Swift Observations of GRB 121212A

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1 Introduction

At 06:56:13 UT on 2012-12-12, the Swift Burst Alert Telescope (BAT) triggered and located GRB 121212A (trigger=541371). Swift slewed immediately to the burst and found an uncatalogued X-ray source (Grupe et al., *GCN Circ.* 14064).

The best *Swift* position of this burst is the Swift UVOT position given in Kuin & Grupe (*GCN Circ.* 14069) with RA-2000 = 11h 51m 10.30s, and Dec-2000 = +78° 02′ 14.3″ with an uncertainty of 0.62″.

The burst was also detected by INTEGRAL (Mereghetti et al., *GCN Circ.* 14065). The Keck I telescope observed the optical afterglow of GRB 121212A about 8.7 hours after the burst and found it at R≈21 mag (Perley & Horesh, *GCN Circ.* 14070). Spectra taken by Keck suggest a redshift of the burst of z<2 which is consistent with the detections in the UVOT and the excess absorption found in the spectrum of the X-ray afterglow. The optical afterglow was also detected by the ISON-NM observatory (Elenin et al., *GCN Circ.* 14071), Palomar 60 inch telescope (Cenko, *GCN Circ.* 14065), Maidanak observatory (Pazaenko et al., *GCN Circ.* 14079), and the Nordic Optical telescope (Schulze et al., *GCN Circ.* 14082). Upper limites were reported by PAIRITEL (Morgan, *GCN Circ.* 14074), RAPTOR (Wren et al., *GCN Circ.* 14075), PdBI mm observatory (Castro-Tirado et al., *GCN Circ.* 14083), and LOAO 1.0m telescope (Jang et al., *GCN Circ.* 14085).

2 BAT Observation and Analysis

At 06:56:13 UT on 2012-12-12, the Swift Burst Alert Telescope (BAT) triggered and located GRB 121212A (trigger=541371, Grupe et al., *GCN Circ.* 14064). Using the data set from T-60 to T+243 s, the BAT ground-calculated position is RA, Dec = 177.787, +78.052 deg which is

RA(J2000) = 11h 51m 08.8s

Dec(J2000) = +78° 03′ 05.4″

with an uncertainty of 2.1 arcmin, (radius, sys+stat, 90% containment). The partial coding was 100% (Barthelmy et al. *GCN Circ.* 14068).

The mask-weighted light curve (Figure 1) shows several peaks starting at T-3 s, peaking at T+0 s, and ending at T+16s. The T_{90} (15-350 keV) is 6.8±1.3 s (estimated error including systematics).

The time-averaged spectrum from T-0.02 to T+7.84 s is best fit by a single power law. This fit gives a photon index of 2.65±0.40 ($\chi^2 = 55.8$ for 57 d.o.f.). For this model the total fluence in the 15-150 keV band is $1.2 \pm 0.3 \times 10^{-7}$ erg cm^{-2}. The 1s peak flux measured from T+0.02 s in the 15-150 keV band is 0.7 ±0.1 photons 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/541371/BA/.

3   XRT Observations and Analysis

The XRT began observing the field of GRB 121212A at 06:57:21.7 UT on 2012-12-12, 68.4 seconds after the BAT trigger. Using 1924 s of XRT Photon Counting mode data and 2 UVOT images for GRB 121212A, Beardmore et al. (*GCN Circ.* 14066) found an astrometrically corrected X-ray position (using the XRT-UVOT alignment and matching UVOT field sources to the USNO-B1 catalogue): RA, Dec = 177.79152, +78.03739 which is equivalent to:

RA (J2000): 11h 51m 09.96s

Dec (J2000): +78° 02′ 14.6″

with an uncertainty of 1.7″ (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 can be fitted with an absorbed power-law with a photon spectral index of $\Gamma = 2.42^{+0.18}_{-0.16}$. The best-fitting absorption column is $2.04^{+0.47}_{-0.42} \times 10^{21}$ cm^{-2}, in excess of the Galactic value of 3.7×10^{20} cm^{-2} (Kalberla et al. 2005). Following the relation given in Grupe et al. (2007, AJ, 133, 2216) the excess column density $\Delta N_{\mathrm{H}} = 1.7 \times 10^{21}$ cm^{-2} suggests that the redshift of this burst is z<4.7. The counts to observed (unabsorbed) 0.3-10 keV flux conversion factor deduced from this spectrum is 3.1×10^{-11} (6.2×10^{-11}) erg cm^{-2} count^{-1}.

The light curve of the X-ray afterglow displays two strong flares peaking at about 250 s and 600 s after the trigger over a canonical light curve. The $0.3 - 10$ keV light curve given below (Fig.2) can be modeled by a broken power-law model, with a decay slope during the plateau phase of $\alpha_2 = 0.50 \pm 0.13$, a break after the plateau phase at $T_{\mathrm{break},2} = 3.3^{+15.8}_{-2.3}$ ks, and the decay slope during the normal decay phase $\alpha_3 = 0.82 \pm 0.10$.

The results of the XRT-team automatic analysis are available at

http://www.swift.ac.uk/xrt_products/00541371.

4   UVOT analysis

The Swift/UVOT began observations of the field of GRB 121212A 72 s after the BAT trigger (Grupe et al., *GCN Circ.* 14064). with the finding chart in the white filter. Kuin & Grupe (*GCN Circ.* 14069) reported that a source was detected in the initial UVOT exposures which was consistent with the the enhanced XRT position (Beardmore et al, *GCN Circ.* 14066).

The UVOT position is RA, Dec = 177.79292, +78.03730 which is equivalent to:

RA (J2000): 11h 51m 10.30s

Dec (J2000): +78° 02′ 14.3″

with an uncertainty of 0.62 arcsec (radius, 90% confidence).

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

Filter	T_{Start}	T_{stop}	Exposure	Mag
white	72	7133	824	21.23±0.17
v	615	6108	352	>20.3
b	540	13527	1160	>20.9
u	285	1138	285	20.25±0.25
w1	664	11960	1238	>20.8
m2	639	6313	216	>20.5
w2	763	5904	255	>20.9

Table 1: Detections and 3σ upper limits from UVOT observations of GRB 121212A. The quoted values have not been corrected for the expected Galactic extinction along the line of sight of $E_{\text{B}-\text{V}} = 0.07$ mag (Schlegel et al., 1998). All photometry uses the UVOT photometric system as described in Poole et al. (2008, MNRAS, 383, 627) and Breeveld et al. (2011, AIP Conf. Proc., Vol. 1358, 373)
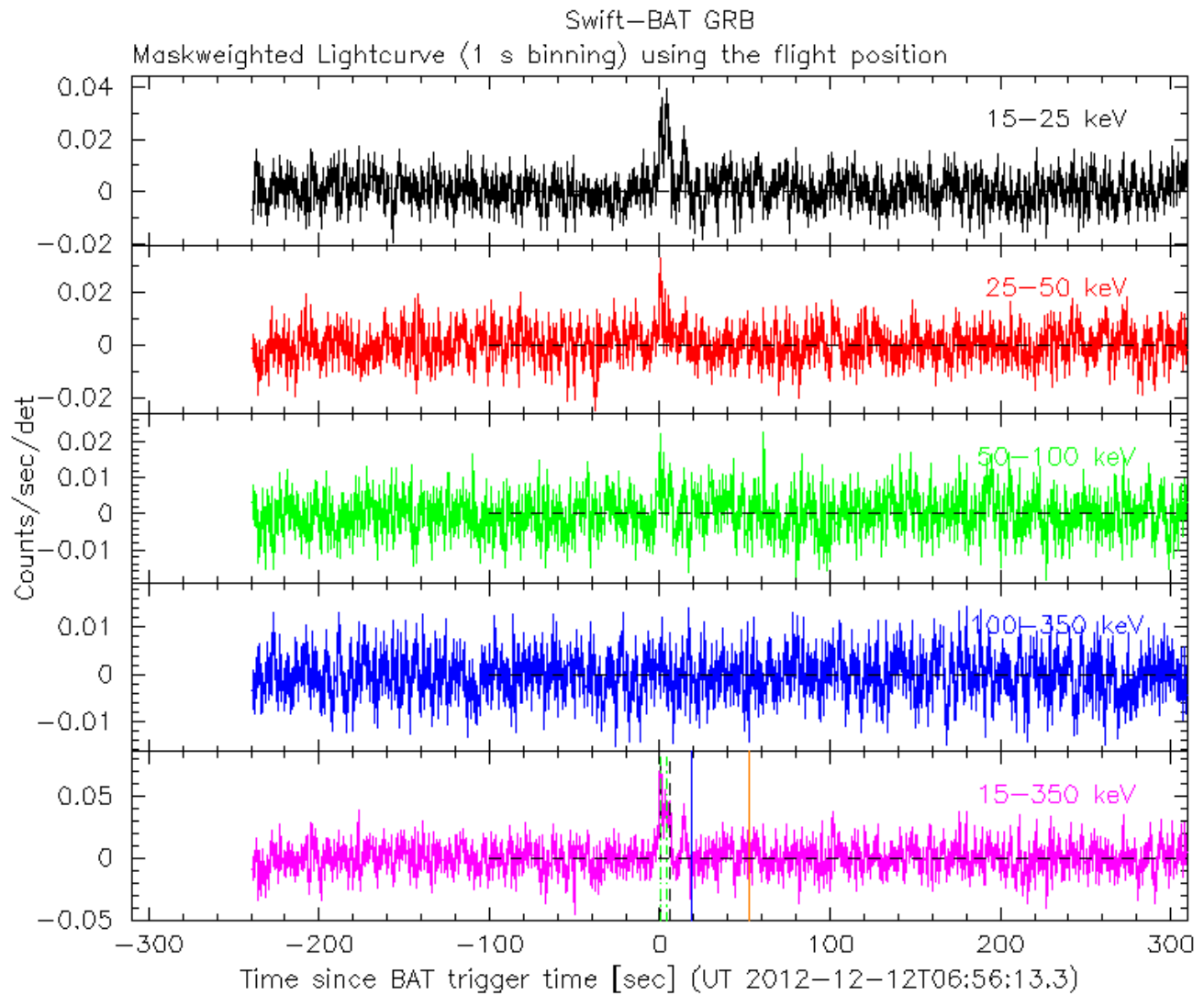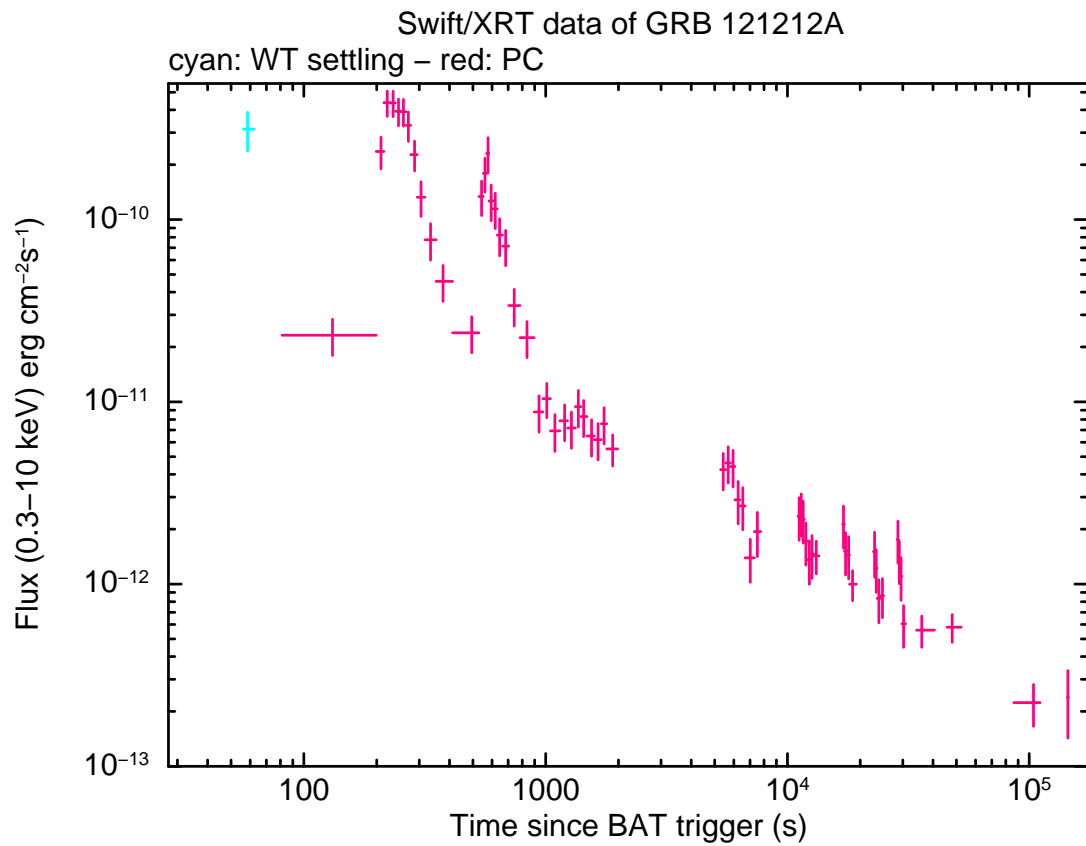
Figure 1: BAT Light curve of GRB 121212A.

Figure 2: XRT flux light curve of GRB 121212A in the 0.3-10 keV band. The approximate conversion is 1 count s^{-1} = $\sim 3.2 \times 10^{-11}$erg s^{-1} cm^{-2}.