within photometric errors during our multicolor observation.

The $R_c$ band magnitudes exhibited short-time variation. The first two points in $R_c$ band at $t \sim 0.07 - 0.09$ days were kept with 16.4 mag. After that, it was temporary fading to 16.6 mag at $t \sim 0.1$ days and brightened up to 16.5 mag at $t \sim 0.11$ days. The time interval of this short-time variation was within ∼30 min. This "dip" behavior could be found in the unfiltered data of Uemura (2003). Furthermore the brightness of the afterglow was constant $t \sim 0.25 - 0.29$ days (∼1 hour) and fading again after $t \sim 0.3$ days. Similar bumps also appeared in later observations (e.g. Bersier et al., 2003).

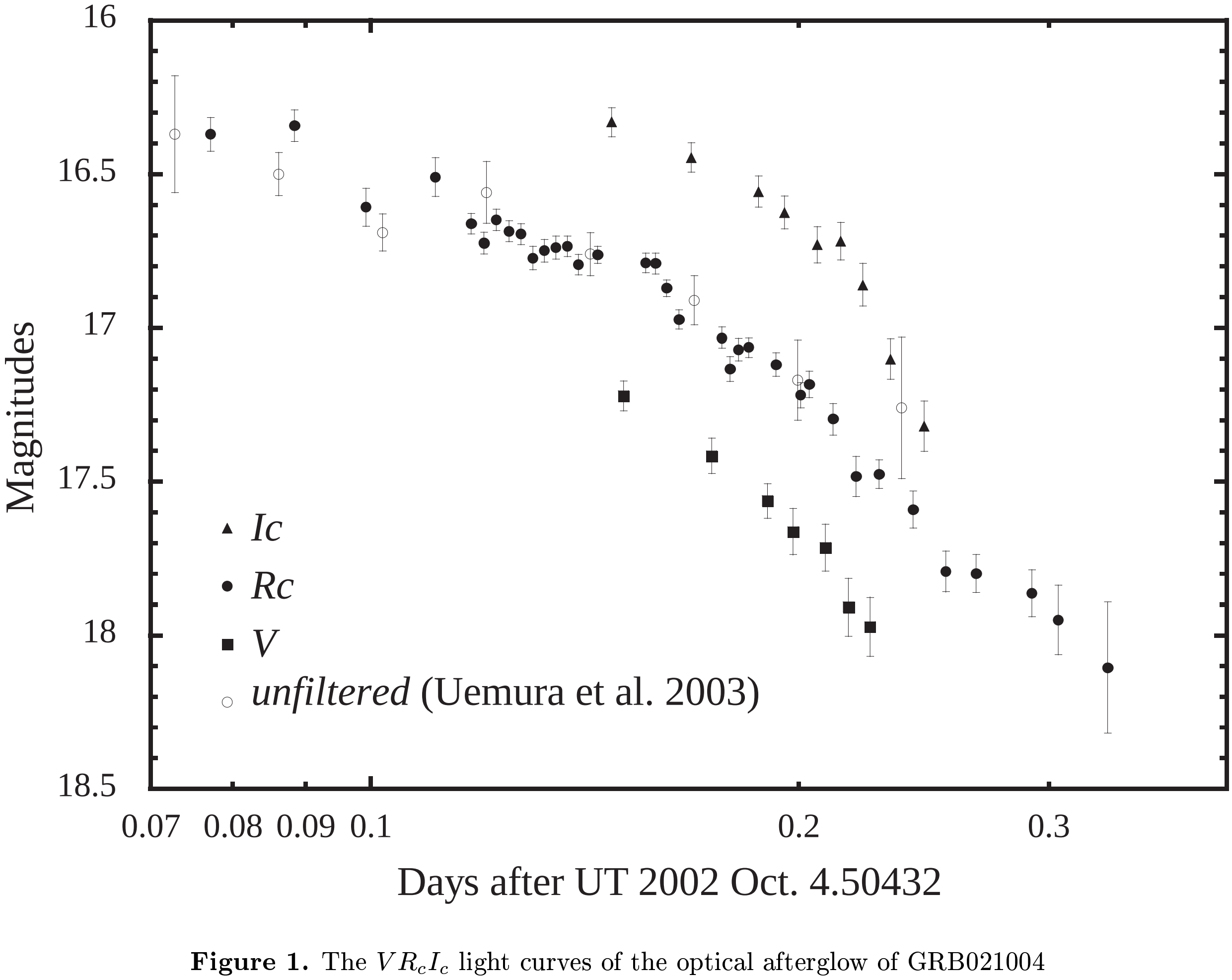


**Figure 1.** The $VR_cI_c$ light curves of the optical afterglow of GRB021004

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## ERRATUM FOR IBVS 5531

Figure captions in this issue are swapped, Fig. 1. shows the primary eclipse, while Fig. 2. is the secondary eclipse.

The Editors