

## Swift Observations of Fermi-LAT GRB 090902B

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### 1 Introduction

At 11:05:08.31 UT, the Fermi Gamma-Ray Burst Monitor (GBM) triggered and located GRB 090902B (trigger 273582310 / 090902462) (Bissaldi et al. GCN Circ. 9866). The burst was also detected and located with the Fermi Large Area Telescope (LAT) (de Palma et al. GCN Circ. 9867).

At 23:36 UT, September 2nd, 2009, Swift began a Target of Opportunity of the LAT position ( $\sim 12.5$  hours after the Fermi detection). The afterglow was discovered in both the XRT 0.3-10 keV energy range and UVOT u-band (Kennea et al. GCN Circ. 9868, Swenson et al. 9877).

Cucchiara et al. (GCN Circ. 9873) determined a spectroscopic redshift of  $z = 1.822$  with the Gemini-N telescope equipped with the GMOS spectrograph. Several other ground based optical observations have been performed (Perley et al., GCN Circ. 9870; Olivares et al., GCN Circ. 9874; Guidorzi et al., GCN Circ. 9875, Pandey et al. GCN Circ. 9878)

The afterglow was also detected with the Westerbork Synthesis Radio Telescope on 2009 Sep. 3, 12.72 UT (about 1.07-1.55 days after the trigger), with a 4-sigma level flux density of  $111 \pm 28 \mu\text{Jy}$  at a frequency of 4.8 GHz (van der Host et al. GCN Circ. 9883) and with the Very Large Array on 2009 Sep. 03.94 UT with a flux density of  $141 \pm 39 \mu\text{Jy}$  at a frequency of 8.46 GHz (Chandra et al. GCN Circ. 9889).

The GBM light curve consists of a bright pulse with a duration of about 21 s. More than 200 photons above 100 MeV and more than 30 photons above 1 GeV are observed within 100 seconds with the LAT instrument. The highest energy photon is a 33.4 GeV event which is observed 82 seconds after the GBM trigger. The GBM and LAT time-integrated spectra fitted jointly are best fit with a Band model with a peak energy of  $798 \pm 7$  keV plus a power law model with index of  $1.94 \pm 0.01$  that shows no evidence for a spectral cut-off below 100 GeV. The fluence between 8 keV and 30 GeV is  $(4.86 \pm 0.06) \times 10^{-4}$  ergs  $\text{cm}^{-2}$  (de Palma et al. GCN Circ. 9872).

The burst was also detected with Suzaku WAM (Terada et al. GCN Circ. 9897).

### 2 XRT Observations and Analysis

The XRT began observing GRB 090902B about 12.5 hrs after the Fermi trigger in Photon Counting (PC) mode.

Using 2.7 ks of XRT PC mode data and 2 UVOT images, Evans et al. (GCN Circ. 9871) found a UVOT-enhanced XRT position of RA (J2000) = 264.93859 deg, Dec (J2000) = 27.32448 deg, which is equivalent to RA (J2000) =  $17^{\text{h}} 39^{\text{m}} 45.26^{\text{s}}$  and Dec (J2000) =  $27^{\text{d}} 19' 28.1''$  with an uncertainty of 2.1 arcseconds (radius, 90% confidence).

The X-ray light curve from T+12.5 hr up to T+17 days after the trigger (Figure 1), can be fit with a single power-law model with a decay index of  $-1.38 \pm 0.06$  (90% confidence level).

With 4.8 ks of integration time, the X-ray spectrum from T+12.53 hr to T+17.38 hr after the Fermi/GBM trigger can be fit by an absorbed power-law model with a photon index of  $2.1 \pm 0.3$  and a rest frame column density of  $(3.4 \pm 0.9) \times 10^{22} \text{ cm}^{-2}$  at  $z=1.822$  in addition to the Galactic column density in the direction of the burst ( $3.88 \times 10^{20} \text{ cm}^{-2}$ , Kalberla et al. 2005). Errors are at 90% confidence level. The observed 0.3-10.0 keV flux is  $3.2 \times 10^{-12} \text{ erg cm}^{-2} \text{ s}^{-1}$  which corresponds to an unabsorbed flux of  $4.1 \times 10^{-12} \text{ erg cm}^{-2} \text{ s}^{-1}$ .

Detailed light curves in both count rate and flux units are available in both graphical and ASCII formats at [http://www.swift.ac.uk/xrt\\_curves/00020111/](http://www.swift.ac.uk/xrt_curves/00020111/).

### 3 UVOT Observation and Analysis

The Swift/UVOT began observations of the field of GRB 090902B approximately 12.5 hours after the Fermi GBM/LAT trigger, detecting the optical afterglow (Swenson et al., GCN Circ. 9869) coincident with the enhanced Swift-XRT position (Evans, GCN Circ. 9871). The observed magnitudes using the UVOT photometric system (Poole et al. 2008, MNRAS, 383, 627) are reported in Table 1 and are uncorrected for the estimated Galactic reddening of  $E(B - V) = 0.04$  mag towards the direction of the burst (Schlegel et al. 1998).

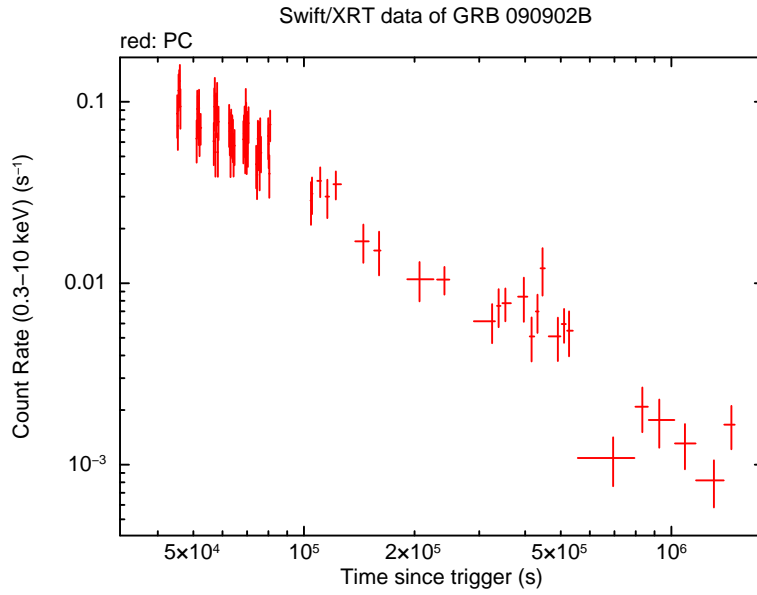


Figure 1: XRT Lightcurve. Counts  $\text{s}^{-1}$  in the 0.3–10 keV band taken in Photon Counting mode. The approximate conversion is  $1 \text{ count s}^{-1} \sim 4.6 \times 10^{-11} \text{ erg cm}^{-2} \text{ s}^{-1}$ .

Filter	T_start (s)	T_stop (s)	Exp (s)	mag
u	45096	46188	1075	$20.26 \pm 0.19$
u	50891	58703	3613	$20.50 \pm 0.11$
u	62457	81106	8756	$20.85 \pm 0.10$

Table 1: Magnitudes from UVOT observations.