

Swift Observations of GRB 090904A

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1 Introduction

The Swift BAT triggered on and located GRB 090904A at 01:01:06 UT (trigger=361830) (Perri et al., GCN Circ. 9879). Swift slewed immediately to the burst and XRT and UVOT observations of the field started 134 and 141 seconds after the trigger, respectively. The best Swift position is the XRT localization at RA(J2000)= 100.88480 deg, Dec(J2000)= 50.20300 deg, RA(J2000)= 06^h43^m32.35^s, Dec(J2000)= +50^d 12' 10.8", with an error radius of 1.6 arcsec (90% confidence).

A candidate optical afterglow was detected from the ground by NOT (Malesani et al., GCN Circ. 9884).

2 BAT Observations and Analysis

Using the data set from T-119 s to T+276 s (Palmer et al., GCN Circ. 9888), the BAT ground-calculated position is RA(J2000)= 100.855 deg, Dec(J2000)= 50.235 deg, RA(J2000)= 06^h43^m25.2^s, Dec(J2000)= +50^d 14' 06.9", with an uncertainty of 3.0 arcmin, (radius, sys+stat, 90% containment). The partial coding was 75%.

The mask-weighted light curve (Figure 1) shows low level emission starting at \sim T-40 s, with a small peak at \sim T+5 s. Then there was a larger peak at \sim T+50 s, and then the largest peak (FRED-like) starting at \sim T+123 s and peaking at \sim T+128 s. Riding on that tail is a peak \sim T+173 s. The event is over in the BAT energy band at \sim T+240 s. T_{90} (15–350 keV) is 122 ± 10 s (estimated error including systematics).

The time-averaged spectrum from T+29.3 s to T+186.3 s is best fit by a simple power-law model. The power law index of the time-averaged spectrum is 2.01 ± 0.10 . The fluence in the 15–150 keV band is $(3.0 \pm 0.2) \times 10^{-6}$ erg cm⁻². The 1-second peak photon flux measured from T+127 s in the 15–150 keV band is 1.9 ± 0.2 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/361830/BA/>

3 XRT Observations and Analysis

Swift-XRT began observing the field of GRB 090904A 134 seconds after the BAT trigger (Perri et al., GCN Circ. 9894).

Using all the XRT available data, the astrometrically corrected X-ray position (using the XRT-UVOT alignment with 10129 seconds of overlapping time and matching UVOT field sources to the USNO-B1 catalogue) (Evans, GCN Circ. 9891) is: RA(J2000)= 100.88480 deg, Dec(J2000)= 50.20300 deg, RA(J2000)= 06^h43^m32.35^s, Dec(J2000)= +50^d 12' 10.8", with an error radius of 1.6 arcsec (radius, 90% confidence).

During the first Swift orbit, the 0.3–10 keV light curve (Figure 2) shows a steep decay with a large superimposed flare peaking at about T+300 s. Starting from T+1000 s up to T+398 ks, the curve is well described by a broken power-law model with temporal decay indices $\alpha_1 = 0.25(+0.15)(-0.19)$, $\alpha_2 = 1.25(+0.17)(-0.15)$ and a temporal break $t_b = 15(+6)(-4)$ ks. At later times the X-ray afterglow is no longer detected by XRT.

The average X-ray spectrum (0.3–10 keV) from T+460 s up to T+29.6 ks is well fit by an absorbed power-law model with a photon index $\Gamma = 2.46(+0.16)(-0.26)$ and an absorption column density $N_H = 1.03(+0.66)(-0.64) \times 10^{21} \text{ cm}^{-2}$ in excess to the Galactic one in the direction of the source ($N_H = 9.3 \times 10^{20} \text{ cm}^{-2}$, Kalberla et al. 2005).

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 090904A starting 141 s after the BAT trigger (Pritchard et al., GCN Circ. 9899).

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 $E_{(B-V)} = 0.1 \text{ mag}$ (Schlegel et al. 1998). All photometry is in the UVOT photometric system described in Poole et al. (2008, MNRAS, 383, 627).

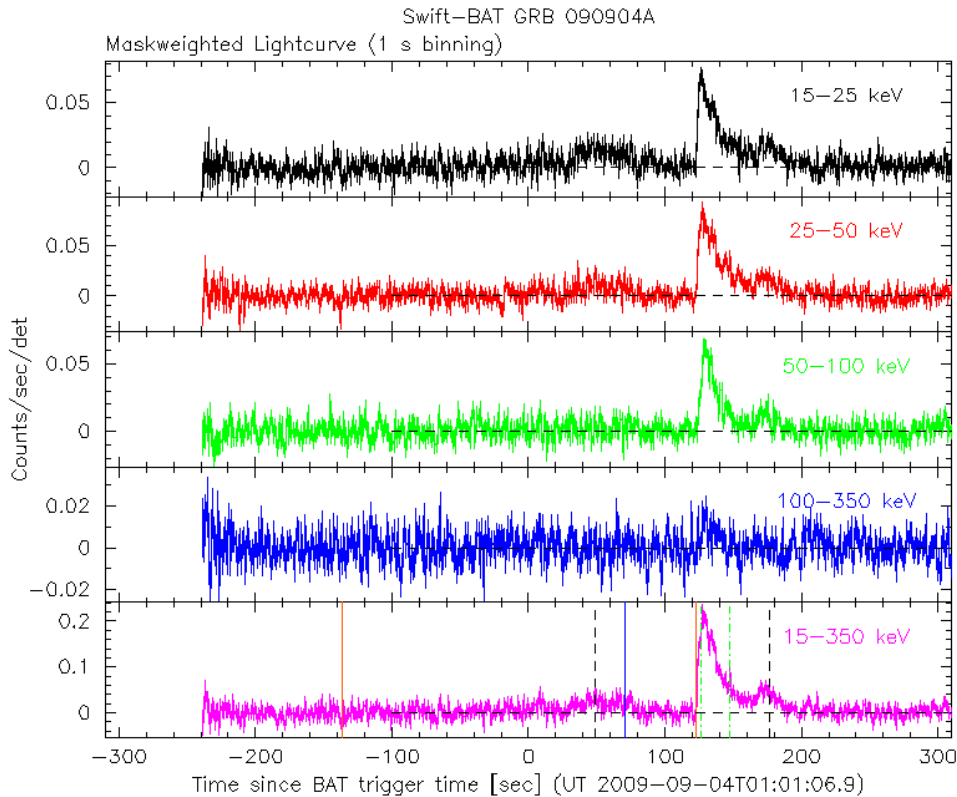


Figure 1: BAT light-curve. The mask-weighted light curve in the 4 individual plus total energy bands. Green dotted line: T_{50} , Black dotted line: T_{90} . Blue: Slew start, Orange: Slew end Time. The units are counts s^{-1} illuminated-detector $^{-1}$ (note illum-det = 0.16 cm^2).

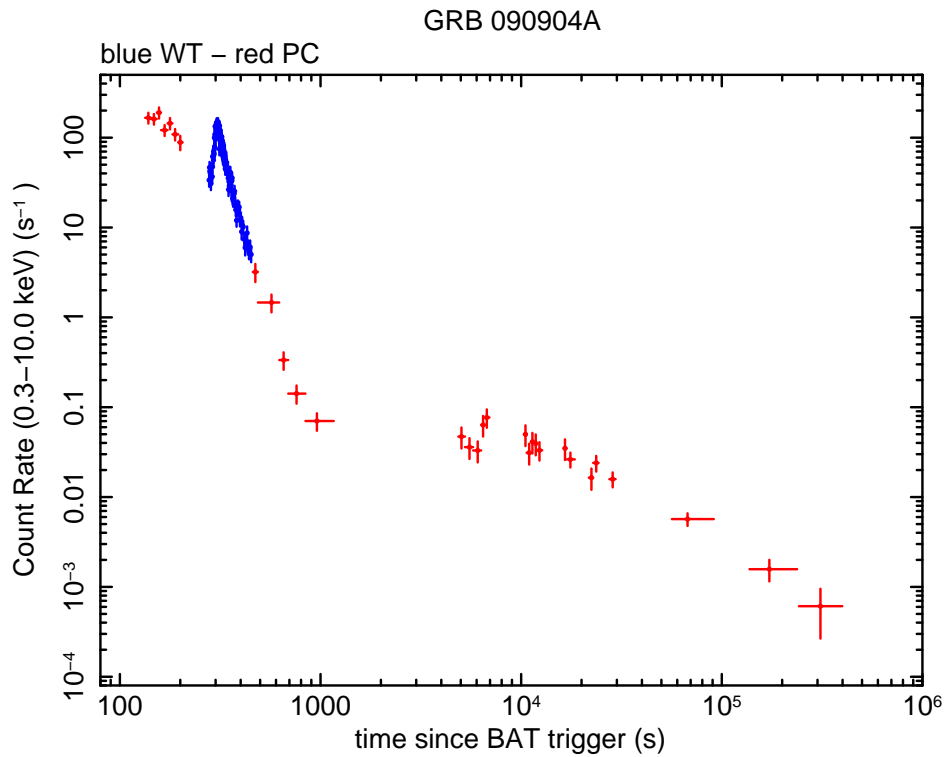


Figure 2: XRT light-curve. Count rates in the 0.3–10 keV band taken in Windowed Timing (WT) and Photon Counting (PC) mode are plotted. The approximate conversion of the 0.3–10 keV observed flux is 1 count/s $\sim 5.4 \times 10^{-11}$ erg cm $^{-2}$ s $^{-1}$.

Filter	T_start (s)	T_stop (s)	Exp (s)	Mag
white	141	1189	341	> 21.57
v	629	1078	58	> 18.72
b	555	1177	58	> 19.59
u	299	1152	285	> 20.43
uvw1	679	1127	58	> 19.11
uvm2	827	847	19	> 17.61
uvw2	605	1054	58	> 19.17

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