

Swift Observations of GRB 090813

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1. INTRODUCTION

At 04:10:43 UT, the Swift Burst Alert Telescope (BAT) triggered and located GRB 090813 (trigger=359884). It was a long-type GRB. Swift slewed immediately to the burst. The XRT found a fading source within the BAT error circle. The UVOT did not find a source.

The burst was also observed by Konus-Wind¹, Fermi-GBM², and Suzaku-WAM³, and the afterglow was observed by several ground-based telescopes⁴. No redshift has been reported as of this time, but the ground measurements report detections only in the red and infrared.

2. BAT OBSERVATION AND ANALYSIS

Using the data set from T-60 to T+243 sec further analysis gives a BAT ground-calculated position of RA, Dec = 225.065, 88.571 deg which is

RA, Dec (J2000) 15:00:15.6, +88d 34' 15.8"

with an uncertainty of 1.3 arcmin, (radius, sys+stat, 90% containment). The partial coding was 18%.

The mask weighted lightcurve had three main spikes, at T+0, T+1 and T+6.5 sec, each with a duration of about 1 sec. T90 (15-350 keV) was 7.1 ± 0.6 sec (estimated error including systematics). The three spikes were progressively softer.

The time-averaged spectrum from T-0.8 to T+7.3 sec was best fit by a simple power-law model. The power law index of the time-averaged spectrum was 1.69 ± 0.12 . The fluence in the 15-150 keV band was $1.3 \pm 0.1 \times 10^{-6}$ erg/cm². The 1-sec peak photon flux measured from T-0.04 sec in the 15-150 keV band was 8.5 ± 0.6 ph/cm²/sec. 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/359884/BA/

3. XRT OBSERVATION AND ANALYSIS

Using 615 s of XRT Photon Counting mode data and 1 UVOT images, the astrometrically corrected X-ray position (using the XRT-UVOT alignment and matching UVOT field sources to the USNO-B1 catalogue) is RA, Dec = 225.77887, +88.56795 which is equivalent to:

RA, Dec (J2000): 15:03:6.93, +88d 34' 04.6"

with an uncertainty of 1.7 arcsec (radius, 90% confidence).

Using 8.8 ks of XRT data from 84 s to 19.3 ks after the BAT trigger over four orbits, comprising 810 s in Windowed Timing (WT) mode with the remainder in Photon Counting (PC) mode, the X-ray light curve initially follows a shallow decay, with a decay

index of 0.22 ± 0.10 , before steepening to an index of 1.15 ± 0.03 at about 450 s after the trigger. Fitting with a broken powerlaw yields the parameters

$$\alpha_1 = 0.40 \pm 0.05$$

$$T_{\text{break}} - T_0 = 715 \pm 90 \text{ s}$$

$$\alpha_2 = 1.30 \pm 0.03$$

There was a late-time flare of about a factor of 3 at about 3×10^5 sec, returning gradually to the previous decay curve over the next 2×10^5 seconds. Disregarding the flare, and fitting the decay after $T+5000$ sec, the late-time decay index was 1.36 ± 0.05 .

A spectrum formed from the WT mode data can be fitted with an absorbed power-law with a photon spectral index of 2.10 ± 0.07 . The best-fitting absorption column was $(2.23 +0.20 -0.19) \times 10^{21} \text{ cm}^{-2}$, in excess of the Galactic value of $6.3 \times 10^{20} \text{ cm}^{-2}$ (Kalberla et al. 2005). The PC mode spectrum has a photon index of $2.00 +0.11 -0.10$ and a best-fitting absorption column of $(2.3 \pm 0.3) \times 10^{21} \text{ cm}^{-2}$. The counts to observed (unabsorbed) 0.3-10 keV flux conversion factor deduced from this spectrum is 4.3×10^{-11} (6.4×10^{-11}) $\text{erg cm}^{-2} \text{ count}^{-1}$. The results of the XRT-team automatic analysis are available at http://www.swift.ac.uk/xrt_products/00359884.

4. UVOT OBSERVATION AND ANALYSIS

The Swift/UVOT began settled observations of the field of GRB 090813 88s after the BAT trigger (Cummings et al., GCN Circ 9781). No new source is detected within the XRT error circle or at the optical position reported by Cenko (GCN Circ. 9783) in any of the individual or combined UVOT filters.

The 3-sigma upper limits of detected a source at the position of the optical afterglow reported by Cenko (GCN Circ. 9783) in the first white band finding chart (fc) observation, and in consecutive coadded observations for each of the UVOT filters are as follows:

Filter	T_start(s)	T_stop(s)	Exp(s)	Mag 3-sig UL
wh (fc)	88	237	147	> 20.55
wh	581	1894	264	> 21.35
vv	631	1943	156	> 19.39
bb	556	1869	136	> 20.29
uu	300	2017	382	> 20.44
w1	681	1992	156	> 19.73
m2	656	1967	156	> 19.41
w2	607	1919	156	> 19.83

The values quoted above are not corrected for the Galactic extinction due to the large reddening of $E(B-V) = 0.17$ in the direction of the burst (Schlegel et al., 1998). The photometry is on the UVOT photometric system described in Poole et al. (2008, MNRAS, 383, 627).

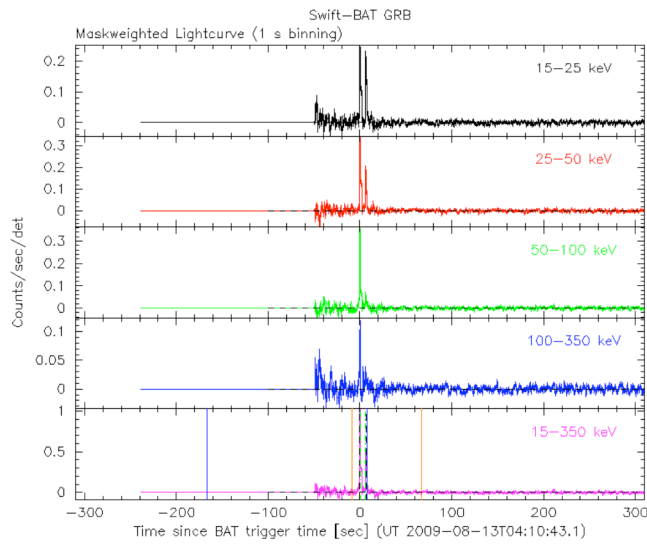


Fig.1: BAT Lightcurve. The light curve in the 4 individual plus total energy bands. The vertical blue lines are the beginning of slews, the vertical orange lines are the end of slews. The vertical dashed lines mark the time of the discovery image.

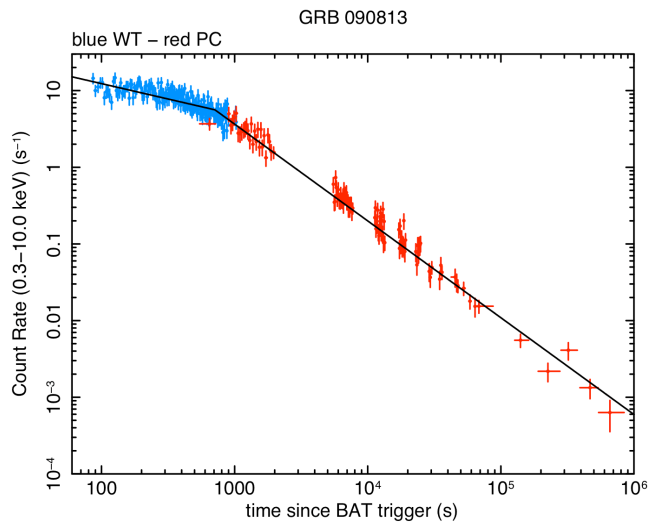


Fig. 2: XRT Lightcurve . The broken powerlaw fit is shown.

References:

- 1) S. Golenetskii, et al., GCN Circ. 9787, 2009 (Corrected in 9798).
- 2) A. von Kienlin, et al., GCN Circ. 9792, 2009.
- 3) T. Uehara, et al., GCN Circ. 9817, 2009.
- 4) J. Gorosabel, et al., GCN Circ. 9782, 2009;
 S. B. Cenko, et al., GCN Circ. 9783, 2009;
 R. J. Smith, et al., GCN Circ. 9784, 2009;
 A. Volnova, et al., GCN Circ. 9811, 2009;

J. Gorosabel, et al., GCN Circ. 9820, 2009.