Swift Observations of GRB 111225A
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1 Introduction

At 03:50:37 UT on 25 December 2011, the Swift Burst Alert Telescope (BAT) triggered and located GRB 111225A (trigger=510341). Swift slewed immediately to the burst and identified an X-ray and optical afterglow (Siegel et al., GCN Circ. 12720). Optical and infrared observations by TAROT (Klotz et al., GCN Circ. 12721, 12722), Super-LOTUS (Updike et al., GCN Circ. 12723), TNT (Xin et al., GCN Circ. 12725) and CAHA (Gorosabel et al. GCN Circ. 12728) confirmed the fading afterglow. Later observations by MITSuME (Kuroda et al., GCN Circ. 12730), PAIRITEL (Morgan GCN Circ. 12731), Keck (Cenko et al., GCN Circ. 12733), Swift/UVOT (Siegel et al., GCN Circ. 12734), T100 (Sonbas et al., GCN Circ. 12740) and CrAO (Rumyantsev et al., GCN Circ. 12793) showed that the optical afterglow faded rapidly. The XRT afterglow was detected out to 430 ks after the burst.

The best Swift position for this burst is the UVOT position given in Siegel et al. (GCN Circ. 12734): RA, Dec (J2000) = 13.15510 (00h 52m 37.22s), 51.57208 (51° 34′ 19.5″) with an uncertainty of 0.67″.

2 BAT Observation and Analysis

At 03:50:37 UT on 25 December 2011, the Swift Burst Alert Telescope (BAT) triggered and located GRB 111225A. Using the data set from T-240 to T+963 sec for further analysis¹, the BAT ground-calculated position is RA, Dec (J2000) = 13.158 (00h 52m 37.9 s), 51.573 deg (51° 34′ 21.8″) with an uncertainty of 1.3 arcmin, (radius, sys+stat, 90% containment). The partial coding was 93% (Baumgartner et al., GCN Circ. 12726).

The mask-weighted light curve shows a FRED like structure with the emission starting at ~T-15 sec, peaking at ~T-5 sec and ending at ~T+150 sec. $T_{90}$ (15-350 keV) is 106.8±26.7 sec (estimated error including systematics).

The time-averaged spectrum from T-14.28 to T+111.24 sec is best fit by a simple power-law model. The power law index of the time-averaged spectrum is 1.70±0.15. The fluence in the 15-150 keV band is 1.3±0.1 × 10^{-6} erg cm^{-2}. The 1-sec peak photon flux measured from T-4.40 sec in the 15-150 keV band is 0.7±0.1 ph cm^{-2} sec^{-1}. All the quoted errors are at the 90% confidence level.

3 XRT Observations and Analysis

The XRT began observing the field at 03:52:05.9 UT, 88.1 seconds after the BAT trigger. Using promptly downlinked data we found a fading, uncatalogued X-ray source. Using 1857 s of XRT PC data and 2 UVOT image, we find an enhanced position of RA, Dec (J2000) = 13.15557 (00h 52m 37.34s), +51.57157 (+51° 34′ 17.6″) with an uncertainty of 2.2 arcseconds (radius, 90% containment).

¹The results of the batgrbproduct analysis are available at http://gcn.gsfc.nasa.gov/NOTICES_s/510341/BA/

We collected 83 ks of XRT data from 88 s to 432 ks after the BAT trigger. The data comprised 556 s in Windowed Timing (WT) mode with the remainder in Photon Counting (PC) mode (Zhang et al., GCN Circ. 12727).

The light curve (Figure 2) can be modelled with a series of power-law decays. The initial decay index is $\alpha=0.6$ ($+0.4, -0.3$). At $T+114$ s the decay steepens to an $\alpha$ of 1.87 ($+0.10, -0.09$). The light curve breaks again at $T+344$ s to a decay with $\alpha=2.6$ ($+0.22, -0.19$), before a final break at $T+1030$ s, after which the decay index is $\alpha=1.03$ ($+0.16, -0.15$). An early time flare (from $T+214.6$ to $T+321.8$ s) and a possible late time flare (from $T+20000$s) are excluded from the fit.

A spectrum formed from the WT mode data can be fitted with an absorbed power-law with a photon spectral index of 2.43 ($\pm0.07$). The best-fitting absorption column is 2.09 ($+0.16, -0.15$)$\times10^{21}$ cm$^{-2}$, in excess of the Galactic value of 1.7 $\times10^{21}$ cm$^{-2}$ (Kalberla et al. 2005). The PC mode spectrum
has a photon index of 1.71 (+0.17, -0.15) and a best-fitting absorption column consistent with the Galactic value. The counts to observed (unabsorbed) 0.3-10 keV flux conversion factor deduced from this spectrum is $4.5 \times 10^{-11} (5.7 \times 10^{-11})$ erg cm$^{-2}$ count$^{-1}$.

Figure 2: XRT flux light curve of GRB 111225A in the 0.3-10 keV band. The approximate conversion is 1 count s$^{-1} = \sim 4.5 \times 10^{-11}$ ergs s$^{-1}$ cm$^{-2}$.

4 UVOT analysis

The Swift/UVOT began settled observations of the field of GRB 111225A 95 s after the BAT trigger (Siegel, GCN Circ. 12735). A source consistent with the XRT position was detected in the initial UVOT exposures at the position RA, Dec (J2000) = 13.15510 (00 h 52m 37.22s), +51.57208 (+51° 34′ 19.5″).

The afterglow was not been detected after the first orbit. Detections and 3-sigma upper limits using the UVOT photometric system (Breeveld et al. 2011, AIP Conf. Proc. 1358, 373) for the early exposures are: listed in Table 1 with light curves shown in Figure 3.
Table 1: Magnitudes from UVOT observations of GRB 111225A. The quoted upper limits have not been corrected for the expected Galactic extinction along the line of sight of $E_{B-V} = 0.26$ mag. All photometry is on the UVOT photometric system described in Breeveld et al. (2011, AIP Conf. Proc. 1358, 373).

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Figure 3: UVOT light curves of GRB 111225A.