Swift Observation of GRB 091109A
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1 Introduction

BAT triggered on GRB 091109A at 04:57:43 UT (Trigger 375246) (Oates, et al., GCN Circ. 10138). Swift XRT and UVOT observations began 154s and 156s after the BAT trigger, respectively. A source was detected by the XRT (Beardmore, et al., GCN Circ. 10140) and a faint source was detected in the UVOT (Oates, et al., GCN Circ. 10143). Our best position is the UVOT location RA(J2000) = 309.25749 deg (20h 37m 01.80s), Dec(J2000) = −44.1582 deg (−44d 09′ 29.4″) with an error of 0.6 arcsec (radius, 90% containment). The optical afterglow was also detected by REM (Antonelli, et al., GCN Circ. 10139 & 10147), Faulkes Telescope South (Guidorzi, et al., GCN Circ. 10142), GROND and VLT (Afonso, et al., GCN Circ. 10158). A redshift of 3.5 has been determined photometrically by GROND and spectroscopically by VLT, but these observations are also consistent with a host galaxy at a redshift of 0.44, which can not be excluded at this time (Afonso, et al., GCN Circ. 10158).

2 BAT Observation and Analysis

Using the data set from T-240 to T+962 sec we report on the analysis of BAT GRB 091109A (trigger 375246) (Oates, et al., GCN Circ. 10138). The BAT ground-calculated position is RA, Dec(J2000) = 309.252, −44.177 deg, which is

RA(J2000) = 20h 37m 00.5s
Dec(J2000) = −44d 10′ 36.0″

with an uncertainty of 2.1 arcmin, (radius, sys+stat, 90% containment). The partial coding was 19%.

The mask-weighted light curve, shown in Fig. 1, consists of a couple overlapping peaks. The first starts at T-15 sec, peaks at T+10 sec. The second (weaker) peaks at T+40 sec and ends at T+60 sec. T90 (15-350 keV) is 48±17 sec (estimated error including systematics).

The time-averaged spectrum from T-0.8 to T+51.5 sec is best fit by a simple power-law model. The power law index of the time-averaged spectrum is 1.31 ± 0.25. The fluence in the 15-150 keV band is 1.6±0.2 × 10^{-6} erg cm^{-2}. The 1-sec peak photon flux measured from T+8.20 sec in the 15-150 keV band is 1.3±0.4 ph cm^{-2} 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/375246/BA/

3 XRT Observations and Analysis

We have analyzed 97.2 ks of Swift-XRT data for GRB 091109A (Oates, et al., GCN Circ. 10138), from 154 s to 815 ks after the BAT trigger. The data span four orbits, comprising 37 s in Windowed Timing (WT) mode with the remainder 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: RA, Dec (J2000) = 309.25767, −44.15863 deg which is equivalent to:

RA (J2000) : 20h 37m 1.84s
Dec (J2000) : −44d 09′ 31.1″
with an error of 1.5 arcsec (radius, 90% containment).

A spectrum formed from the PC mode data (from 175 s to 18.1 ks after the trigger) can be fitted with an absorbed power-law, giving a photon index of 2.10 ± 0.19. The best-fitting absorption column is \((9.9^{+2.1}_{-4.4}) \times 10^{20}\) cm\(^{-2}\), in excess of the Galactic value of \(3.0 \times 10^{20}\) cm\(^{-2}\) (Kalberla et al. 2005) in the direction of the burst. The counts to observed (unabsorbed) 0.3-10 keV flux conversion factor deduced from this spectrum is \(3.5 \times 10^{-11}(4.8 \times 10^{-11})\) erg cm\(^{-2}\) count\(^{-1}\).

The light curve produced from all observations is shown in Fig. 2. The light curve can be modeled by a broken power-law with an initial decay slope of 2.79 ± 0.37, breaking at 370\(^{+70}_{-40}\) s to a shallower decay of 0.91 ± 0.05.

The results of the XRT-team automatic analysis are available at http://www.swift.ac.uk/xrt_products/00375246

## 4 UVOT Observation and Analysis

The Swift/UVOT began observing the field of GRB 091109A 156s after the BAT trigger (Oates, et al., GCN Circ. 10138). The optical afterglow, which faded rapidly, was detected in the white filter only. A light curve can be seen in Fig. 3. Re-analysis of the UVOT position using uvotdetect provides a refined position of RA(J2000) = 309.25749, Dec(J2000) = -44.1582 deg which is:

RA (J2000) = 20h 37m 01.80s
Dec (J2000) = -44 d 09' 29.4''

with an error of 0.6 arcsec (radius, 90% containment). The white magnitude and the 3\(\sigma\) upper limits for the summed exposures are reported in Table 1.

The standard UVOT products are available at http://gcn.gsfc.nasa.gov/swift_gnd_ana.html

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Table 1: White magnitude and 3\(\sigma\) upper limits 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).
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 04:57:43 UT.

Figure 2: XRT light curve in the 0.3-10 keV band. The counts-to-flux conversion factor is 1 count = $3.5 \times 10^{-11}$ erg cm$^{-2}$ s$^{-1}$. 
Figure 3: UVOT white filter light curve. Green arrows are $3\sigma$ upper limits.