

1 Introduction

BAT triggered on GRB 080409 at 01:22:57 UT (Trigger 308812) (Holland, *et al.*, GCN Circ. 7573). This was a long burst with $T_{90} = 20.2 \pm 8.0$ s. *Swift* slewed to this burst immediately. XRT began follow-up observations at $T + 84$ s. UVOT began follow-up observations at $T = 88$ s. Our best position is the UVOT-enhanced XRT location, RA(J2000.0) = 84°32975 (05^h37^m19^s.14), Dec(J2000.0) = +5°08484 (+05°05′05″.4) with an error of 2′.0 (radius, 90% containment).

The Burst Advocate for this burst is Stephen Holland (Stephen.T.Holland@nasa.gov). Please contact the Burst Advocate by e-mail if you require additional information regarding *Swift* follow-up observations of this burst. In extremely urgent cases, after trying the Burst Advocate, you can contact the *Swift* PI by phone (see the *Swift* ToO Web site for information: <http://www.swift.psu.edu/too.html>).

2 BAT Observation and Analysis

Using the data set from $T - 239$ to $T + 963$ s we report our analysis of GRB 080409 (trigger 308812) (Holland, *et al.*, GCN Circ. 7573). The BAT ground-calculated position is RA, Dec (J2000.0) = 84°304, +5°078, which is

$$\text{RA(J2000.0)} = 05^{\text{h}}37^{\text{m}}12^{\text{s}}.9$$

$$\text{Dec(J2000.0)} = +5^{\circ}04'39''.9$$

with an uncertainty of 2′.0, (radius, sys+stat, 90% containment). The partial coding was 46%.

The mask-weighted light curves (Fig. 1) show three well-separated peaks at $T - 13$, $T + 0$, and $T + 10$ s that are about 1, 2, and 2 s wide respectively. The first is much smaller than the others, and the $T + 0$ peak is the largest. T_{90} (15–350 keV) = 20.2 ± 8.0 s (estimated error including systematics).

The time-averaged spectrum from $T - 13.1$ to $T + 10.4$ s is best fit by a simple power-law model. The power-law index of the time-averaged spectrum is 2.10 ± 0.20 . The fluence in the 15–150 keV band is $(6.1 \pm 0.7) \times 10^{-7}$ erg cm⁻². The 1-s peak photon flux measured from $T + 0.00$ s in the 15–150 keV band is 3.7 ± 0.3 ph cm⁻² s⁻¹. All the quoted errors are at the 90% confidence level.

3 XRT Observations and Analysis

The *Swift*/XRT began observing GRB 080409 at 01:24:22 UT, 84 s after the BAT trigger. The UVOT-enhanced position is RA, Dec (J2000) = 84°32975, +5°08484 which corresponds to

$$\text{RA(J2000)} = 05^{\text{h}}37^{\text{m}}19^{\text{s}}.14$$

$$\text{Dec(J2000)} = +05^{\circ}05'05''.4$$

with an estimated uncertainty of 2′.0 (radius, 90% containment).

The light curve shows an initial increase with a power-law slope of $\alpha_1 \sim -0.6$ and a break (peak) at $T + 509_{-108}^{+259}$ s. The light curve then turns over to decay with a power-law slope of $\alpha_2 = +0.89 \pm 0.09$.

The Photon Counting mode spectrum collected from the first three orbits can be fit with an absorbed power law of photon index $\Gamma = 2.2_{-0.7}^{+0.5}$ and a total absorbing column of $N_{\text{H}} = 5_{-4}^{+5} \times 10^{21}$ cm⁻², exceeding the Galactic value of 2.4×10^{21} cm⁻². The 0.3–10 keV observed (unabsorbed) flux is

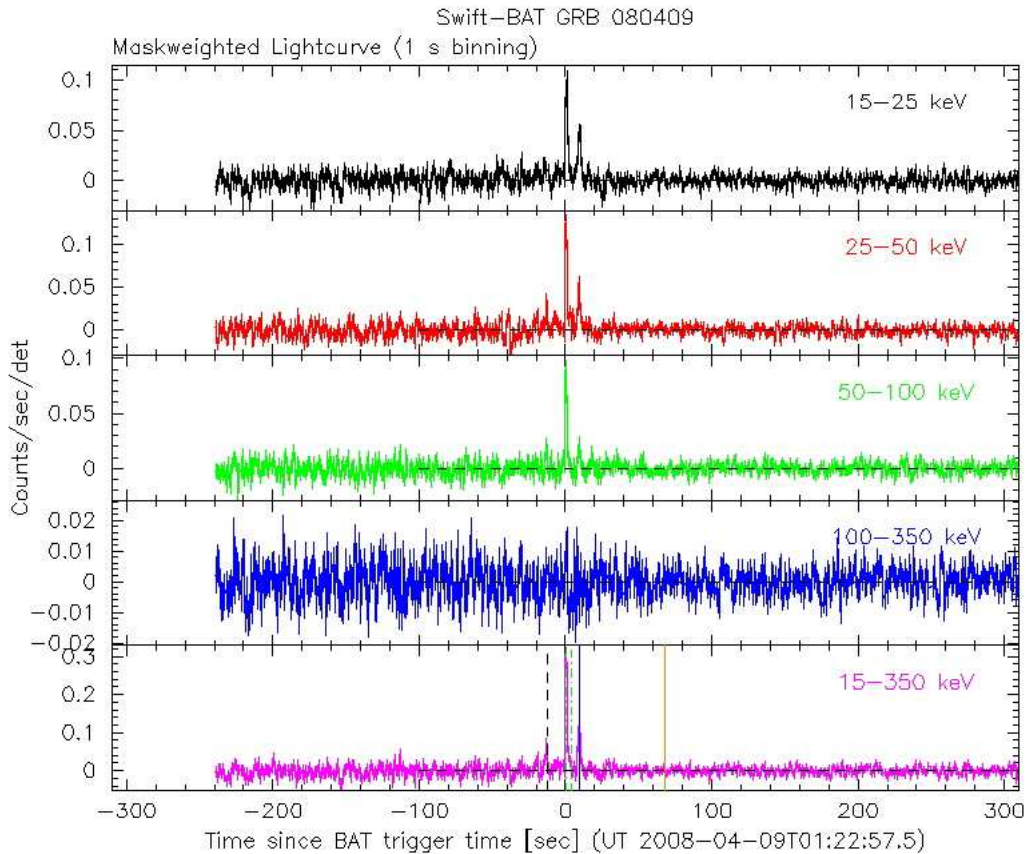


Figure 1: BAT light curves. The mask-weighted 1 s light curves in the four individual plus total energy bands. The units are $\text{count s}^{-1} \text{ illuminated-detector}^{-1}$ and T_0 is 01:22:57.5 UT.

3.2×10^{-12} (6.7×10^{-12}) $\text{erg cm}^{-2} \text{ s}^{-1}$, corresponding to a count rate of $5.8 \times 10^{-2} \text{ count s}^{-1}$ and a count rate to flux conversion of $1 \text{ count s}^{-1} = 5.6 \times 10^{-11} \text{ erg cm}^{-2} \text{ s}^{-1}$.

4 UVOT Observation and Analysis

The Swift/UVOT began settled observations of the field of GRB 080409 starting at $T + 88$ s. No source is detected in any of the UVOT observations at the UVOT-enhanced location of the X -ray afterglow (Evans, *et al.*, 2008 GCN Circ. 7575).

The 3-sigma upper limits for detecting a source at this location in the initial finding chart observations, and in the subsequent co-added images, are listed in Table 1. The quoted upper limits have not been corrected for the expected Galactic extinction along the line of sight corresponding to a reddening of $E_{B-V} = 0.78$ mag (Schlegel *et al.*, 1998, ApJS, 500, 525). All photometry is on the UVOT flight system described in Poole *et al* (2008, MNRAS, 383, 627).

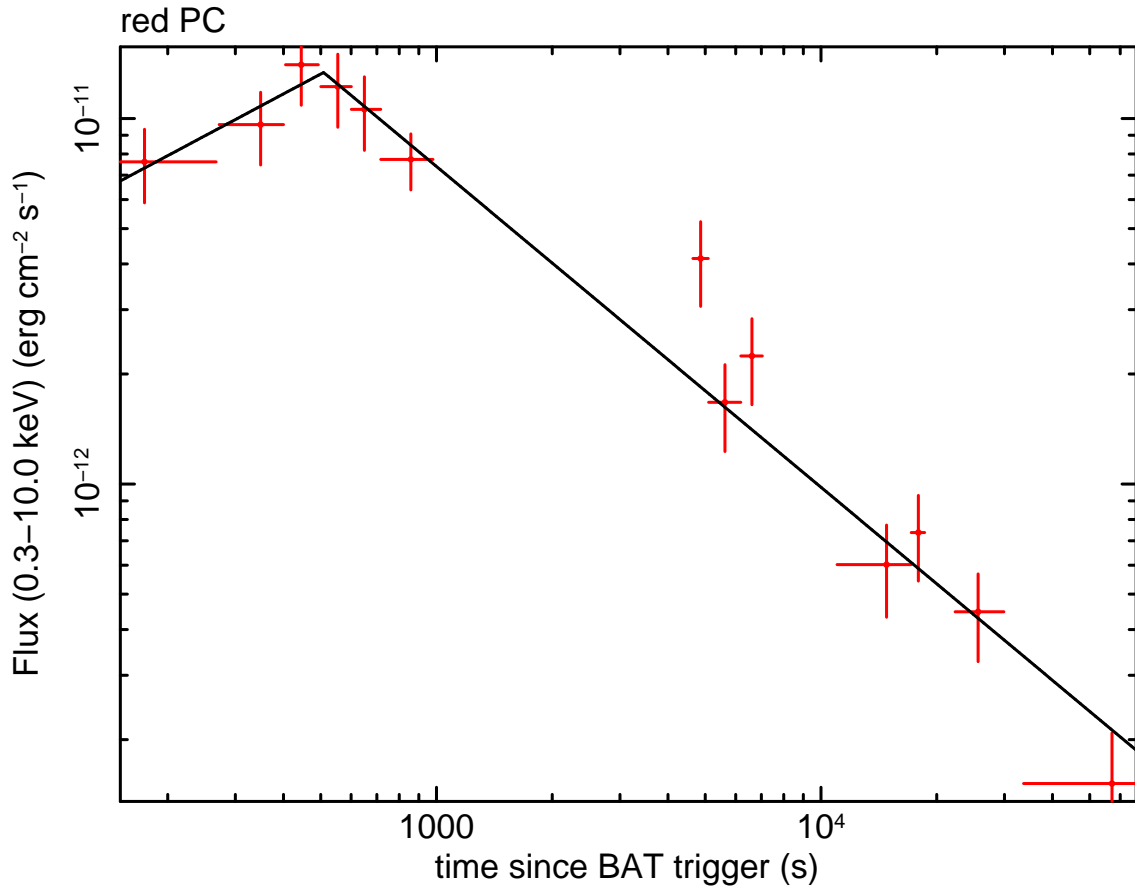


Figure 2: XRT light curve in $\text{erg cm}^{-2} \text{s}^{-1}$ in the 0.3–10 keV band: Photon Counting mode (red).

Filter	T_{start}	T_{stop}	Exp(s)	UL
white	88	187	93	> 20.2
white	682	7079	494	> 21.2
<i>v</i>	188	587	393	> 19.5
<i>v</i>	721	12 243	1099	> 20.0
<i>b</i>	667	676	412	> 20.4
<i>u</i>	642	661	432	> 20.1
uvw1	618	637	430	> 19.9
uvm2	593	12 940	1070	> 20.2
uvw2	697	11 330	1082	> 20.5

Table 1: UVOT $3\text{-}\sigma$ upper limits. T_{start} and T_{stop} are the times, in seconds since the BAT trigger, of the start and stop of the observations. Exp is the total exposure time during the observation.