

Swift Observation of GRB 110315A

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1 Introduction

At 23:57:04 UT, the *Swift* BAT triggered and located GRB 110315A (Trigger 449399, Melandri, *et al.*, *GCN Circ.* 11790). *Swift* slewed immediately to the burst. The BAT on-board calculated location is RA, Dec = (279.191, +17.532) deg, which is

$$\text{RA}(J2000) = 18^h 36^m 46^s$$

$$\text{Dec}(J2000) = +17^\circ 31' 56''$$

with an uncertainty of 3 arcmin (radius, 90% containment, including systematic uncertainty). The BAT light curve showed 3 or 4 peaks with a total duration of about 20 sec. The peak count rate was ~ 1200 counts/s (15 – 350 keV), at ~ 2 s after T_0 .

The XRT began observing the field at $T + 104.6$ s after the BAT trigger finding a bright, uncatalogued X-ray source with an enhanced position RA, Dec = (279.19531, +17.53899) deg, which is

$$\text{RA}(J2000) = 18^h 36^m 46.87^s$$

$$\text{Dec}(J2000) = +17^\circ 32' 20.4''$$

with an uncertainty of 1.4" (radius, 90% containment) (Beardmore, *et al.*, *GCN Circ.* 11792).

UVOT took a finding chart exposure of 150 s with the White filter starting $T + 112$ s after the BAT trigger. No credible afterglow candidate has been found in the initial data products. The $2.7' \times 2.7'$ sub-image covers 100% of the XRT error circle. The typical 3σ upper limit has been about 19.6 mag. The coverage of the XRT error circle by the $8' \times 8'$ region for the list of sources generated on-board is uncertain because the large number of sources filled the available telemetry. No correction has been made for the expected extinction corresponding to $E_{(B-V)}$ of 0.25.

2 BAT Observation and Analysis

Using the data set from $T - 239$ to $T + 963$ s further analysis of BAT GRB 110315A has been performed by *Swift* team (Krimm, *et al.*, *GCN Circ.* 11793). The BAT ground-calculated position is RA($J2000$) = 279.205 deg ($18^h 36^m 49.2^s$), Dec($J2000$) = +17.537 deg ($+17^\circ 32' 13.9''$) $\pm 1.0'$ (radius, sys+stat, 90% containment). The partial coding was 57%.

The mask-weighted light curve (Fig.1) shows a multi-peak structure starting at $\sim T - 70$ s, with several peaks of approximate equal brightness at $T - 21$, $T - 3$, $T + 3$, and $T + 17$ s, and then returning to background at $\sim T + 90$ s. There is weak emission ($\sim 2\sigma$) in the BAT 15 – 25 keV band starting at $\sim T + 440$ out to $\sim T + 580$ s. This is likely associated with the flare in the XRT light curve at $\sim T + 500$ s. $T_{90}(15 - 350 \text{ keV})$ is 77 ± 12 s (estimated error including systematics).

The time-averaged spectrum from $T - 66.8$ to $T + 38.8$ s is best fit by a simple power-law model. The power law index of the time-averaged spectrum is 1.77 ± 0.08 . The fluence in the 15 – 150 keV band is $(4.1 \pm 0.2) \times 10^{-6}$ ergs/cm². The 1-sec peak photon flux measured from $T + 3.13$ s in the 15 – 150 keV band is 1.7 ± 0.2 ph/cm²/sec. All the quoted errors are at the 90% confidence level.

3 XRT Observations and Analysis

We have analysed 14 ks of XRT data for GRB 110315A (Melandri, *et al.*, *GCN Circ.* 11790), from 94 s to 34.8 ks after the BAT trigger. The data comprise 97 s in Windowed Timing (WT) mode (the first 8 s were taken while *Swift* was slewing) with the remainder in Photon Counting (PC) mode. The enhanced XRT position for this burst was given by Beardmore, *et al.*, *GCN Circ.* 11792.

The light curve (Fig.2) can be modelled with an initial power-law decay with an index of $\alpha_1 = 2.48^{+0.64}_{-0.53}$, followed by a break at $T + 150$ s to an $\alpha_2 = 1.03^{+0.03}_{-0.03}$. Flaring activity is detected around $T + 500$ s.

A spectrum formed from the WT mode data can be fitted with an absorbed power-law with a photon spectral index of $2.14^{+0.26}_{-0.24}$. The best-fitting absorption column is $2.5^{+0.8}_{-0.7} \times 10^{21} \text{ cm}^{-2}$, in excess of the Galactic value of $1.8 \times 10^{21} \text{ cm}^{-2}$ (Kalberla et al. 2005). The PC mode spectrum has a photon index of $2.19^{+0.15}_{-0.12}$ and a best-fitting absorption column of $(2.7 \pm 0.4) \times 10^{21} \text{ cm}^{-2}$. The counts to observed (unabsorbed) 0.3 – 10 keV flux conversion factor deduced from this spectrum is $3.9 \times 10^{-11} (6.7 \times 10^{-11}) \text{ erg cm}^{-2} \text{ count}^{-1}$.

4 UVOT Observation and Analysis

The Swift/UVOT began settled observations of the field of GRB 110315A at $T + 113$ s (Hoversten & Melandri, *GCN Circ.* 11795) after the BAT trigger (Melandri, *et al.*, *GCN Circ.* 11790). No optical afterglow consistent with the enhanced XRT position (Beardmore, *et al.*, *GCN Circ.* 11792) was detected in the initial UVOT exposures. 3σ 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:

Filter	Start	Stop	Exposure	3σ UL
WHITE(fc)	113	263	147	> 20.5
WHITE	113	12119	1275	> 21.8
u(fc)	325	559	230	> 19.7

Table 1: Magnitude limits from UVOT observations . The values quoted above are not corrected for the Galactic extinction due to the reddening of $E_{(B-V)} = 0.25$ in the direction of the burst (Schlegel et al. 1998)

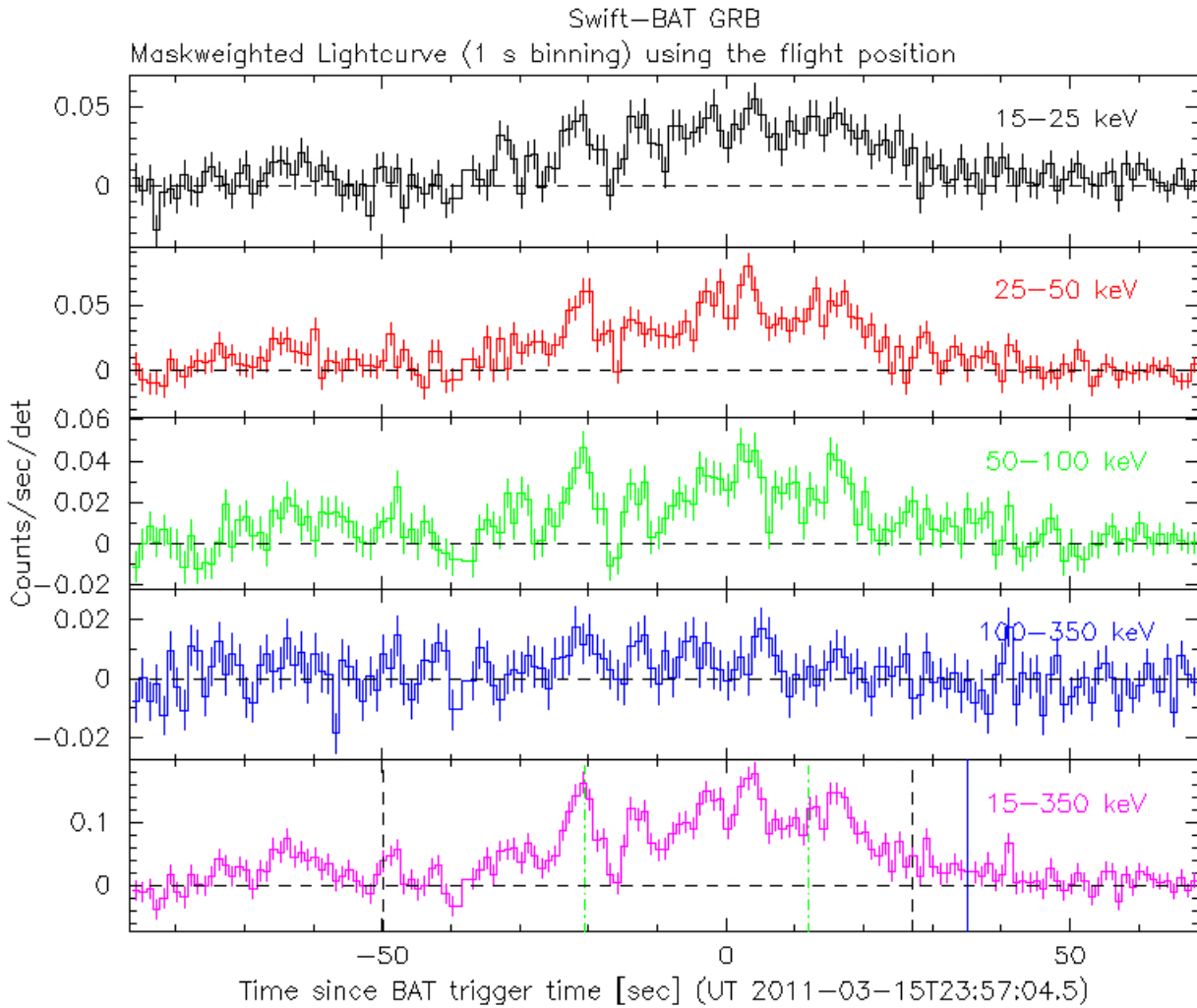


Figure 1: BAT Light curve. The mask-weighted light curve in the 4 individual plus total energy bands (15 - 25, 25 - 50, 50 - 100, 100 - 350 and 15 - 350 keV).

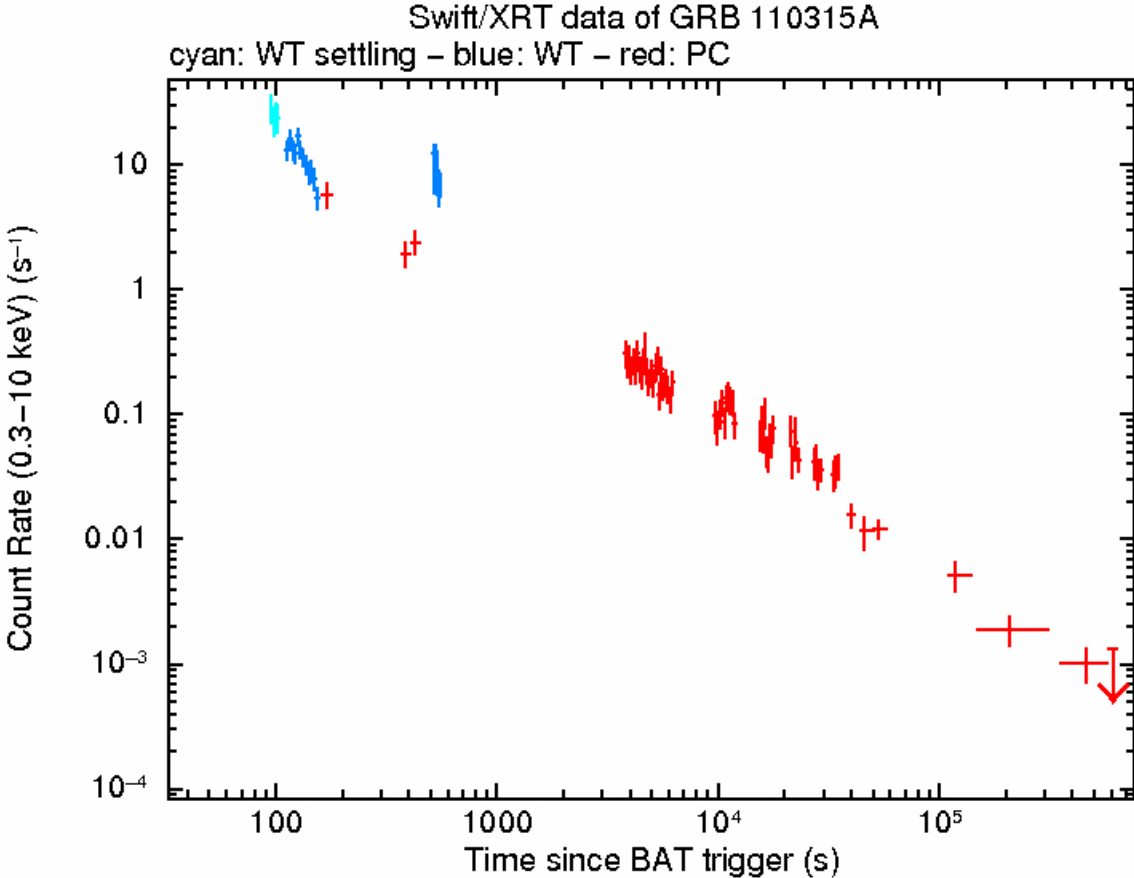


Figure 2: XRT Lightcurve. It can be modelled by a broken power-law with flaring activity around $T + 500$ s. Data are from WT mode (blue) and PC mode (red).