Swift Observation of GRB 090419

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1 Introduction

At 13:43:31 UT Swift/BAT triggered and located the GRB 090419 (trigger=349592, Stratta et al. GCN Circ. 9161). The BAT light curve showed a long burst with multiple peaks. The peak count rate was ~ 800 counts/sec (15-350 keV), at ~ 30 sec after the trigger. Swift slewed immediately to the burst. A bright fading uncatalogued X-ray source was found within the BAT error circle and identified as the X-ray afterglow. UVOT data summed over the first orbit reveals a very faint (3.3 sigma) counterpart in the white (160-650 nm) filter at the refined position of the X-ray afterglow with 21.07 ± 0.31 mag, not detected in the second orbit data.

Possible detection of the optical counterpart 9.5 h after the trigger from ground-based facilities has been reported (Afonso et al. GCN Circ. 9169).

2 BAT Observation and Analysis

Using the data set from T-239 sec to T+704 sec the BAT ground-calculated position is RA(J2000)= 27.891 deg, Dec(J2000)= +61.352 deg, that is RA(J2000)= $13^h08^m01.5^s$, Dec(J2000)= -75^d 36' 55.6", with an uncertainty of 2.1 arcmin (radius, sys+stat, 90% containment).

The mask-weighted light curve shows a long burst with multiple peaks. The first peak starts at $\sim$T-30 sec. There are comparably bright peaks at T+50, 100, and 320 sec. There is continued emmission out to at least T+1000 sec and possibly T+1800 sec. T90 (15-350 keV) is 450 ± 50 sec (estimated error including systematics) (Figure 1).

The time-averaged spectrum from T+8.1 sec to T+522.8 sec is best fit by a simple power-law model with index 1.38 ± 0.16. The fluence in the 15-150 keV band is $(2.5 \pm 0.2) \times 10^{-6}$ erg cm^{-2}. The 1-sec peak photon flux measured from T+37.18 sec in the 15-150 keV band is (0.4 ± 0.1) ph cm^{-2} sec^{-1}. All the quoted errors are at the 90% confidence level (Krimm et al. GCN Circ. 9167).

3 XRT Observations and Analysis

During the first 4 orbits of the XRT data, from T+125 sec to T+268 sec in Windowed Timing (WT) mode and from T+300 sec to T+4.9 h in Photon Counting (PC) mode, the 0.3-10 keV light curve shows an initial flaring activity superimposed on a constant continuum at a level of $\sim$5 counts/s up to $\sim$T+520 sec that is consistent with being the X-ray tail of the BAT data during the prompt emission. Starting from 520 sec up to 1200 sec the count rate decays as a power law with $\alpha_1 = 3.5 \pm 0.5$ and from T+1200 sec to T+12 ks it features a possible flattening with index $\alpha_2 = 1.1 \pm 0.2$ followed by a steep decay (Figure 2).

The average WT spectrum (corresponding to the initial flat decay phase) can be fitted by an absorbed power-law model (reduced chi square 1.0 with 18 degrees of freedom), with photon index 1.3 ± 0.3. The absorbing equivalent hydrogen column density in excess with respect to the Galactic absorption value (1.2×10^{21} cm-2, Kalberla et al. 2005) is $N_H = (1.1 \pm 0.6) \times 10^{21}$ cm^{-2}. The observed (unabsorbed) 0.3-10 keV flux is 4.2(5.4) $\times 10^{-10}$ erg cm^{-2} s^{-1} (Stratta et al. GCN Circ. 9172).

Using 1541 s of XRT Photon Counting mode data and one UVOT image, the astrometrically corrected

X-ray position (using the XRT-UVOT alignment and matching UVOT field sources to the USNO-B1 catalogue) is RA(J2000)= 196.92894 deg, Dec(J2000)= −75.60586 deg which is equivalent to RA(J2000)= $13^h07^m42.95^s$, Dec(J2000)= $−75^d$ $36'$ $21.1''$ with an uncertainty of 1.8 arcsec (radius, 90% confidence) (Osborne et al. GCN Circ. 9164).

Detailed light curves in both count rate and flux units are available in both graphical and ASCII formats at http://www.swift.ac.uk/xrt_curves/.

4   UVOT Observation and Analysis

The Swift/UVOT observed the field of GRB 090419 starting 126 s after the BAT trigger (Siegel et al. GCN Circ. 9177). Data summed over the first orbit reveals a very faint (3.3 sigma) source in the white filter at the refined position of the X-ray afterglow. This source is not detected in the second orbit data. The detection and 3-sigma upper limits for the finding chart (fc) and summed exposures are reported in Table 1. The reported upper limits are not corrected for the Galactic extinction corresponding to a reddening of $E_{B−V} = 0.296$ mag towards the direction of the burst (Schlegel et al. 1998). The photometry is based on the UVOT photometric system described in Poole et al. (2008, MNRAS, 383, 627).
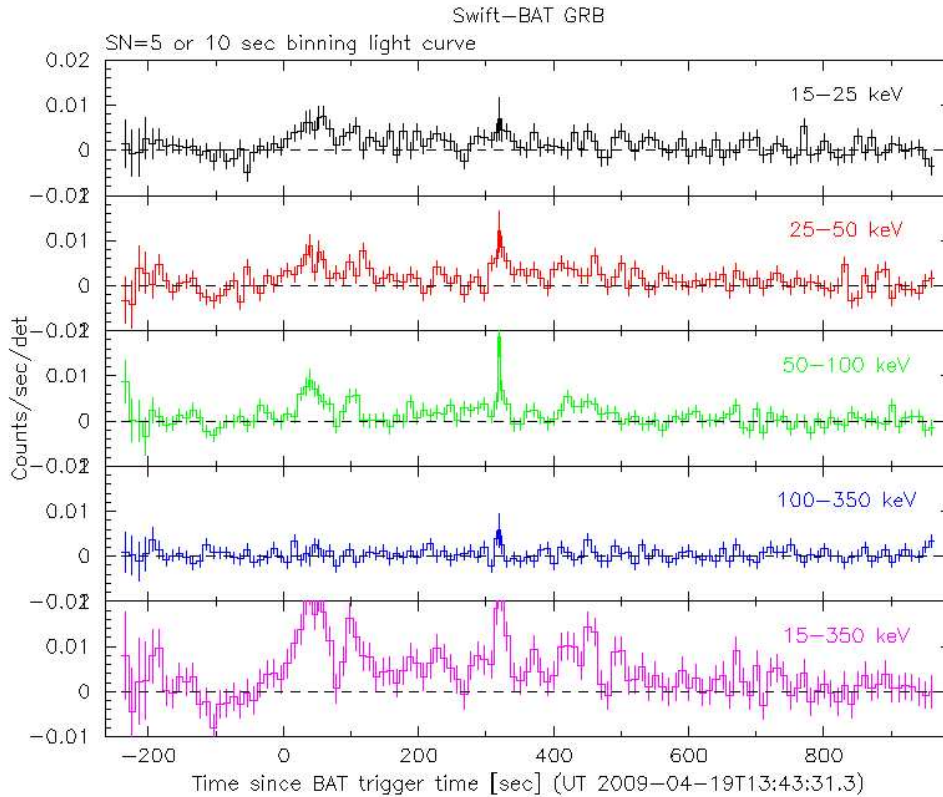

Figure 1: BAT Light curve. The mask-weighted light curve in the 4 individual plus total energy bands: 15-25 keV (black), 25-50 keV (red), 50-100 keV (green), 15-350 keV (magenta). The units are counts $s^{−1}$ illuminated-detector$^{−1}$ (note illum-det = 0.16 cm^2).
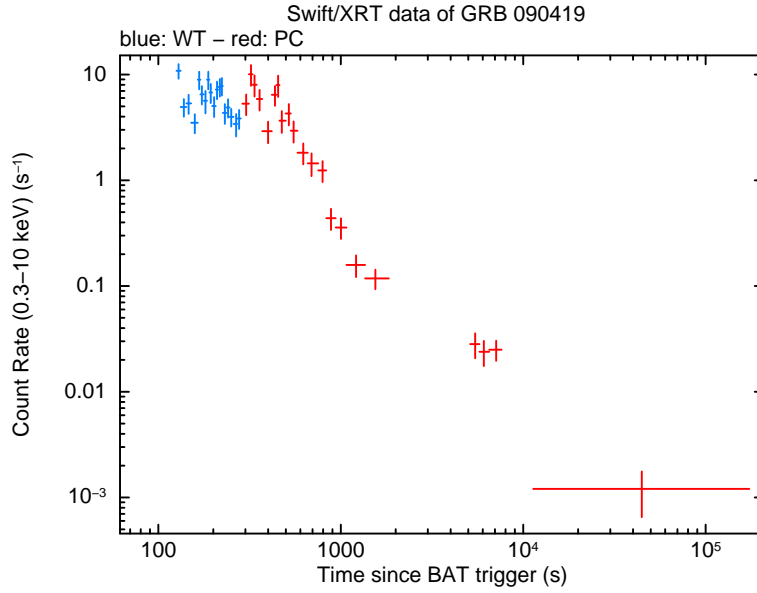
Figure 2: XRT Lightcurve. Counts s^{-1} in the 0.3-10 keV band: Window Timing mode (blue), Photon Counting mode (red). The approximate conversion is 1 count s$^{-1} \sim 9.2 \times 10^{-11}$ erg cm^{-2} s^{-1}.

Filter	T_start (s)	T_stop (s)	Exp (s)	3-sigma UL mag
white (fc)	126	276	147	> 20.69
white	126	1706	410	21.07 ± 0.31
white	5320	6956	393	> 21.25
v	614	1756	136	> 18.93
v	5732	7367	393	> 19.60
b	540	1682	116	> 19.87
b	5116	13394	572	> 20.69
u	284	1829	362	> 20.25
u	6346	13206	1081	> 20.89
uvw1	664	1805	136	> 19.31
uvw1	6142	12292	1118	> 20.63
uvm2	639	1608	58	> 18.41
uvm2	5936	17728	465	> 19.99
uvw2	590	1731	136	> 19.37
uvw2	5527	7162	393	> 20.13

Table 1: Magnitudes from UVOT observations.