Swift Observations of GRB 090904B

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1 Introduction

The Swift BAT triggered on and located GRB 090904B at 01:24:18 UT (trigger=361831) (D'Elia et al., GCN Circ. 9881). Swift slewed immediately to the burst and XRT and UVOT observations of the field started 134 and 137 seconds after the trigger, respectively. The best Swift position is the XRT localization at RA(J2000)= 264.18534 deg, Dec(J2000)= −25.21305 deg, RA(J2000)= $17^{\rm h}36^{\rm m}44.48^{\rm s}$, Dec(J2000)= $-25^{\rm d}$ 12' 47.0", with an error radius of 1.8 arcsec (90% confidence).

The optical afterglow was detected from the ground by GROND (Olivares et al., GCN Circ. 9901).

The prompt emission of GRB 090904B was also detected by the Fermi Gamma-Ray Burst Monitor (Goldstein, GCN Circ. 9895) and by INTEGRAL/SPI-ACS.

2 BAT Observations and Analysis

Using the data set from T-119 s to T+303 s (Sakamoto et al., GCN Circ. 9890), the BAT ground-calculated position is RA(J2000)= 264.194 deg, Dec(J2000)= −25.219 deg, RA(J2000)= $17^{\rm h}36^{\rm m}46.5^{\rm s}$, Dec(J2000)= $-25^{\rm d}$ 13' 09.0", with an uncertainty of 1.2 arcmin, (radius, sys+stat, 90% containment). The partial coding was 8%.

The mask-weighted light curve (Figure 1) shows the burst starting at ∼T-30 sec with multiple overlapping peaks between ∼T-5 s and ∼T+20 s. T_{90} (15–350 keV) is 47.0 ± 1.7 s (estimated error including systematics).

The time-averaged spectrum from T-2.5 s to T+49.7 sec is best fit by a simple power-law model. The power law index of the time-averaged spectrum is 1.59 ± 0.07. The fluence in the 15–150 keV band is $(1.23 \pm 0.05) \times 10^{-5}$ erg cm^{-2}. The 1-second peak photon flux measured from T+12.42 sec in the 15–150 keV band is 5.3 ± 0.9 ph cm^{-2} s^{-1}. All the quoted errors are at the 90% confidence level.

The results of the batgrbproduct analysis are available at http://gcn.gsfc.nasa.gov/notices_s/361831/BA/

3 XRT Observations and Analysis

Swift-XRT began observing the field of GRB 090904B at 01:26:32.3 UT, 134.2 seconds after the BAT trigger (D'Elia et al., GCN Circ. 9881, 9893).

Using all the XRT available data (all in PC mode), we find an astrometrically corrected X-ray position (using the XRT-UVOT alignment with 6206 seconds of overlapping time and matching UVOT field sources to the USNO-B1 catalogue): RA(J2000)= 264.18537 deg, Dec(J2000)= −25.21326 deg, RA(J2000)= $17^{\rm h}36^{\rm m}44.49^{\rm s}$, Dec(J2000)= $-25^{\rm d}$ 12' 47.7", with an uncertainty of 1.8 arcsec (radius, 90% confidence).

The 0.3–10 keV light curve (Figure 2) shows a rising behaviour and a peak at T=250 s. After this time up to ∼T+200 ks it can be modelled with a simple power-law with a decay index of $\alpha_1 = 1.20^{+0.03}_{-0.05}$. At later times the X-ray afterglow is no longer detected by XRT.

The average X-ray spectrum (0.3–10 keV) from T+137 s up to T+53 ks is well fit by an absorbed power-law model with a photon index $\Gamma = 1.81 \pm 0.25$ and a column density $N_H = 7.5^{+2.5}_{-2.2} \times 10^{21}$

cm^{-2} in excess to the Galactic one in the direction of the source ($N_H = 3.3 \times 10^{21}$ cm^{-2}, Kalberla et al. 2005). The average observed 0.3–10 keV flux for this spectrum is $(9.3^{+1.1}_{-3.2}) \times 10^{-12}$ erg cm^{-2} s^{-1}.

All the quoted errors are at the 90% confidence level.

4 UVOT Observation and Analysis

The UVOT began settled observations of the field of GRB 090904B starting 138 s after the BAT trigger (Pritchard & D'Elia, GCN Circ. 9898).

The optical/UV afterglow was not detected and the corresponding 3-sigma upper limits are listed in Table 1. The values quoted are not corrected for the expected Galactic extinction in the direction of the burst corresponding to a reddening of $E_{(B-V)} = 1.76$ mag (Schlegel et al. 1998, ApJS, 500, 525). All photometry is in the UVOT photometric system described in Poole et al. (2008, MNRAS, 383, 627).

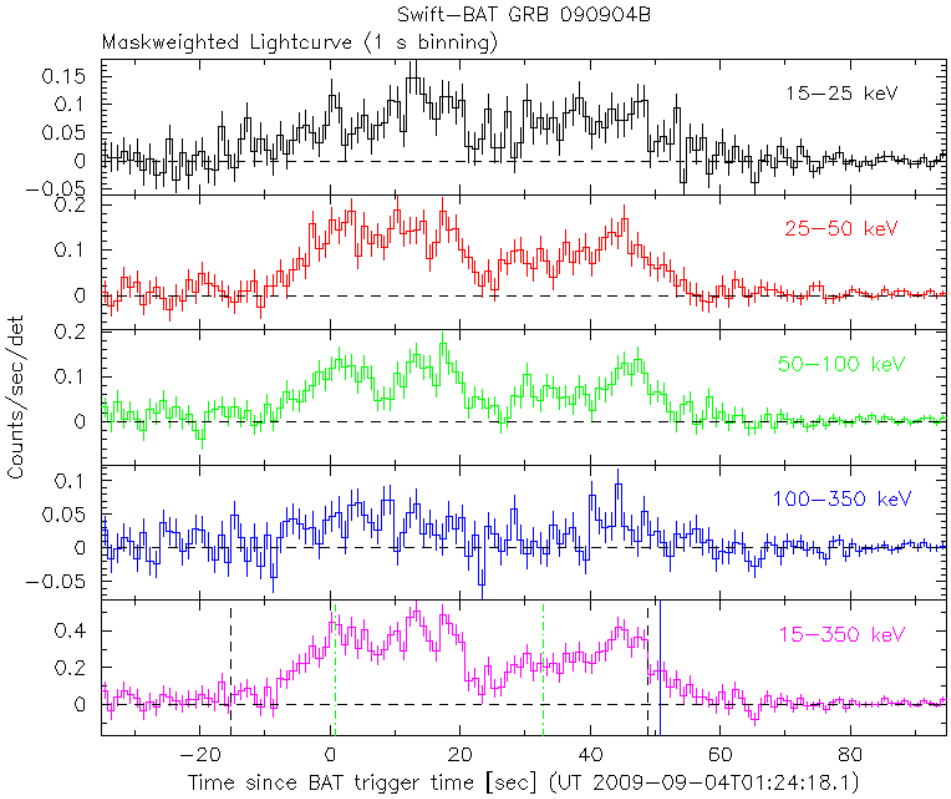

Figure 1: BAT light-curve. The mask-weighted light curve in the 4 individual plus total energy bands. Green dotted line: T_{50}, Black dotted line: T_{90}. Blue: Slew start. The units are counts s^{-1} illuminated-detector^{-1} (note illum-det = 0.16 cm^2).

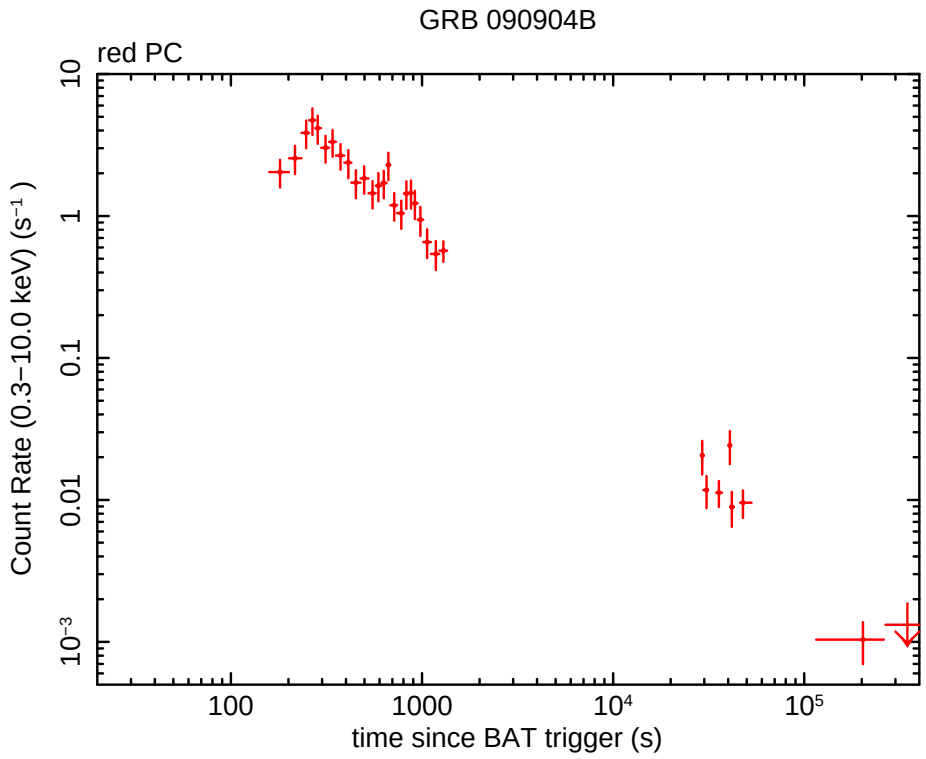

Figure 2: XRT light-curve. Count rates in the 0.3–10 keV band taken in Photon Counting (PC) mode are plotted. The approximate conversion of the 0.3–10 keV observed flux is 1 count/s $\sim 6.6 \times 10^{-11}$ erg cm^{-2} s^{-1}.

Filter	T_start (s)	T_stop (s)	Exp (s)	Mag
white	138	1357	369	> 22.17
v	625	1237	78	> 19.08
b	551	1335	78	> 20.08
u	295	545	246	> 20.41

Table 1: 3-sigma upper limits from UVOT observations.