

Swift Observations of GRB 110201A

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1 Introduction

At 09:35:08 UT, the Swift Burst Alert Telescope (BAT) triggered and located GRB 110201A (trigger=444230). Swift slewed immediately to the burst and identified an X-ray afterglow (Siegel et al., *GCN Circ.* 11622). Optical observations by UVOT, MASTER (Yurkov et al., *GCN Circ.* 11623 and MITSuME (Kuroda et al., *GCN Circ.* 11626) failed to detect any optical counterpart. Later observations by Shajn (Rumyantsev et al., *GCN Circ.* 11688) showed a diffuse source within $4''$ of the XRT position while Subaru observations (Onodera et al., *GCN Circ.* 11698) showed a faint constant source within the XRT error circle.

The best *Swift* position for this burst is the initial XRT position given in Siegel et al. (*GCN Circ.* 11622): RA, Dec (J2000) = 137.5802 (09h 10m 19.25s), $88.6054 (+88^\circ 36' 19.3'')$ with an uncertainty of $2.3''$.

2 BAT Observation and Analysis

At 09:35:08 UT on 2011-02-01, the Swift Burst Alert Telescope (BAT) triggered and located GRB 110201A. Using the data set from T-240 to T+878 sec for further analysis¹, the BAT ground-calculated position is RA, Dec (J2000) = 137.489 (09h 09m 57.3s), $88.610 \text{ deg } (+88^\circ 36' 36.9'')$ with an uncertainty of 1.3 arcmin, (radius, sys+stat, 90% containment). The partial coding was 97% (Krimm et al., *GCN Circ.* 11624).

The mask-weighted light curve (Figure 1) shows 3 or 4 overlapping peaks starting at $\sim T-2$ sec, peaking at $\sim T_{zero}$, and ending at $\sim T+30$ sec. T_{90} (15-350 keV) is 13.0 ± 2.2 sec (estimated error including systematics).

The time-averaged spectrum from T-2.8 to T+13.3 sec is best fit by a simple power-law model. The power law index of the time-averaged spectrum is 1.09 ± 0.11 . The fluence in the 15-150 keV band is $7.0 \pm 0.5 \times 10^{-7} \text{ erg cm}^{-2}$. The 1-sec peak photon flux measured from T-0.28 sec in the 15-150 keV band is $1.1 \pm 0.1 \text{ ph cm}^{-2} \text{ sec}^{-1}$. All the quoted errors are at the 90% confidence level.

3 XRT Observations and Analysis

The XRT began observing the field at 09:36:15.5 UT, 66.6 seconds after the BAT trigger. Using promptly downlinked data we found a fading, uncatalogued X-ray source with an enhanced position of RA, Dec (J2000) = 137.5802 (09h 10m 19.25s), $88.6054 (+88^\circ 36' 1.3'')$ with an uncertainty of 2.3 arcseconds (radius, 90% containment). This location is 107 arcseconds from the BAT onboard

¹The results of the batgrbproduct analysis are available at http://gcn.gsfc.nasa.gov/notices_s/44230/BA/

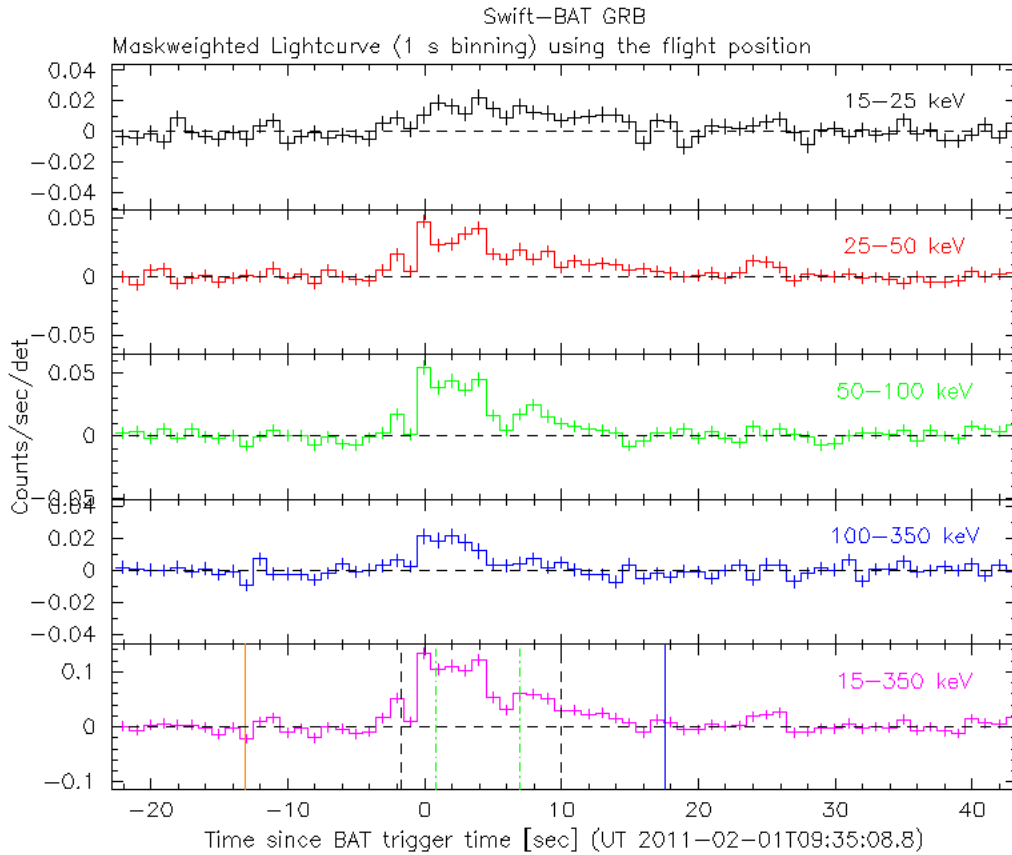


Figure 1: BAT Light curve of GRB 110201A.

position. The GRB was too faint to produce a UVOT-enhanced XRT position as described by Goad et al. (2007, *A&A*, 476, 1401) and Evans et al. (2009, *MNRAS*, 397, 1177).

We collected 21 ks of XRT data from 54 s to 83.0 ks after the BAT trigger. The data comprised 6 s in Windowed Timing (WT) mode (taken while Swift was slewing), with the remainder in Photon Counting (PC) mode (Grupe & Siegel, *GCN Circ.* 11627).

The light curve (Figure 2) can be modeled with a broken power-law model with an initial decay slope of $\alpha_1 = 3.25 (+0.40, -0.66)$ and a break at $T_{break} = 380 (+120, -55)$ s. After this break, the afterglow decays with a slope of $\alpha_2 = 1.03 (+0.12, -0.11)$.

A spectrum formed from the PC mode data can be fitted with an absorbed power-law with a photon spectral index of $2.04 (+0.26, -0.29)$. The best-fitting absorption column is $3.1 (+0.5, -1.0) \times 10^{21} \text{ cm}^{-2}$, in excess of the Galactic value of $2.8 \times 10^{20} \text{ cm}^{-2}$ (Kalberla et al. 2005). The counts to observed (unabsorbed) 0.3-10 keV flux conversion factor deduced from this spectrum is $4.3 \times 10^{-11} (7.1 \times 10^{-11}) \text{ erg cm}^{-2} \text{ count}^{-1}$.

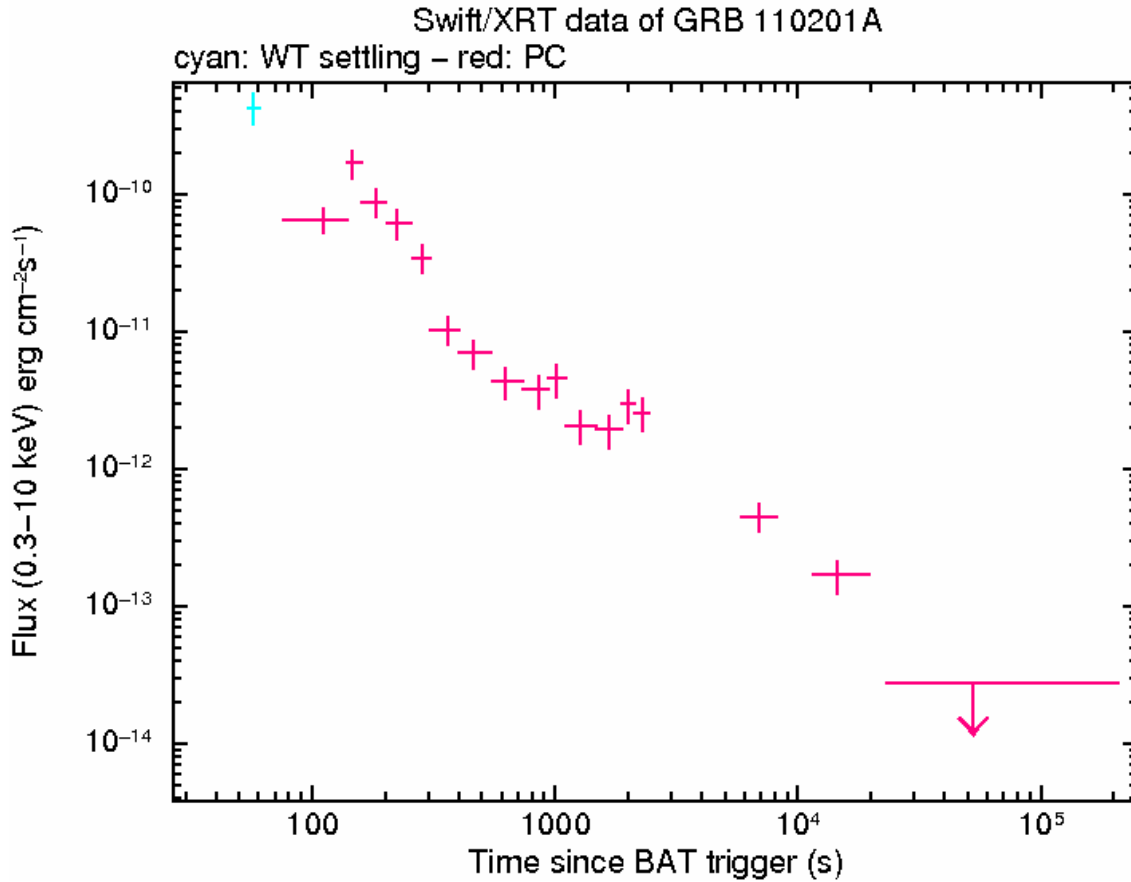


Figure 2: XRT flux light curve of GRB 110201A in the 0.3-10 keV band. The approximate conversion is $1 \text{ count s}^{-1} = \sim 4.3 \times 10^{-11} \text{ ergs s}^{-1} \text{ cm}^{-2}$.

4 UVOT analysis

The Swift/UVOT began settled observations of the field of GRB 110201A 127 s after the BAT trigger (De Pasquale & Siegel, *GCN Circ.* 11625). No optical afterglow consistent with the XRT position is detected in the initial UVOT exposures. Preliminary 3-sigma upper limits using the UVOT photometric system (Poole et al. 2008, *MNRAS*, 383, 627) for the first finding chart (FC) exposure and subsequent exposures are listed in Table 1.

Filter	T_{Start}	T_{stop}	Exposure	Mag
u (FC)	127	377	246	>20.0
u	127	2348	627	>20.4
v	433	2424	253	>19.5
b	382	2373	272	>20.4
w1	482	2324	233	>19.7
m2	457	2449	233	>19.6
w2	408	2400	253	>19.1

Table 1: Magnitudes from UVOT observations of GRB 110201A. The quoted upper limits have not been corrected for the expected Galactic extinction along the line of sight of $E_{B-V} = 0.35$ mag. All photometry is on the UVOT photometric system described in Poole et al. (2008, MNRAS, 383, 627).