Swift Observations of GRB 110312A

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1 Introduction

BAT detected GRB 110312A at 17:55:37 UT on the 12^{th} March 2011 (Oates, *et al.*, *GCN Circ.* 11782). This GRB was detected with an image trigger of a duration of 64s at a significance of 8.46σ. The $T_{90}(15-350$ keV) for this GRB is 28.7 ± 7.6 s (estimated error including systematics).

Swift BAT slewed immediately to this burst and XRT observations and UVOT settled observations began $\sim$ 147 s and 168 s, respectively, after the BAT trigger (Target ID 449074). A source was detected only by the XRT (Osborne, *et al.*, *GCN Circ.* 11784). There was no optical detection by the UVOT (Oates, *et al.*, *GCN Circ.* 11787) and there was no detection reported by several ground observatories, GROND (Nicuesa Guelbenzu, *et al.*, *GCN Circ.* 11785), RTT150 (Bikmaev, *et al.*, *GCN Circ.* 11788) and MITSuME (Kuroda, *et al.*, *GCN Circ.* 11789)

Our best position is the XRT location RA($J2000$) = 157.48111 *deg* ($10h$ $29m$ $55.47s$), Dec($J2000$) = -5.26256 *deg* ($-05d$ $15'$ $45.2''$) with an error of 1.4 arcsec (radius, 90% containment).

2 BAT Observation and Analysis

Using the data set from T-60 to T+243 sec, we report on the refined analysis of BAT GRB 110312A (trigger 449074) (Oates, *et al.*, *GCN Circ.* 11782). The BAT ground-calculated position is RA, Dec = 157.500, -5.259 *deg*, which is:

RA(J2000) = $10h$ $30m$ $00.0s$
Dec(J2000) = $-05d$ $15'$ 32.6"

with an uncertainty of 2.3 arcmin, (radius, sys+stat, 90% containment). The partial coding was 26%.

The mask-weighted light curve, see Fig. 1, shows a single start at $\sim$T+25 sec, peaking around $\sim$T+45 sec, and ending at $\sim$T+65 sec. The $T_{90}(15-350$ keV) is 28.7 ± 7.6 sec (estimated error including systematics).

The time-averaged spectrum from T+24.1 to T+64.9 sec is best fit by a simple power-law model. The power law index of the time-averaged spectrum is 2.32$\pm$0.26. The fluence in the 15-150 keV band is $8.2 \pm 1.3 \times 10^{-7}$ erg cm^{-2}. The 1-sec peak photon flux measured from T+44.08 sec in the 15-150 keV band is 1.2 ± 0.3 ph cm^{-2} sec^{-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/449074/BA/`

3 XRT Observations and Analysis

The XRT began observations of GRB 110312A 147 s after the BAT trigger.

The XRT found a bright, uncatalogued X-ray source located at RA, Dec = 157.48111, -5.26256 *deg* which is equivalent to:

RA (J2000): $10h\ 29m\ 55.47s$
Dec (J2000): $-05d\ 15'\ 45.2$"

with an uncertainty of 1.4 arcsec (radius, 90% confidence).

We analyzed 40 ks of XRT data for GRB 110312A, from 147 s to 9.4×10^5 s after the BAT trigger. The data comprise 82 s in Windowed Timing (WT) mode (the first 9 s were taken while Swift was slewing) with the remainder in Photon Counting (PC) mode.

The light curve consists of 4 segments, which can be modeled with double broken power-law decay. The initial decay index is $\alpha_1 \sim 2.89^{+1.21}_{-0.44}$. At 447^{+78}_{-116} s the decay flattens to $\alpha_2 = 0.46^{+0.07}_{-0.06}$ and at 36.06 ± 9.8 ks the light curve breaks to the final decay of $\alpha_3 = 1.21^{+0.14}_{-0.12}$.

A spectrum formed from the WT mode data can be fitted with an absorbed power-law with a photon spectral index of $2.34^{+0.46}_{-0.39}$. The best-fitting absorption column is $1.56^{+1.10}_{-0.93} \times 10^{21}$cm^{-2}, in excess of the Galactic value of 3.7×10^{20}cm^{-2} (Kalberla et al. 2005). The PC mode spectrum has a photon index of 2.41 ± 0.21 and a best-fitting absorption column of $3.81^{+0.67}_{-0.64} \times 10^{21}$cm^{-2}. The counts to observed (unabsorbed) 0.3-10 keV flux conversion factor deduced from this spectrum is $3.8 \times 10^{-11}(8.9 \times 10^{-11})$ erg cm^{-2} count^{-1}.

The results of the XRT-team automatic analysis are available at:
`http://www.swift.ac.uk/xrt_products/00449074`

4 UVOT Observation and Analysis

The Swift/UVOT began settled observations of the field of GRB 110312A 168 s after the BAT trigger (Oates, *et al.*, *GCN Circ.* 11787). No optical afterglow is found consistent with the XRT position.

The results of the UVOT-team automatic analysis are available at:
`http://gcn.gsfc.nasa.gov/swift_gnd_ana.html`

The 3-sigma upper limits for the finding chart exposures (FC) and summed images provided in Table 1.

Filter	Start (s)	Stop (s)	Exposure (s)	Magnitude/3σ UL
white (FC)	168	318	147	>21.8
u (FC)	327	577	246	>20.1
white	168	1896	429	>21.3
v	657	1946	156	>19.2
u	582	6063	315	>20.6
b	327	2020	382	>20.1
*uvw*1	706	1995	136	>19.6
*uvm*2	682	1970	156	>19.6
*uvw*2	1036	1402	39	>18.8

Table 1: Magnitude limit from UVOT observations. The values quoted above are not corrected for the expected Galactic extinction corresponding to a reddening of E(B-V) = 0.04 mag in the direction of the burst (Schlegel, Finkbeiner & Davis, 1998).

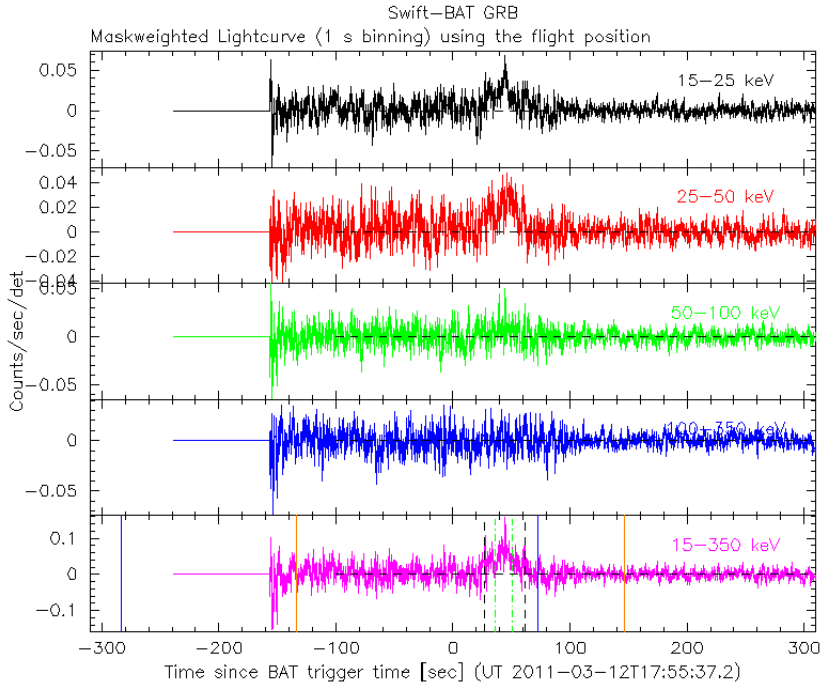

Figure 1: BAT light curve. The mask-weighted light curve in the 4 individual plus total energy bands: 15 - 25 keV (black), 25 - 50 keV (red), 50 - 100 keV (green), 100 - 350 keV (blue), 15 - 350 keV (magenta)

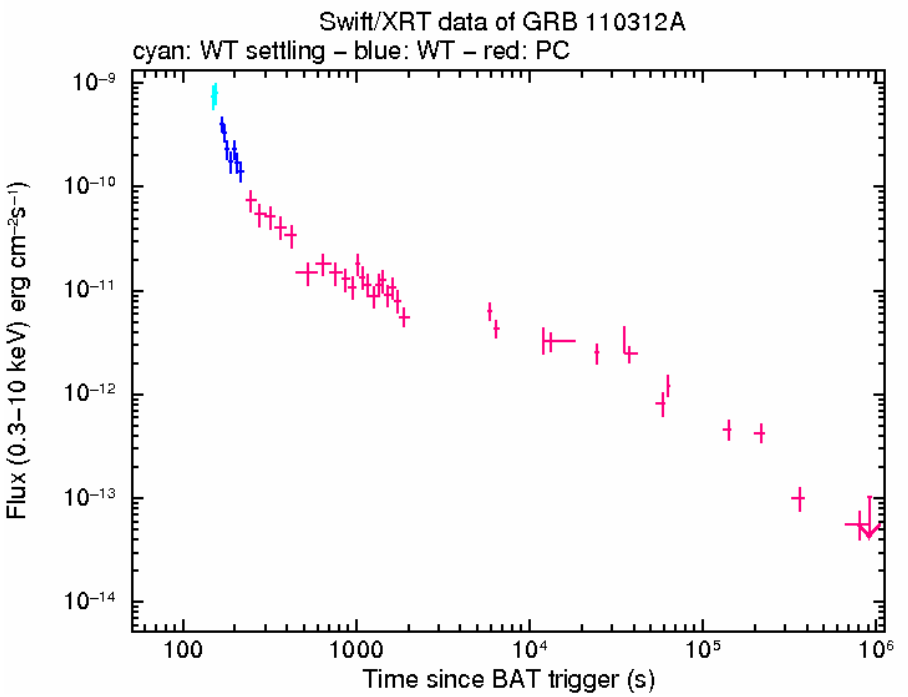

Figure 2: XRT light curve in the 0.3-10 keV band. The counts-to-observed-flux conversion factor is 1 count $= 3.8 \times 10^{-11}$ erg cm^{-2}.