Swift Observations of GRB 100213A

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1 Introduction

At 22:27:48 UT on 2010-02-13, the Swift Burst Alert Telescope (BAT) triggered and located GRB 100213A (trigger=412217). Swift slewed immediately to the burst and found an X-ray counterpart of the burst in the XRT (Grupe et al. *GCN Circ.* 10411)

The best *Swift* position of this burst is the XRT position given in Beardmore et al. (*GCN Circ.* 10418) with RA-2000 = 23h 17m 34.04s, and Dec-2000 = +43° 22′ 44.1″ with an uncertainty of 2.2″.

Due to the small sun-angle only two optical follow-up observation were reported by Updike et al. (*GCN Circ.* 10415) and Sakamoto et al. (*GCN Circ.* 10425) who could not detect any new source down to limiting magnitudes of R=20 mag and R=17.5 mag, respectively.

2 BAT Observation and Analysis

At 22:27:48 UT on 2010-02-13, the Swift Burst Alert Telescope (BAT) triggered and located GRB 100213A (trigger=412217, Grupe et al. *GCN Circ.* 10411). Using the data set from T-61 to T+242 s, the BAT ground-calculated position is RA, Dec = 349.379, 43.370 deg deg which is

RA(J2000) = 23h 17m 31.0s

Dec(J2000) = +43° 22′ 13.1″

with an uncertainty of 1.4 arcmin, (radius, sys+stat, 90% containment). The partial coding was 59% (Barthelmy et al. *GCN Circ.* 10424).

The mask-weighted light curve shows four spikes between T-0.7 and T+2.5 s plus a low level tail out to T+40 s. T_{90} (15-350 keV) is 2.4±0.4 s (estimated error including systematics).

Temporal analysis of BAT data for GRB 100213A suggests that the burst is likely a member of the short, hard class (Norris et al. *GCN Circ.* 10427). Structures in the burst's most intense pulse complex are as short as 10-25 ms, typical of most short bursts. Spectral lag analysis of this most intense pulse complex indicate a lag between BAT channels 4 (100-350 keV) and 2 (25-50 keV) of 5 ms ±15 ms. For the whole event, the lag between these same channels is 15 ms ±15 ms.

A Bayesian Block analysis reveals no significant emission after the T_{90} duration of 2.4 s (reported in Barthelmy et al., *GCN Circ.* 10424), for 400 s following the BAT trigger time. This is inconsistent only at the 2σ level with the finding in *GCN Circ.* 10424 that there was "low level emission out to T+40 s", and we further note that this emission is only in the 15-25 keV band.

The time-averaged spectrum from T-0.7 to T+2.2 s is best fit by a single power law model. The power law index of the time-averaged spectrum is 1.34±0.15 (χ^2 = 74 for 57 d.o.f.). For this model the total fluence in the 15-150 keV band is 2.7 $\pm 0.3 \times 10^{-7}$ ergs cm^{-2}. The 1s peak photon flux measured from

T+0.01 s in the 15-150 keV band is 2.1±0.2 photons s^{-1} 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/412217/BA/

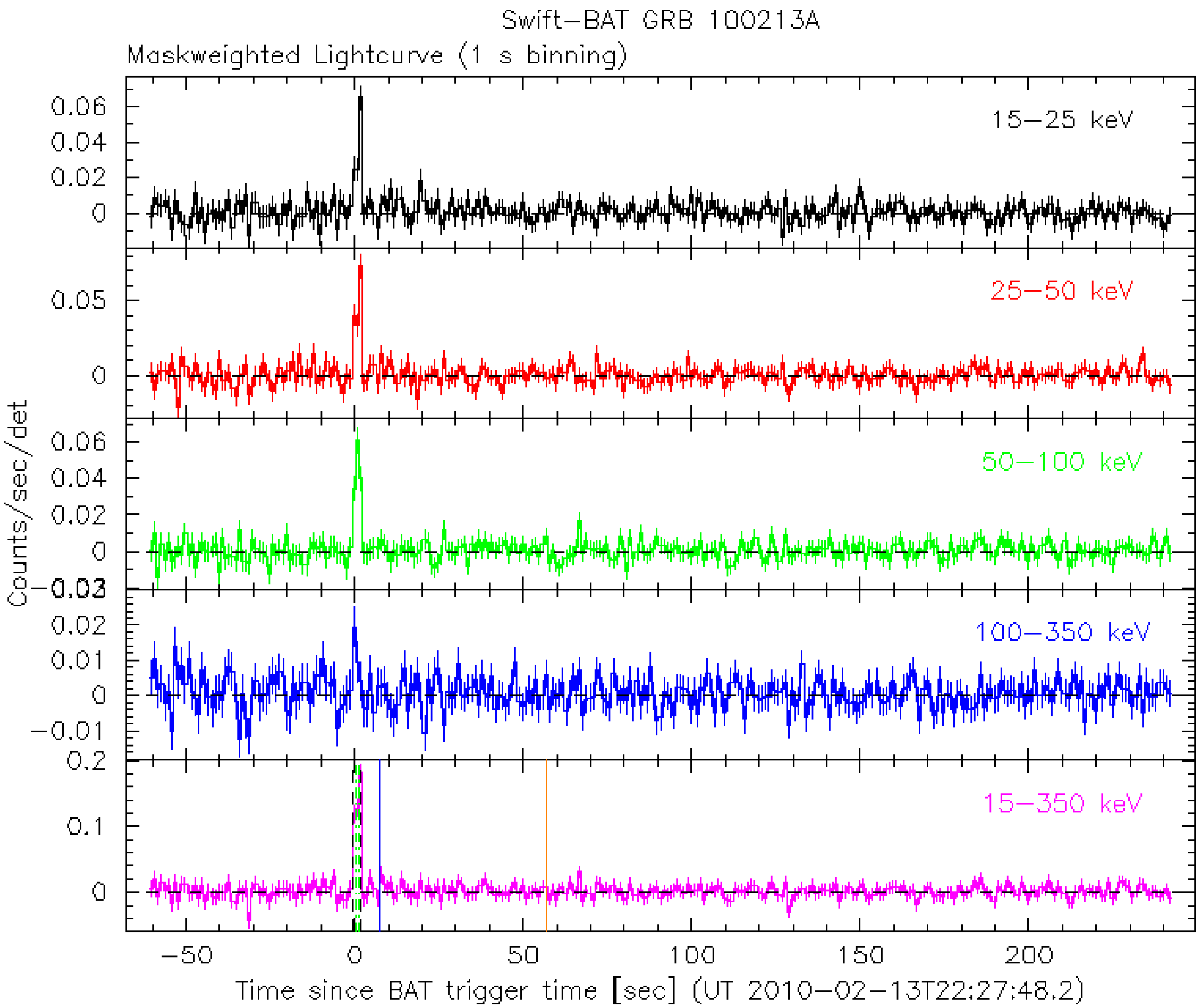

Figure 1: BAT Light curve of GRB 100213A.

3 XRT Observations and Analysis

The XRT began observing the field of GRB 100213A at 22:29:00.9 UT, 72.7 seconds after the BAT trigger. Using 273 s of XRT Photon Counting (pc) mode data and 1 UVOT image for GRB 100213A, Beardmore et al. (*GCN Circ.* 10418) found an astrometrically corrected X-ray position (using the XRT-UVOT alignment and matching UVOT field sources to the USNO-B1 catalogue): RA, Dec = 349.39183, +43.37892 which is equivalent to:

RA (J2000): 23h 17m 34.04s

Dec (J2000): $+43^{\circ}\ 22^{\prime}\ 44.1^{\prime\prime}$

with an uncertainty of $2.2^{\prime\prime}$ (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 pc mode data (274s exposure) can be fitted with an absorbed single power-law model with a photon spectral index of $2.04^{+0.45}_{-0.56}$ (Grupe *GCN Circ.* 10414) with the absorption column density fixed to the Galactic value of 1.1×10^{21} cm^{-2} (Kalberla et al. 2005). The counts to observed (unabsorbed) 0.3-10 keV flux conversion factor deduced from this spectrum is 4.5 $\times 10^{-11}$ (5.9 $\times 10^{-11}$) ergs cm^{-2} counts^{-1}.

The $0.3 - 10$ keV light curve given below (Fig.2). The afterglow was only detected during the 274s observation in the first orbit. Because Swift detected and slewed to GRB 100213B (Vetere et al. *GCN Circ.* 10416) about half an hour after the detection of GRB 100212A, the afterglow was observed only for an additional 8.7 ks between 3 to 11 hours after the burst in which the X-ray afterglow could not be detected anymore. The 3σ upper limit in this data set is 2×10^{-3} counts s^{-1} (1.2×10^{-13} ergs s^{-1} cm^{-2}.)

4 UVOT analysis

The Swift/UVOT began settled observations of the field of GRB 100213A 77 s after the BAT trigger (Grupe et al., GCN Circ. 10411). Curran & Grupe (*GCN Circ.* 10420) reported on no optical afterglow detected within the enhanced XRT error circle position (Beardmore et al., *GCN Circ.* 10418) in the initial UVOT exposure and in all other summed exposures at 3σ level.

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

Filter	$T_{\rm Start}$	$T_{\rm stop}$	Exposure	Mag
white	77	227	147	>20.20
v	59	68	9	>17.19
u	289	366	75	>19.7

Table 1: Magnitudes from UVOT observations of GRB 100213A. The quoted upper limits have not been corrected for the expected Galactic extinction along the line of sight of $E_{\rm B-V} = 0.31$ mag. All photometry is on the UVOT photometric system described in Poole et al. (2008, MNRAS, 383, 627).

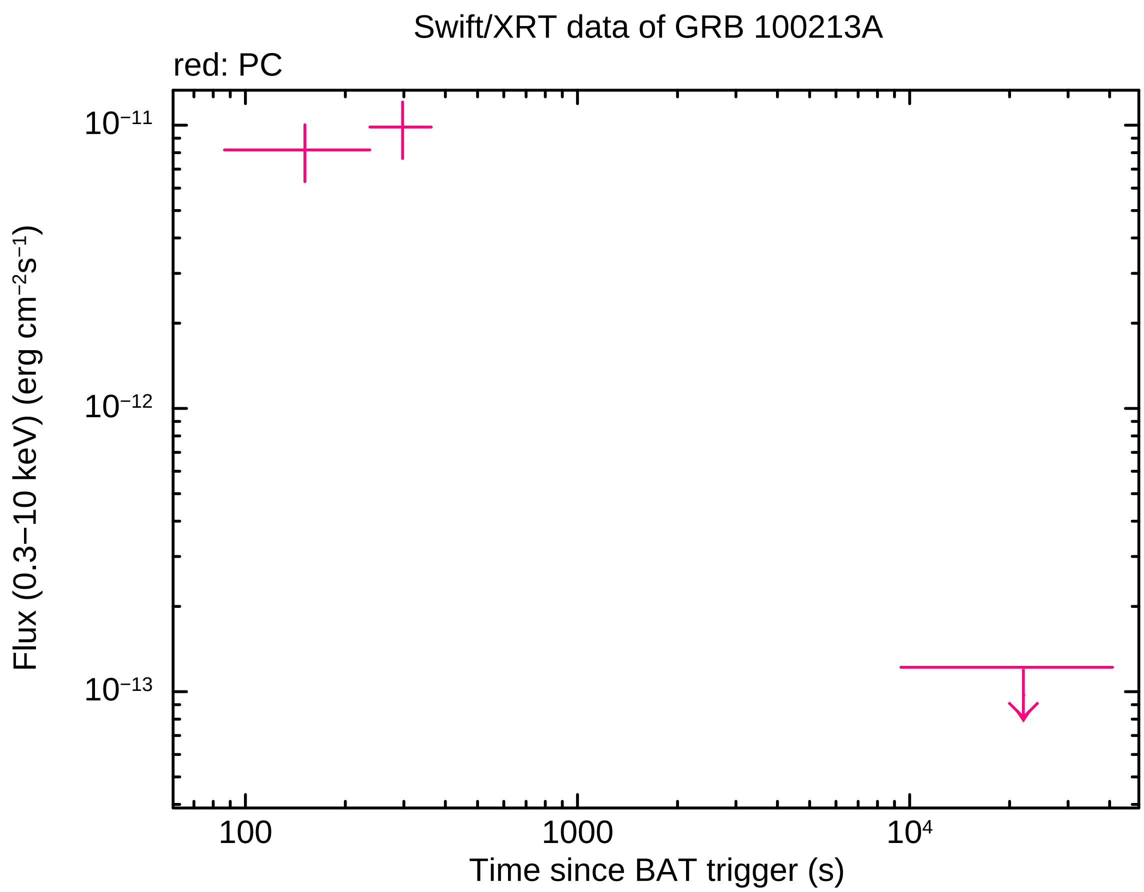

Figure 2: XRT flux light curve of GRB 100213A in the 0.3-10 keV band. The approximate conversion is 1 count s^{-1} $= \sim 5.9 \times 10^{-11}$ $ergs\ s^{-1} cm^{-2}$.