Swift Observation of long GRB 090814A

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1 Introduction

BAT triggered on GRB 090814A at 00:52:19 UT (Trigger 359951) (Ukwatta, *et al.*, *GCN Circ.* 9793). This was a 10 sigma image-trigger on a long burst with $T_{90} = 80 \pm 8$ sec. Swift slewed immediately to the burst. Narrow field instruments started observations at $\sim T + 159$ sec, and our best position is the UVOT-enhanced XRT location RA($J2000$) = 239.61014 deg (15h 58m 26.43s), Dec($J2000$) = +25.63088 deg (+25d 37′ 51.2″) with an uncertainty of 1.8 arcsec (90% confidence, including boresight uncertainties), reported by Beardmore *et al.*, *GCN Circ.* 9796.

2 BAT Observation and Analysis

Using the data set from $T - 239$ to $T + 963$ sec, further analysis of BAT GRB 090814A has been performed by BAT team (Krimm, *et al.*, *GCN Circ.* 9799). The BAT ground-calculated position is RA($J2000$) = 239.613 deg (15h 58m 27.2s), Dec($J2000$) = 25.586 deg (+25d 35′ 09.0″) ± 2.0 arcmin, (radius, systematic and statistical, 90% containment). The partial coding was 37% (the bore sight angle was 30.2 deg).

The mask-weighted light curve (Fig. 1) shows a few semi-overlapping peaks starting at $\sim T - 18$ sec, peaking at $\sim T - 13$ sec, peaking at $\sim T + 8$ sec, and ending at $\sim T + 115$ sec. There is possible 10-sec precursor peak (3 sigma) at $\sim T - 145$ sec (see Fig. 2). T90 ($15 - 350$ keV) is 80 ± 8 sec (estimated error including systematics).

The time-averaged spectrum from $T - 16.44$ to $T + 73.64$ sec is best fit by a simple power-law model. The power law index of the time-averaged spectrum is 1.81 ± 0.19. The fluence in the $15 - 150$ keV band is $1.3 \pm 0.2 \times 10^{-6}$ erg/cm2. The 1-sec peak photon flux measured from $T - 12.68$ sec in the $15 - 150$ keV band is 0.6 ± 0.2 ph/cm2/sec. 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/359951/BA/

3 XRT Observations and Analysis

XRT data were collected from 165 s to 418 ks after the BAT trigger. These data comprise 258 s in Windowed Timing (WT) mode and 44.7 ks in Photon Counting mode. The best position of the X-ray afterglow is the UVOT-enhanced XRT position (Beardmore , *et al.*, *GCN Circ.* 9796)

RA(J2000) = 15h 58m 26.43s
Dec(J2000)= +25d 37' 51.2"

with an uncertainty of 1.8 arcsec (radius, 90% confidence).

The light curve (Fig. 3) can be modelled with a series of power-law decays, starting with $\alpha_1 = 2.60 \pm 0.08$ until $\sim T + 830$ s, at which point the decay flattens slightly to $\alpha_2 = 1.91 \pm 0.20$. The light curve flattens again at $\sim T + 4.4$ ks, to a slope of $\alpha_3 = 1.0 \pm 0.2$.

The spectrum extracted from the WT data can be fitted with an absorbed power-law, with $\Gamma = 2.78^{+0.12}_{-0.11}$, absorbed by the Galactic column of NH = 4.76×10^{20} cm^{-2} (Kalberla *et al.*2005),

together with an intrinsic column (assuming z = 0.696; Jakobsson *et al.*, *GCN Circ.* 9797) of $(2.0 \pm 0.4) \times 10^{21}\,\mathrm{cm}^{-2}$. Note, however, that this redshift determination is uncertain. The total (including Galactic) column at z = 0 would be $(1.3 \pm 0.2) \times 10^{21}\,\mathrm{cm}^{-2}$. Alternatively, the spectrum is better fitted (at $>3\ \sigma$) by a broken power-law with $\Gamma_1 = 0.47^{+0.72}_{-1.59}$ below a break energy of $0.62^{+0.09}_{-0.08}$ keV, followed by $\Gamma_2 = 2.62 \pm 0.09$; this fit only requires the Galactic column. The counts to observed (unabsorbed) $0.3 - 10$ keV flux conversion factor deduced from the broken power-law fit is 2.5×10^{-11} (3.0×10^{-11}) $\mathrm{ergcm}^{-2}\,\mathrm{count}^{-1}$.

The results of the XRT-team automatic analysis are available at
http://www.swift.ac.uk/xrt_products/00359951.

4 UVOT Observation and Analysis

The Swift/UVOT began settled observations of the field of GRB 090814A 170s after the BAT trigger. The proposed optical counterpart (Updike *et al.*, *GCN Circ.* 9794) is marginally detected in the u and white UVOT exposures. No optical afterglow consistent with the enhanced XRT position (Beardmore *et al.*, *GCN Circ.* 9796) is detected in the other UVOT exposures.

Preliminary magnitudes and 3-sigma upper limits using the UVOT photometric system (Poole *et al.*, 2008, MNRAS, 383, 627) for the first finding charts (fc) and subsequent exposures are:

Filter	Tstart (s)	Tstop (s)	Exposure (s)	Magnitude
u(fc)	328	577	246	>20.16
white(fc)	170	319	147	>20.70
white	170	7117	699	21.54±0.27
u	328	8144	834	21.05±0.35
b	584	8340	599	>21.30
v	658	7528	607	>20.18
uvw1	708	7939	529	>20.66
uvm2	683	7733	529	>20.5
uvw2	708	7939	607	>20.81

Table 1: Magnitudes and limits from UVOT observations

The values quoted above are not corrected for the Galactic extinction due to the reddening of E_{B-V} = 0.078 in the direction of the burst (Schlegel, *et al.*1998, ApJS, 500, 525).

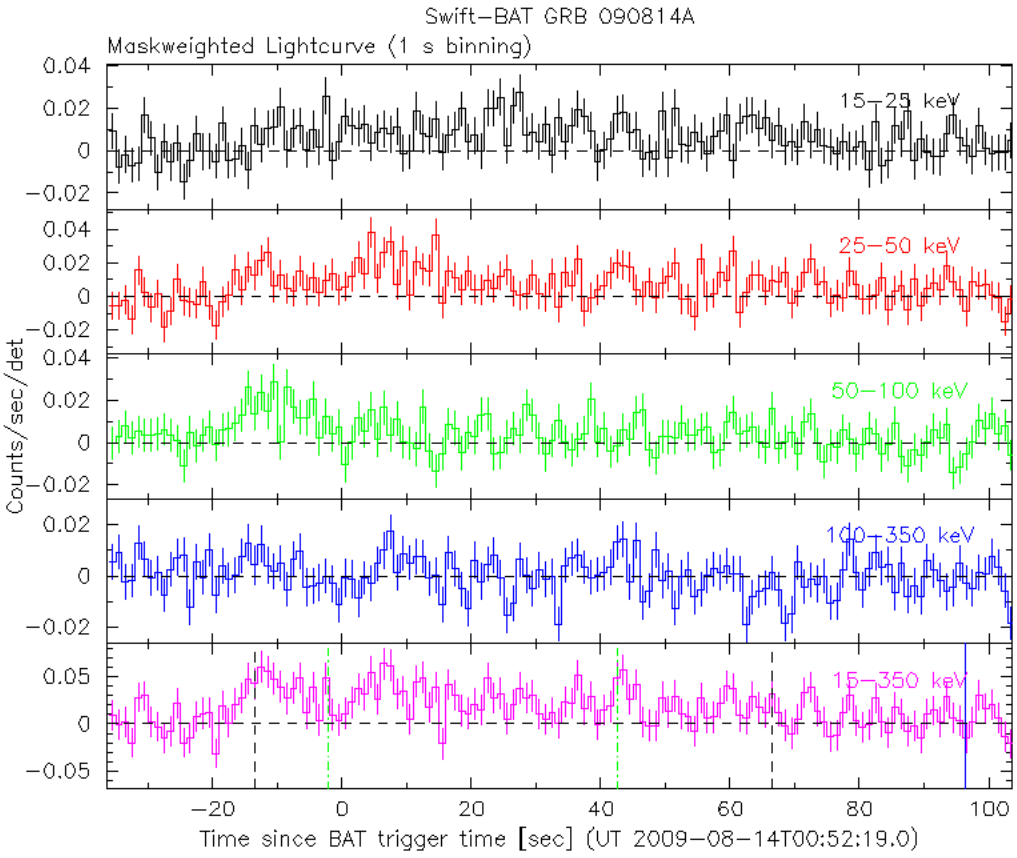

Figure 1: The mask-weighted light curve in the 4 individual plus total energy bands. The units are counts/sec/illuminated-detector and T_0 is 00:52:19 UT.

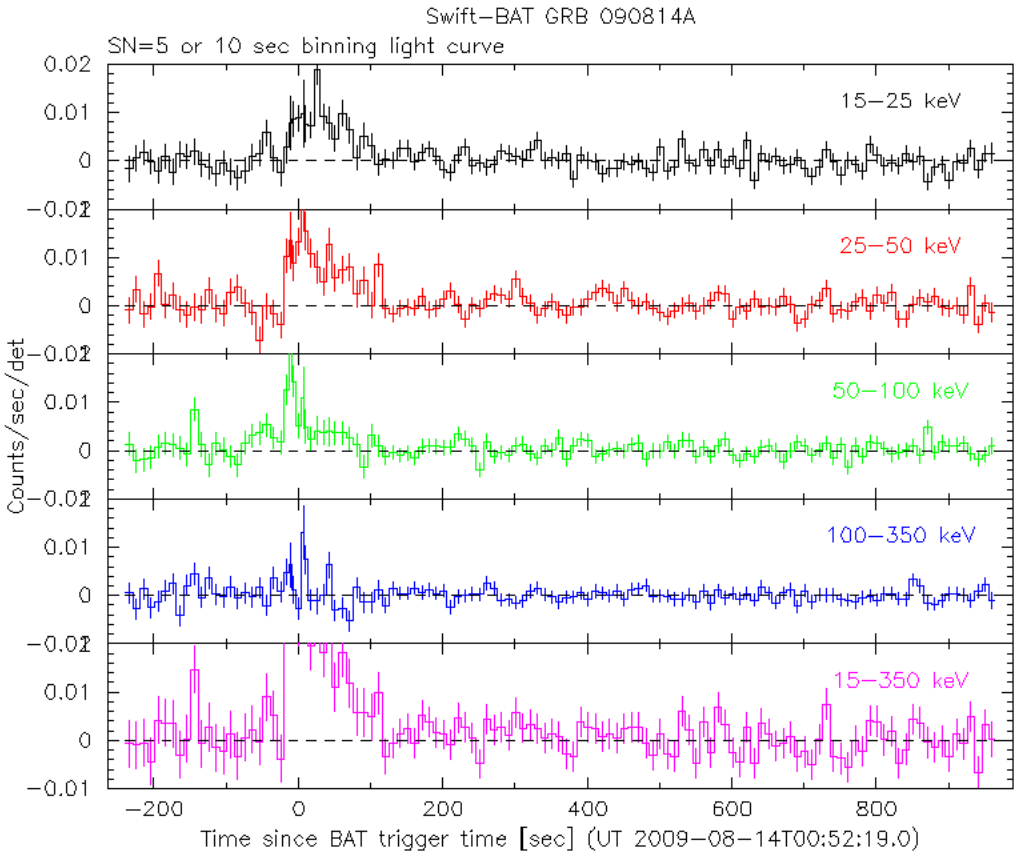

Figure 2: The mask-weighted light curve in the 4 individual plus total energy bands. The units are counts/sec/illuminated-detector and T_0 is 00:52:19 UT.

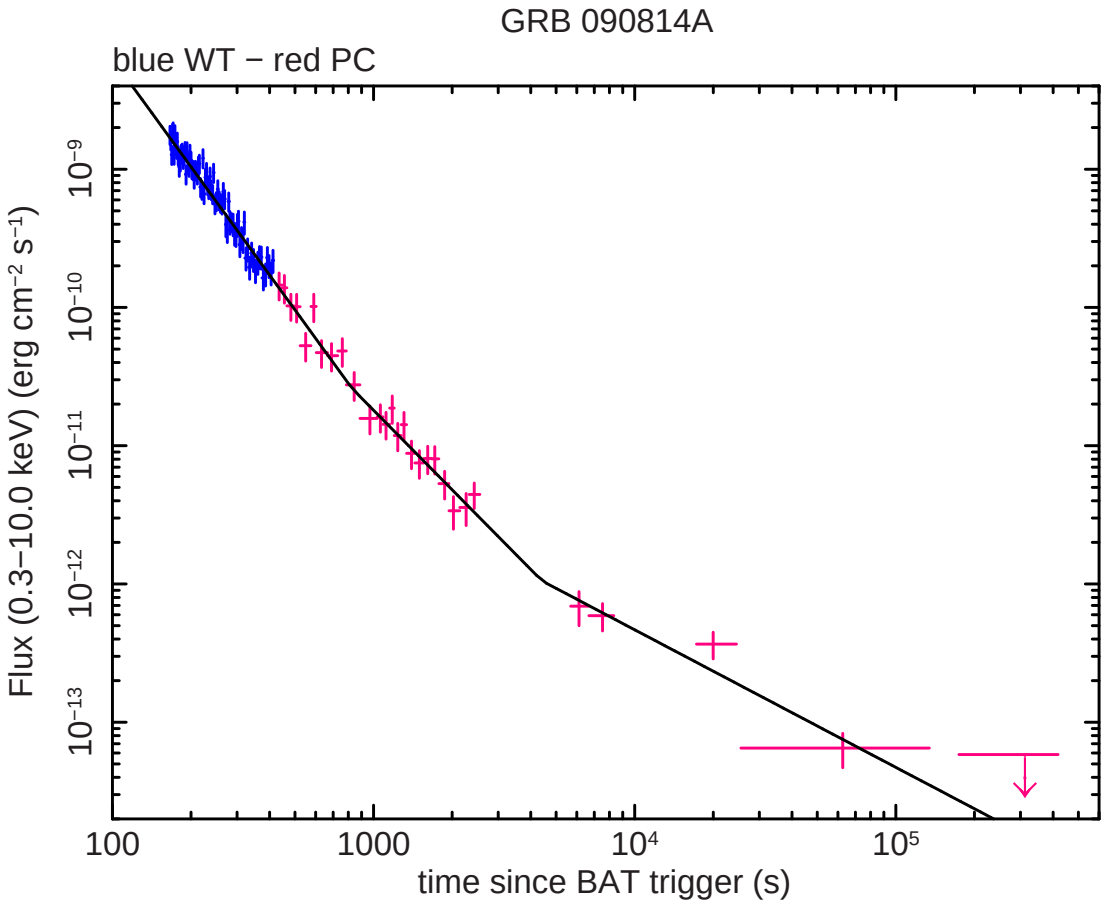

Figure 3: XRT Lightcurve. Flux in the $0.3 - 10$ keV band.