

Swift Observations of GRB 090309

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1 Introduction

Swift-BAT triggered on GRB 090309 at 23:29:13 UT (Trigger 345945) (Evans, *et al.*, *GCN Circ.* 8964). This was a 3 sec rate trigger with $T_{90} = 3$ sec. Swift slewed to this burst immediately, and XRT began follow-up observations at $T + 80$ sec, UVOT at $T + 82$ sec. Our best position is the enhanced XRT position $RA(J2000) = 274.97426deg$ ($18h59m53.82s$), $Dec(J2000) = -25.26099deg$ ($-25d15'39.6''$) with an error of 2.0 arcsec (radius, 90% confidence).

2 BAT Observation and Analysis

Using the data set from $T - 240$ to $T + 362$ sec, analysis of GRB 090309 has been performed by the Swift team (Palmer, *et al.*, *GCN Circ.* 8967). The BAT ground-calculated position is $RA(J2000) = 284.978deg$ ($18h59m55.5s$), $Dec(J2000) = -25.274deg$ ($-25d16'42.0''$) ± 2.3 arcmin, (radius, systematic and statistical, 90% containment). The partial coding was 61% .

The mask-weighted light curve (Fig.1) shows a single peak starting at $T - 1$ sec, peaking at $\sim T + 1$ sec and ending at $\sim T + 2$ sec. $T_{90}(15 - 350keV)$ is 3.0 ± 1.4 sec (estimated error including systematics).

The time-averaged spectrum from $T - 0.8$ to $T + 2.2$ sec is best fitted by a simple power law model. This fit gives a photon index of 1.36 ± 0.33 . For this model the total fluence in the 15 – 150 keV band is $(1.3 \pm 0.3) \times 10^{-7}$ ergs/cm² and the 1-sec peak flux measured from $T + 0.18$ sec in the 15 – 150 keV band is 0.9 ± 0.2 ph/cm²/sec. All the quoted errors are at the 90% confidence level.

We are unable to determine if this is a short or long burst. The reasons are as follows: (1) the spectral lag is 0.044 ± 0.16 sec (between the 50 – 100 keV and 15 – 25 keV bands). (2) T_{90} is midway between the two T_{90} distributions. (3) The photon index is also in the middle of the short and hard distributions (Fig. 13 of Sakamoto et al., ApJS, 175, 179).

3 XRT Observations and Analysis

Swift-XRT observed the field of GRB 090309 for 31 ksec, from 86 sec to 173 ksec after the BAT trigger. The data are entirely in Photon Counting (PC) mode. The enhanced XRT position is $RA(J2000) = 284.97425deg$ ($18h59m53.82s$), $Dec(J2000) = -25.26099deg$ ($-25d15'39.6''$) with an error of 2.0 arcsec (radius, 90% confidence).

The light curve (Fig. 2) shows a power-law decay, with an initial decay index of 0.35 (± 0.12) with a break at $T + 7200$ sec to a decay index of 0.9 (± 0.2).

The PC mode spectrum can be fitted with an absorbed power-law, with a photon index of 2.2 (± 0.3) and an absorbing column of $2.8 (+1.5, -1.1) \times 10^{21}$ cm⁻², in excess of the Galactic value of 1.1×10^{21} cm⁻². The counts to observed (unabsorbed) 0.3–10 keV flux conversion factor deduced from this spectrum is 4.0×10^{-11} (6.8×10^{-11}) erg/cm²/count.

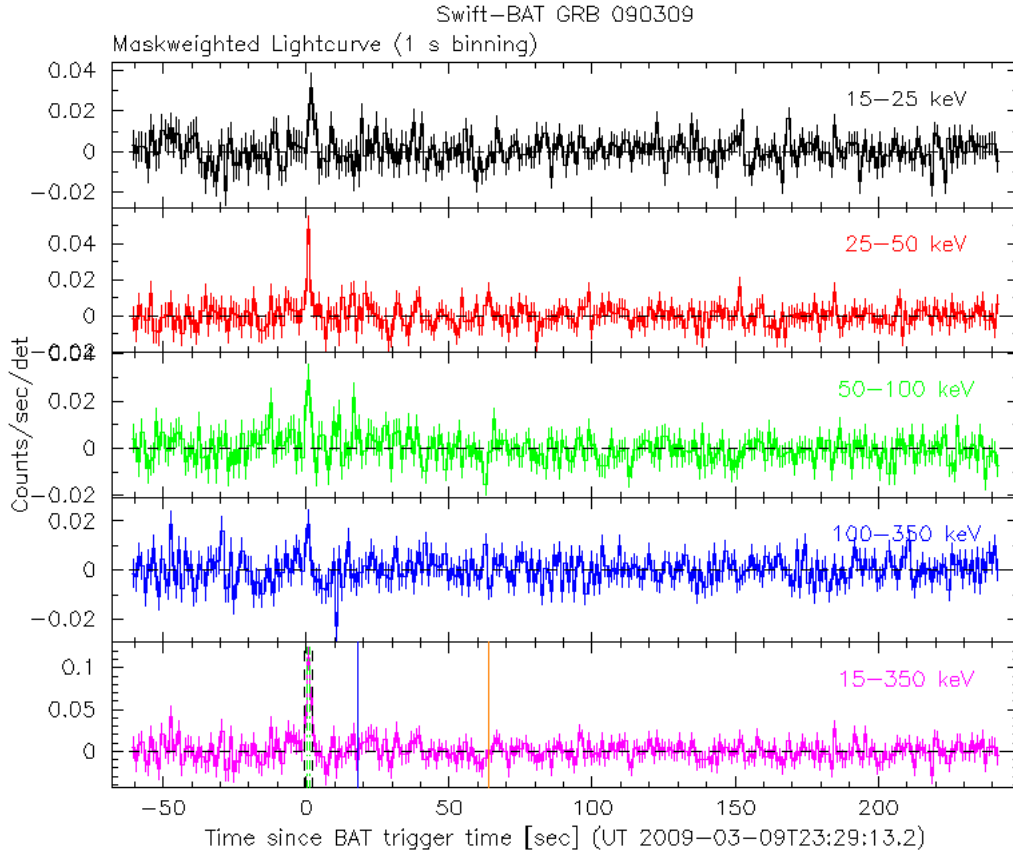


Figure 1: BAT Light curve. The mask-weighted light curve in the 4 individual plus total energy bands. The units are counts/sec/illuminated-detector.

4 UVOT Observation and Analysis

The UVOT began observations of the field of GRB 090308 82 s after the BAT trigger. No optical afterglow is detected in the initial UVOT exposures at the position of the X-ray afterglow. Three-sigma upper limits are summarized in Table 1. These upper limits are not corrected for Galactic extinction $E(B - V) = 0.23$.

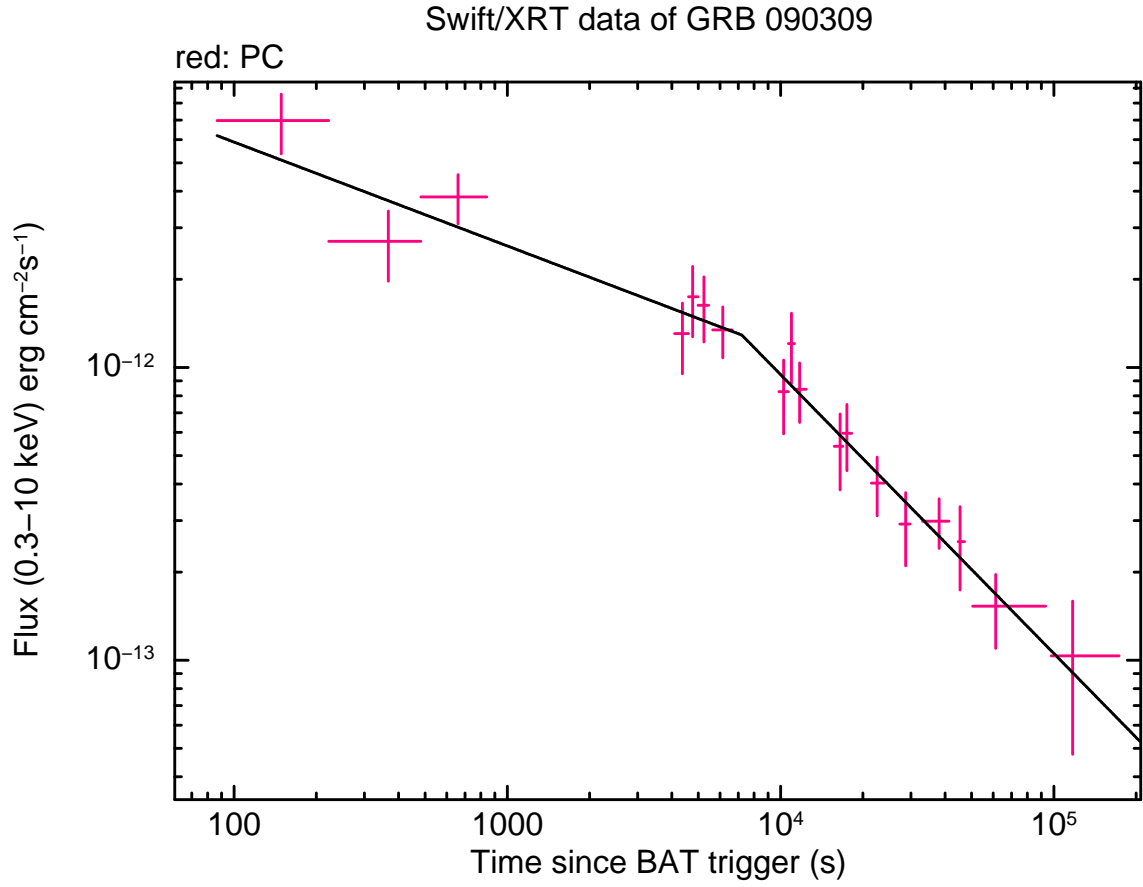


Figure 2: XRT Lightcurve. Flux in the 0.3–10 keV band. The counts-to-flux conversion is $1 \text{ count/sec} = 4.0 \times 10^{-11} \text{ ergs/cm}^2/\text{sec}$.

Filter	Start	Stop	Exposure	3-Sigma UL
white (FC)	82	231	147	21.0
white	82	6136	564	21.8
v	624	17530	1317	20.7
b	549	23995	1088	21.4
u	294	23315	2241	21.5
uvw1	673	22401	1998	21.6
uvm2	648	18210	1875	21.6
uvw2	599	16617	1318	21.6

Table 1: Magnitude limits from UVOT observations