

Swift Observations of GRB 110210A

V. D'Elia (ASDC), J. Cummings, W. Baumgartner (GSFC/UMBC),

G. Stratta (ASDC), M. De Pasquale (MSSL-UCL)

S.D. Barthelmy (GSFC), D.N. Burrows (PSU),

M. Siegel (PSU), N. Gehrels (GSFC) for the Swift Team

1 Introduction

The Swift BAT triggered on and located GRB 110210A at 09:52:41 UT (trigger=445141) (D'Elia et al., GCN Circ. 11687). Swift slewed immediately to the burst and XRT and UVOT observations of the field started 137 and 144 seconds after the trigger, respectively. The best Swift position is the XRT localization at RA(J2000)= 13.05658 deg, Dec(J2000)= +7.77957 deg, RA(J2000)= 00^h52^m13.58^s, Dec(J2000)= +07^d 46' 46.5", with an error radius of 1.4 arcsec (90% confidence).

The optical afterglow was not detected from the ground.

2 BAT Observations and Analysis

Using the data set from T-239 s to T+963 s (Stamatikos et al., GCN Circ. 11677), the BAT ground-calculated position is RA(J2000)= 13.108 deg, Dec(J2000)= +7.778 deg, RA(J2000)= 00^h52^m25.9^s, Dec(J2000)= +07^d 46' 39.5", with an uncertainty of 3.2 arcmin, (radius, sys+stat, 90% containment). The partial coding was 83%.

The mask-weighted light curve (Figure 1) shows the emission starting at \sim T-100 s, peaking at \sim T+50 s and ending at \sim T+150 s. T_{90} (15–350 keV) is 233 ± 60 s (estimated error including systematics).

The time-averaged spectrum from T-102.9 s to T+153.6 s is best fit by a simple power-law model. The power law index of the time-averaged spectrum is 1.73 ± 0.29 . The fluence in the 15–150 keV band is $(9.6 \pm 1.9) \times 10^{-7}$ erg cm⁻². The 1-second peak photon flux measured from T-54.44 s in the 15–150 keV band is 0.3 ± 0.1 ph cm⁻² s⁻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/445141/BA/

3 XRT Observations and Analysis

Swift-XRT began observing the field of GRB 110210A at 09:54:57.8 UT, 136.5 seconds after the BAT trigger (D'Elia et al., GCN Circ. 11687, Stratta & D'Elia, GCN Circ. 11693).

Using 6322 s of XRT Photon Counting mode data and 8 UVOT images for GRB 110210A, we find an astrometrically corrected X-ray position (using the XRT-UVOT alignment and matching UVOT field sources to the USNO-B1 catalogue): RA(J2000)= 13.05658 deg, Dec(J2000)= 7.77957 deg, RA(J2000)= 00^h52^m13.58^s, Dec(J2000)= +07^d 46' 46.5", with an uncertainty of 1.4 arcsec (radius, 90% confidence).

We analyzed 39.21 ks of XRT data for GRB 110210A (D'Elia, et al., GCN Circ. 11687), from 136 s to 400 ks after the BAT trigger. The data comprise \sim 250 s in Windowed Timing (WT) mode with the remainder in Photon Counting (PC) mode.

The 0.3–10 keV light curve (Figure 2) can be modelled with an initial power law decay with an index $\alpha_1 = 1.2 \pm 0.1$, followed by a break at T+251 s to an alpha of $\alpha_2 = 5.0(+0.4, -0.3)$. A second break is found at t+453 s to a power law decay with an index $\alpha_3 = 3.3 \pm 0.6$. A third break is found at t+1100 s to a power law decay with an index $\alpha_4 = 0.33(+0.08, -0.14)$. A fourth break is found at

t+44 ks to a final power law decay with an index $\alpha_5 = 0.82(+0.17, -0.20)$. At later times there are no more observations.

A spectrum formed with the 39 ks of PC mode data can be fitted with an absorbed power-law with a photon spectral index of $\Gamma = 2.12(+0.09, -0.14)$. The best-fitting absorption column is $N_H = 7.7(+2.7, -1.1) \times 10^{20} \text{ cm}^{-2}$ in excess to the Galactic one in the direction of the source ($N_H = 5.3 \times 10^{20} \text{ cm}^{-2}$ (Kalberla et al. 2005)). The counts to observed (unabsorbed) 0.3–10 keV flux conversion factor deduced from the PC spectrum is 3.6×10^{-11} (4.5×10^{-11}) $\text{erg cm}^{-2} \text{ count}^{-1}$.

All the quoted errors are at the 90% confidence level.

4 UVOT Observation and Analysis

The UVOT observed the field of GRB 110210A settling 144 s after the BAT trigger (De Pasquale & D’Elia, GCN Circ. 11738).

No optical afterglow consistent with the enhanced XRT position (Goad et al, GCN Circ. 11689) is detected in the initial UVOT exposures or in the summed ones. Preliminary 3-sigma upper limits for detecting a source in the finding charts and in the following exposures are listed in Table 1. The quoted upper limits have not been corrected for the expected Galactic extinction along the line of sight corresponding to a reddening of $E_{(B-V)} = 0.06 \text{ mag}$ (Schlegel, et al., 1998, ApJS, 500, 525). All photometry is on the UVOT photometric system described in Poole et al. (2008, MNRAS, 383, 627).

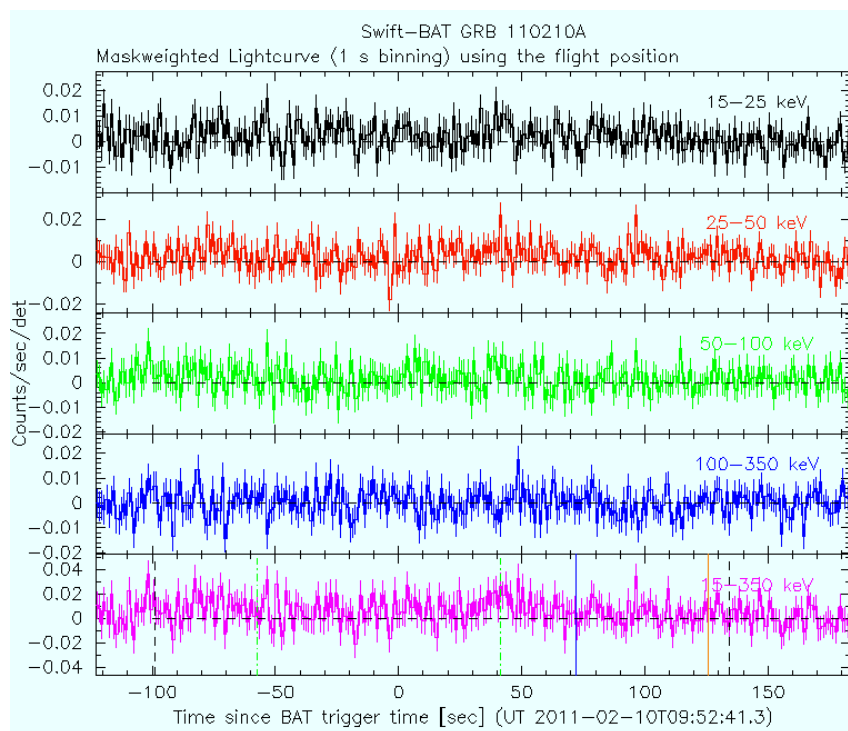


Figure 1: BAT light-curve. The mask-weighted light curve in the 4 individual plus total energy bands. Green dot-dashed lines: T_{50} and T_{90} . Blue: Slew start, Orange: Slew end Time. The units are $\text{counts s}^{-1} \text{ illuminated-detector}^{-1}$ (note $\text{illum-det} = 0.16 \text{ cm}^2$).

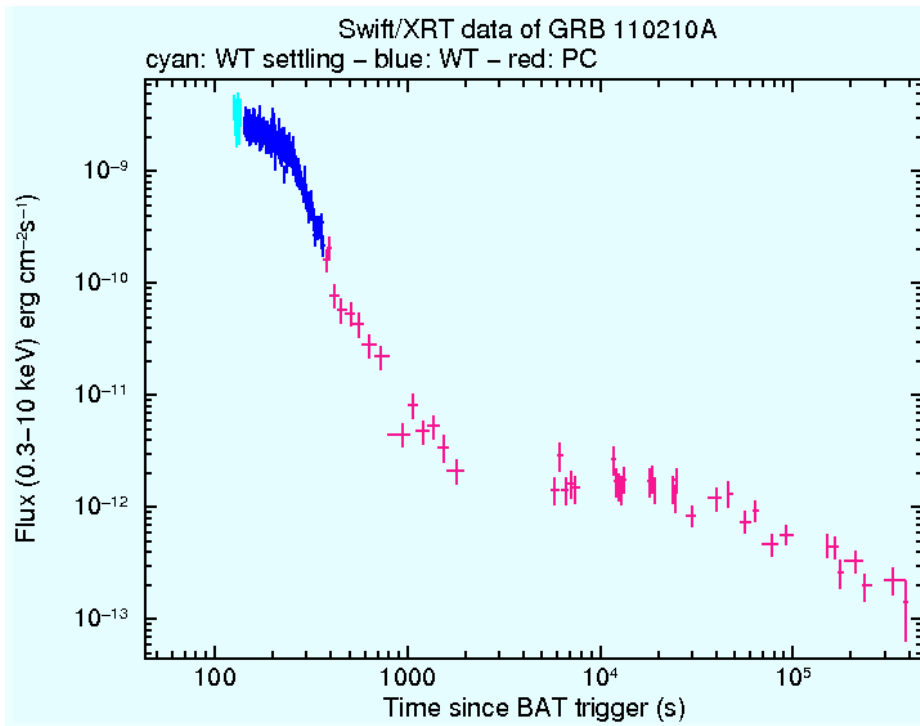


Figure 2: XRT light-curve. Count rates in the 0.3–10 keV band taken in Windowed Timing (WT) and Photon Counting (PC) mode are plotted. The approximate conversion of the 0.3–10 keV observed flux is 1 count/s $\sim 3.6 \times 10^{-11}$ erg cm $^{-2}$ s $^{-1}$.

Filter	T_start (s)	T_stop (s)	Exp (s)	Mag
white (fc)	144	294	147	> 20.1
white	144	7686	746	> 21.0
u (fc)	302	552	246	> 19.4
u	302	7276	756	> 19.9
v	633	13497	1238	> 19.7
b	558	7481	526	> 20.1
uvw1	682	7072	294	> 19.5
uvm2	660	18180	839	> 20.6
uvw2	608	12588	1082	> 21.0

Table 1: 3-sigma upper limits from UVOT observations.