

Swift Observations of GRB 100212A

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1 Introduction

At 14:07:22 UT on 2010-02-12, the Swift Burst Alert Telescope (BAT) triggered and located GRB 100212A (trigger=412081). Swift slewed immediately to the burst and found an X-ray counterpart of the burst in the XRT (Grupe et al. *GCN Circ.* 10401)

The best *Swift* position of this burst is the XRT position given in Osborne et al. (*GCN Circ.* 10403) with RA-2000 = 23h 45m 40.39s, and Dec-2000 = +49° 29' 39.6'' with an uncertainty of 2.0''.

Due to the small sun-angle only two optical follow-up observations were reported with detections in R by Malesani et al. (*GCN Circ.* 10402) and Im & Urata (*GCN Circ.* 10407).

The FERMI GBM measured a hard X-ray photon spectral index $\Gamma=1.15\pm0.20$ and a peak energy at $E_{\text{peak}}=159\pm45$ keV (Guiriec & Tierney, *GCN Circ.* 10406).

2 BAT Observation and Analysis

At 14:07:22 UT on 2010-02-12, the Swift Burst Alert Telescope (BAT) triggered and located GRB 100212A (trigger=412081, Grupe et al. *GCN Circ.* 10401). Using the data set from T-61 to T+243 s, the BAT ground-calculated position is RA, Dec = 356.445, 49.492 deg deg which is

RA(J2000) = 23h 45m 46.9s

Dec(J2000) = +49° 29' 30.5''

with an uncertainty of 2.1 arcmin, (radius, sys+stat, 90% containment). The partial coding was 86% (Ukwatta et al. *GCN Circ.* 10404).

The mask-weighted light curve shows multiple peaks. The main peak starts with weak emission at $\approx T-45$ s with the peak at $\approx T+0.2$ s and ends at $\approx T+30$ s. A second peak starts at $\approx T+75$ and ends at $\approx T+135$ s. T_{90} (15-350 keV) is 136 ± 14 s (estimated error including systematics).

The time-averaged spectrum from T-4.8 to T+134.0 s is best fit by a single power law model. The power law index of the time-averaged spectrum is 2.20 ± 0.22 ($\chi^2 = 62.3$ for 57 d.o.f.). For this model the total fluence in the 15-150 keV band is $9.1 \pm 1.2 \times 10^{-7}$ ergs cm^{-2} . The 1s peak photon flux measured from T+0.34 s in the 15-150 keV band is 2.2 ± 0.2 photons $\text{s}^{-1} \text{cm}^{-2}$. 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/412081/BA/

3 XRT Observations and Analysis

The XRT began observing the field of GRB 100212A at 14:08:19.8 UT, 57.7 seconds after the BAT trigger. Using 699 s of XRT Photon Counting mode data and 3 UVOT images for GRB 100212A, Osborne et al. (*GCN Circ.* 10403) found an astrometrically corrected X-ray position (using the XRT-UVOT alignment and matching UVOT field sources to the USNO-B1 catalogue): RA, Dec = 356.41830, +49.49432 which is equivalent to:

RA (J2000): 23h 45m 40.39s

Dec (J2000): +49° 29' 39.6''

with an uncertainty of 2.0'' (radius, 90% confidence). The latest position can be viewed at http://www.swift.ac.uk/xrt_positions. Position enhancement is described by Goad et al. (2007, *A&A*, 476, 1401) and Evans et al. (2009, *MNRAS*, 397, 1177).

A spectrum formed from the WT mode data (407s exposure) can be fitted with an absorbed single power-law model with a photon spectral index of 2.03 ± 0.03 (Grupe *GCN Circ.* 10405) with an absorption column density of $1.97 \pm 0.08 \times 10^{21} \text{ cm}^{-2}$ which is in excess of Galactic value of $1.3 \times 10^{21} \text{ cm}^{-2}$ (Kalberla et al. 2005). The counts to observed (unabsorbed) 0.3-10 keV flux conversion factor deduced from this spectrum is 3.8×10^{-11} (5.6×10^{-11}) $\text{ergs cm}^{-2} \text{ counts}^{-1}$.

The 0.3 – 10 keV light curve given below (Fig.2) displays several bright flares within the first few hundred seconds after the burst. The underlying X-ray afterglow can be modelled with a multiple broken power-law model with the following decay slopes and break times:

$$\alpha_1 = 2.57 \pm 0.40$$

$$T_{\text{break1}} = 1550_{-525}^{+1750} \text{ s}$$

$$\alpha_2 = 0.22_{-0.15}^{+0.66}$$

$$T_{\text{break2}} = 5890_{-1960}^{+3500} \text{ s}$$

$$\alpha_3 = 1.31 \pm 0.15$$

4 UVOT analysis

The Swift/UVOT began settled observations of the field of GRB 100212A 68 s after the BAT trigger (Grupe et al., *GCN Circ.* 10401) with the finding chart in white filter. De Pasquale & Grupe (*GCN Circ.* 10408) reported on no optical afterglow detected within the enhanced XRT error circle position (Osborne et al., *GCN Circ.* 10403) in the initial UVOT exposure and in all other summed exposures at 3 sigma level. The optical source detected by NOT (Malesani et al, *GCN Circ.* 10402) is not detected either at 3σ level.

3σ upper limits for the summed images are listed in Table 1.

Filter	T_{Start}	T_{stop}	Exposure	Mag
white_FC	68	218	147	>20.6
u_FC	281	530	246	>19.8
white	68	1181	353	>21.2
v	610	1231	78	>18.7
b	536	1156	58	>19.5
u	281	1304	304	>19.8
w1	660	1280	78	>19.2
m2	635	1255	78	>19.3
w2	586	1206	78	>19.6

Table 1: Magnitudes from UVOT observations of GRB 100212A. The quoted upper limits have not been corrected for the expected Galactic extinction along the line of sight of $E_{\text{B-V}} = 0.18$ mag. All photometry is on the UVOT photometric system described in Poole et al. (2008, MNRAS, 383, 627).

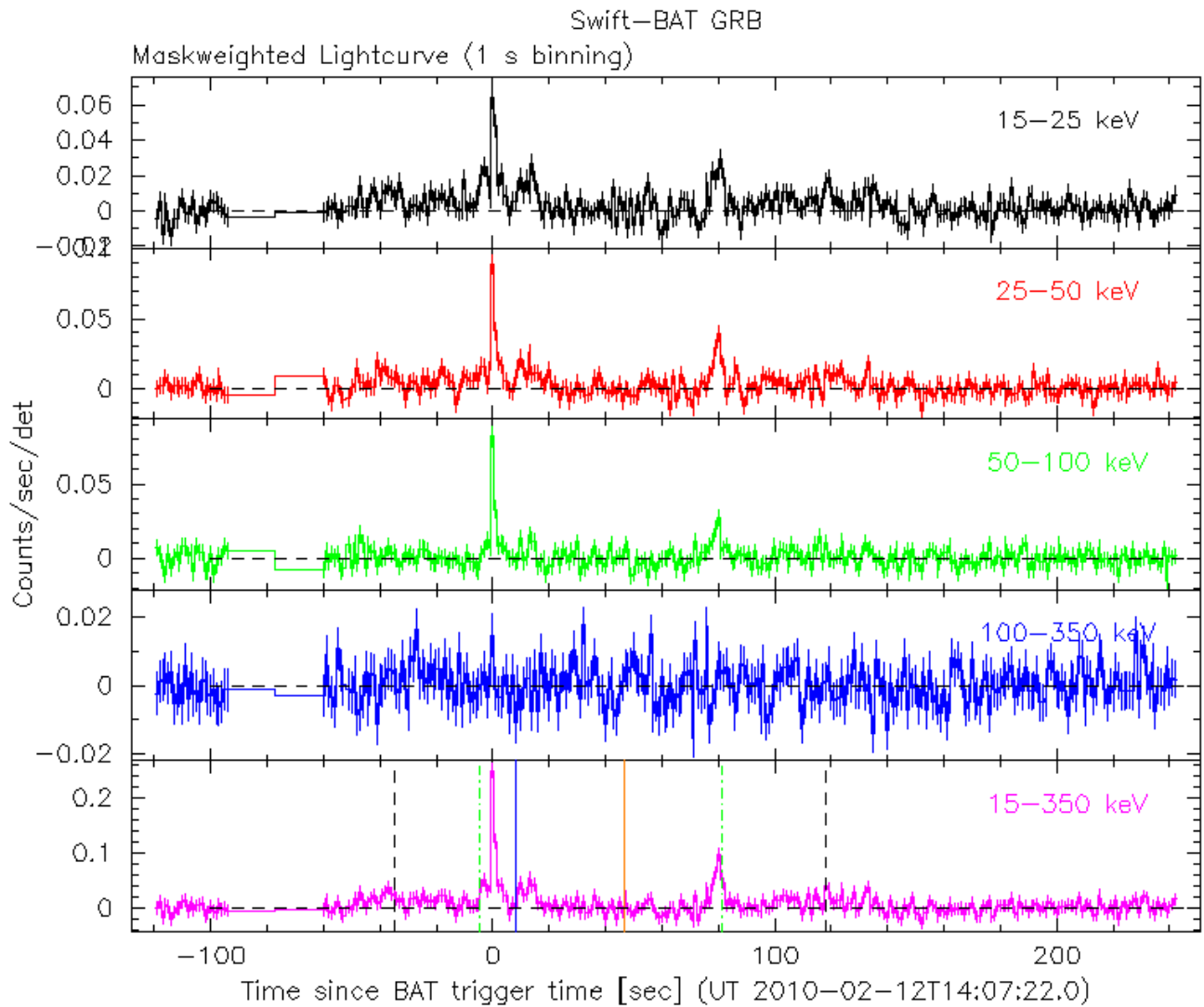


Figure 1: BAT Light curve of GRB 100212A.

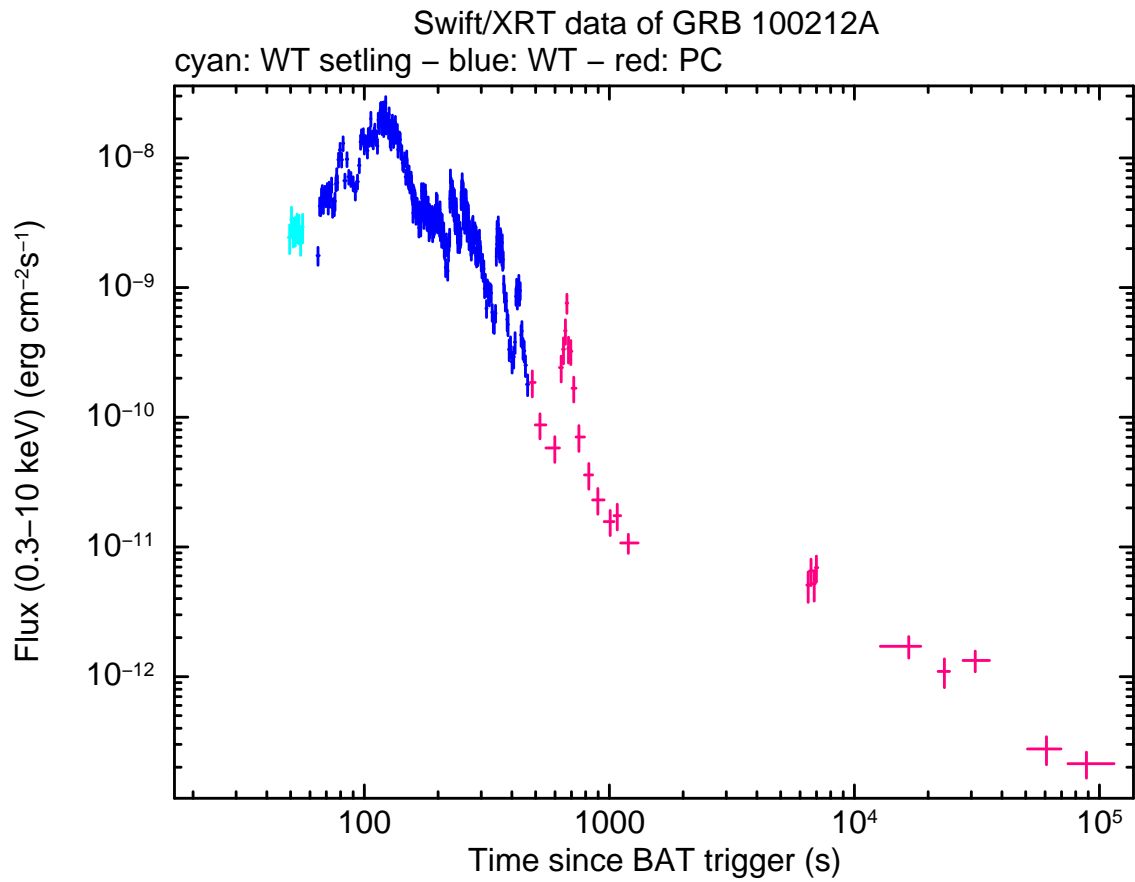


Figure 2: XRT flux light curve of GRB 100212A in the 0.3-10 keV band. The approximate conversion is $1 \text{ count s}^{-1} = \sim 5.6 \times 10^{-11} \text{ ergs s}^{-1}\text{cm}^{-2}$.