Swift Observations of GRB 090313

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1 Introduction

At 09:06:27 UT, the Swift Burst Alert Telescope (BAT) triggered and located GRB 090313 (trigger=346386). The position is given below. The BAT light curve showed a broad series of multiple peaks from approximately T-10 s to T+40 s. The peak count rate was 1300 counts/s (15-350 keV), at 4 s after the trigger. Since this was an image trigger, the light curve shows only rather weak peaks.

Due to a Moon observing constraint, Swift could not slew to the BAT position until 16:45 UT. Thus there were no prompt XRT or UVOT data for this trigger.

The optical afterglow was discovered by Chornock *et al.* (GCN 8979) and then confirmed by the GROND team using IR observations (Updike *et al.*, GCN 8983). The afterglow was observed to rise and peak around 1.3 ks post burst by the Faulkes Telescope North (Guidorzi *et al.*, GCN 8989). De Ugarte Postigo *et al.* (GCN 8992) reported on the optical ongoing plateau phase. Chornock *et al.* (GCN 8994) measured the spectroscopic redshift z=3.375. AAVSO High Energy Network (Nissinen GCN 8993), PAIRITEL (Morgan *et al.*, GCN 8995), TAROT (Klotz *et al.*, GCN 8998), MITSuME Okayama (Yoshida *et al.*, GCN 9002), SMARTS (Cobb, GCN 9008), VLT (Thoene *et al.*, GCN 9012) and X-shooter (de Ugarte Postigo *et al.*, GCN 9015) also observed the optical afterglow.

AMI Large Array (frequency range 14.5 to 17.5 GHz) obtained a flux density of 820 μJy with an rms noise of 71 μJy (Pooley GCN 9003, but see Pooley GCN 9007). The Combined Array for Research in Millimeter-Wave Astronomy (CARMA) detected a flux density of (4.0 ± 0.6) mJy at a frequency of 92.5 GHz (Bock *et al.*, GCN 9005). The Very Large Array (VLA) reported a flux density 269 ± 31 μJy at 8.46 GHz band (Frail *et al.*, GCN 9011). Westerbork Synthesis Radio Telescope observed the radio countpart at 4.9 GHz with a flux density of (165 ± 30) μJy (van der Horst & Kamble GCN 9016).

2 BAT Observation and Analysis

Using the data set from T-239 to T+963 s, the BAT ground-calculated position is RA, Dec = 198.400, 8.086 deg, which is RA(J2000) = 13h 13m 36.0s, Dec(J2000) = +08d 05' 10.7" with an uncertainty of 2.2 arcmin, (radius, sys+stat, 90% containment). The partial coding was 15%.

The mask-weighted light curve (Fig. 1) shows emission starting before T-100 s. BAT triggered on the peak starting at T-20 s, peaking at T+10 s, and ending at T+90 s. T90 (15-350 keV) is 78 ± 19 s (estimated error including systematics).

The time-averaged spectrum from T-21.3 to T+66.6 s is best fit by a simple power-law model. The power law index of the time-averaged spectrum is 1.91 ± 0.29. The fluence in the 15-150 keV band is $(1.4 \pm 0.2) \times 10^{-6}$ erg cm^{-2}. The 1-sec peak photon flux measured from T+4.86 sec in the 15-150 keV band is (0.8 ± 0.3) 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/346386/BA/`

3 XRT Observations and Analysis

Due to a Moon constraint, XRT began observing GRB 090313 26.8 ks after the trigger (Mao *et al.*, GCN Circ. 8980). Using 2038 s of XRT Photon Counting mode data and 1 UVOT image, the astrometrically corrected X-ray position was found to be: RA, Dec = 198.40130, 8.09730 which is equivalent to: RA (J2000): 13h 13m 36.30s, Dec (J2000): +08d 05' 50.4" with an uncertainty of 1.8 arcsec (radius, 90% confidence).

The lightcurve (Fig. 2) can be modeled as a double broken power-law with the following parameters: $\alpha_1 = 1.48 \pm 0.28$, $\alpha_2 = 0.64 \pm 0.38$, and $\alpha_3 = 2.27 \pm 0.12$; the values of break times are about $t_{b1} = 4.5 \times 10^4$ s and $t_{b2} = 7.9 \times 10^4$ s respectively.

The PC mode spectrum spanning from 26.8 to 28.6 ks can be fit with an absorbed simple power-law, with a photon index of 2.12 ± 0.33 and an absorbing column density of $(1.29 \pm 0.97) \times 10^{21}$ cm^{-2}, in excess of the Galactic value of 2.10×10^{20} cm^{-2} (Kalberla *et al.*, 2005). The counts to observed (unabsorbed) 0.3-10 keV flux conversion factor deduced from this spectrum is 5.1×10^{-11}(5.9×10^{-11}) erg cm^{-2} count^{-1}.

The results of the automatic XRT analysis are available online at

`http://www.swift.ac.uk/xrt_products/00346386`.

4 UVOT Observation and Analysis

The Swift/UVOT began observing the field of GRB 0903013 27ks after the BAT trigger. A fading source is detected in the v filter and marginally in the b-band filter. These observations are in agreement with the spectroscopic redshift z=3.375 (Chornock *et al.*, GCN 8994). The magnitudes and 3-sigma upper limits for GRB 090313 within each co-added UVOT filter are reported in Table 1:

Filter	T_{mid} (hrs)	Exp (s)	Mag/3-sigma UL
v	11.0	551	20.10 ± 0.30 (3.6 sigma)
b	11.2	770	21.50 ± 0.38 (2.8 sigma)
u	8.1	1024	> 21.44
uvw1	8.6	1771	> 21.78
uvm2	9.3	886	> 21.22
uvw2	10.9	886	> 21.58

Table 1: Magnitudes from UVOT observations.

where T_{mid} is the weighted mean time of the observations. The values quoted above are not corrected for the Galactic extinction due to the reddening of E(B-V) = 0.03 in the direction of the burst (Schlegel *et al.*, 1998). All photometry is on the UVOT photometry system described in Poole *et al.*, (2008, MNRAS, 383, 627).

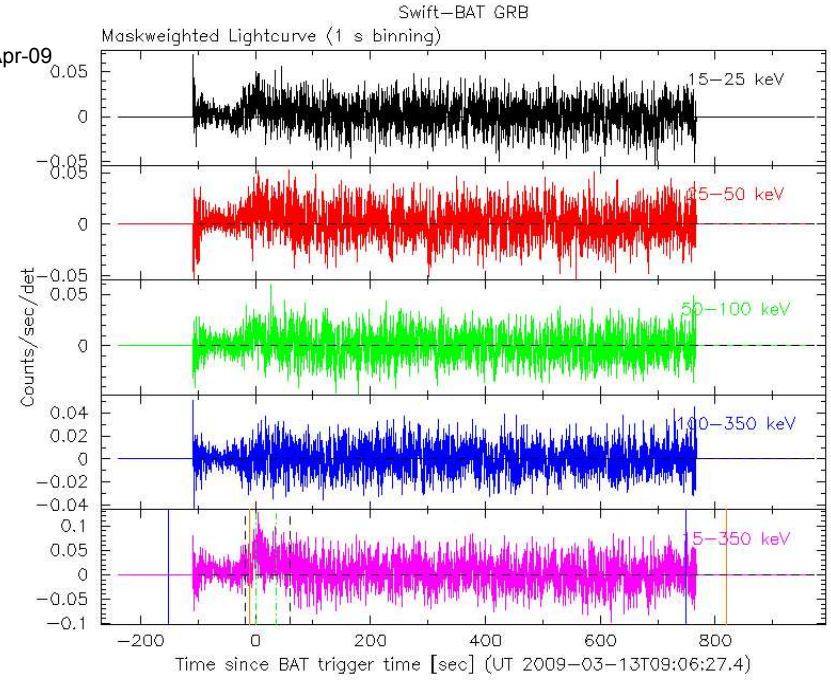

Figure 1: BAT Lightcurve. The mask-weighted light curve in the 4 individual plus total energy bands: 15-25 keV (black), 25-50 keV (red), 50-100 keV (green), 100-350 keV (blue), 15-350 keV (magenta).

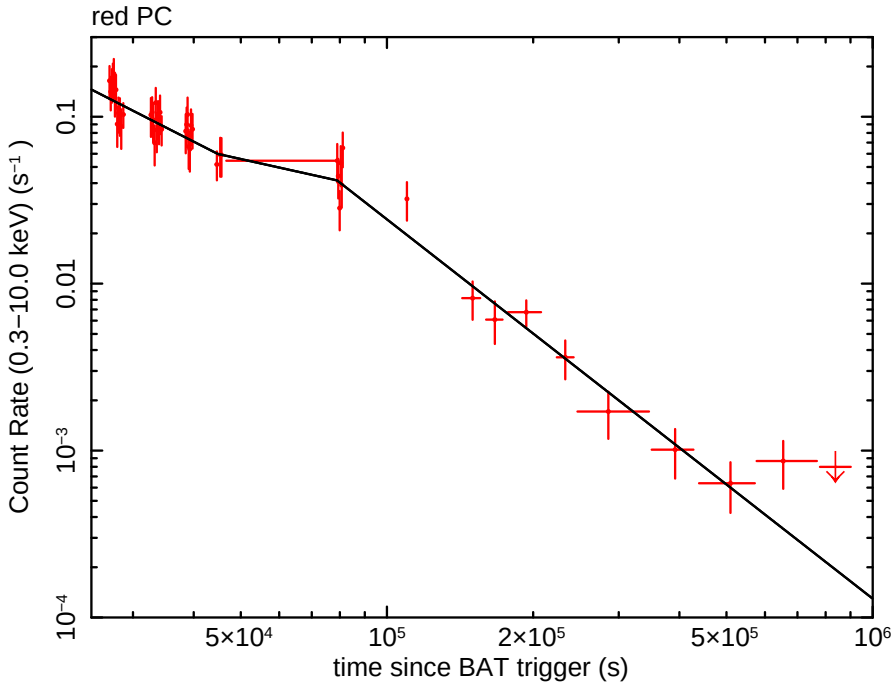

Figure 2: XRT Lightcurve in the 0.3-10 keV band. The approximate conversion is 1 count $s^{-1} \sim 5.1 \times 10^{-11}$ erg cm^{-2} s^{-1}.