

## Swift Observation of GRB 091109B

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### 1 Introduction

BAT triggered on GRB 091109B at 21:49:03 UT (trigger=375409) (Oates, *et al.*, *GCN Circ.* 10148). *Swift* XRT and UVOT observations began 78s and 84s after the BAT trigger, respectively. The prompt emission was also detected by Suzaku (Ohno, *et al.*, *GCN Circ.* 10168) and INTEGRAL/SPI-ACS (V. Beckmann, private communication). A source was detected by the XRT (Evans, *et al.*, *GCN Circ.* 10151 & Page, *et al.*, *GCN Circ.* 10155), but no new source was detected with the UVOT (Oates, *et al.*, *GCN Circ.* 10157). Our best position is the XRT location  $RA(J2000) = 112.73654 \text{ deg}$  (07h 30m 56.77s),  $Dec(J2000) = -54.08994 \text{ deg}$  (-54d 05' 23.8'') with an error of 1.5 arcsec (radius, 90% containment). The optical afterglow was detected by the VLT (Levan, *et al.*, *GCN Circ.* 10154 & Malesani, *et al.*, *GCN Circ.* 10156).

### 2 BAT Observation and Analysis

Using the data set from T-60 to T+243 sec we report analysis of BAT GRB 091109B (trigger 375409) (Oates, *et al.*, *GCN Circ.* 10148). The BAT ground-calculated position is  $RA, Dec(J2000) = 112.750, -54.092 \text{ deg}$ , which is

$$\begin{aligned} RA(J2000) &= 07h 30m 59.9s \\ Dec(J2000) &= -54d 05' 30.6'' \end{aligned}$$

with an uncertainty of 1.2 arcmin, (radius, sys+stat, 90% containment). The partial coding was 76%.

The mask-weighted light curve, shown in Fig. 1, consists of a single symmetrical peak of duration 0.32 seconds. There is no sign of extended emission.  $T_{90}$  (15-350 keV) is  $0.3 \pm 0.03 \text{ sec}$  (estimated error including systematics).

The time-averaged spectrum from T-0.0 to T+0.3 sec is best fit by a simple power-law model. The power law index of the time-averaged spectrum is  $0.71 \pm 0.13$ . The fluence in the 15-150 keV band is  $1.9 \pm 0.2 \times 10^{-7} \text{ erg cm}^{-2}$ . The 1-sec peak photon flux measured from T-0.33 sec in the 15-150 keV band is  $5.4 \pm 0.4 \text{ ph cm}^{-2} \text{ sec}^{-1}$ . 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/375409/BA/](http://gcn.gsfc.nasa.gov/notices_s/375409/BA/)

### 3 XRT Observations and Analysis

We analysed 97 ks of XRT data for GRB 091109B (Oates, *et al.*, *GCN Circ.* 10148), from 86 s to 249 ks after the BAT trigger. The data are entirely in Photon Counting (PC) mode. The best position is that derived from using the XRT-UVOT alignment and matching UVOT field sources to the USNO-B1 catalogue to correct the X-ray location astrometrically is  $RA, DEC (J2000) = 112.73654, -54.08994 \text{ deg}$  which is

$$\begin{aligned} RA(J2000) &= 07h 30m 56.77s \\ Dec(J2000) &= -54d 05' 23.8'' \end{aligned}$$

A spectrum formed from the PC mode data can be fitted with an absorbed power-law with a photon spectral index of  $2.0^{+0.5}_{-0.4}$ . The best-fitting absorption column is  $1.2^{+1.4}_{-0.1} \times 10^{21} \text{ cm}^{-2}$ , in excess of the

Galactic value of  $9.2 \times 10^{20} \text{cm}^{-2}$  (Kalberla et al. 2005). The counts to observed (unabsorbed) 0.3-10 keV flux conversion factor deduced from this spectrum is  $3.7 \times 10^{-11}$  ( $5.3 \times 10^{-11}$ )  $\text{erg cm}^{-2} \text{count}^{-1}$ .

The light curve showing all observations can be seen in Fig. 2 and can be modeled with a broken power-law decay with an initial decay index of  $1.1 \pm 0.4$ , breaking at 635s to a shallower decay of  $0.55^{+0.11}_{-0.12}$ .

The results of the XRT-team automatic analysis are available at

[http://www.swift.ac.uk/xrt\\_products/00375409](http://www.swift.ac.uk/xrt_products/00375409)

## 4 UVOT Observation and Analysis

The Swift/UVOT began settled observations of the field of GRB 091109B 84s after the BAT trigger (Oates et al., GCN 10148). NO source was detected at the enhanced Swift XRT position (Evans, *et al.*, *GCN Circ.* 10151), nor at the location of source A detected by the VLT (Levan, *et al.*, *GCN Circ.* 10154 & Malesani, *et al.*, *GCN Circ.* 10156).

The 3-sigma upper limits for the finding chart exposures (FC) and summed images are:

Filter	Start (s)	Stop (s)	Exposure (s)	Mag/ $3\sigma$ UL
white (FC)	84	234	147	> 21.25
u (FC)	296	546	246	> 20.29
white	577	18629	1313	> 22.09
v	627	11274	1172	> 20.96
b	553	17890	1337	> 21.78
u	701	23171	1761	> 21.61
uvw1	677	22710	1988	> 21.44
uvm2	652	12179	1160	> 20.87
uvw2	603	7050	471	> 20.52

Table 1: Magnitude limit from UVOT observations. The values quoted above are not corrected for the expected Galactic extinction corresponding to a reddening of  $E(B-V) = 0.03$  mag in the direction of the burst (Schlegel, Finkbeiner & Davis, 1998).

The standard UVOT products are available at [http://gcn.gsfc.nasa.gov/swift\\_gnd\\_ana.html](http://gcn.gsfc.nasa.gov/swift_gnd_ana.html)

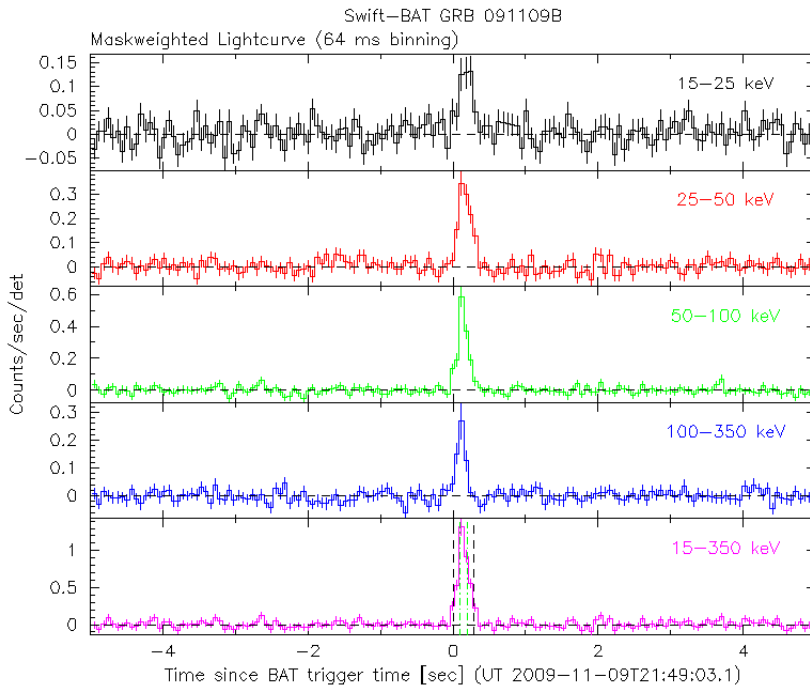


Figure 1: BAT Light curve. The mask-weighted light curve over all energy bands. The units are counts/s/illuminated-detector and  $T_0$  is 21:49:03 UT.

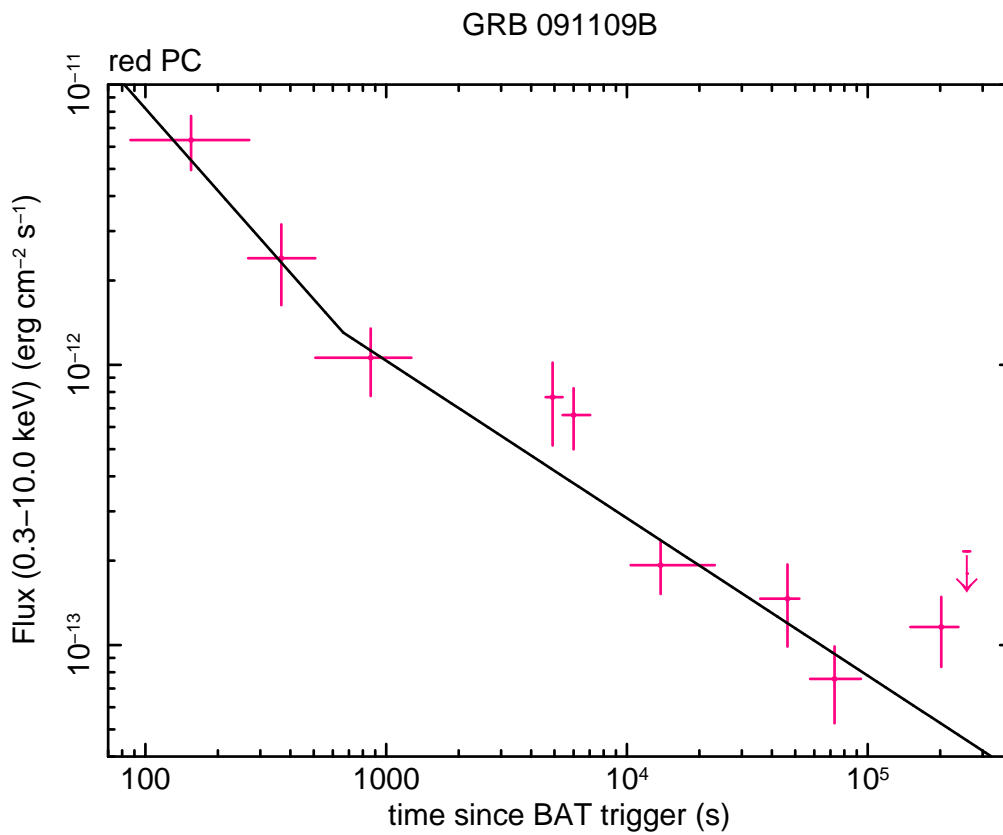


Figure 2: XRT light curve in the 0.3-10 keV band. The counts-to-flux conversion factor is 1 count =  $3.7 \times 10^{-11} \text{ erg cm}^{-2} \text{ s}^{-1}$ .