Swift Observations of GRB 090519

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1 Introduction

The Swift BAT triggered on and located GRB 090519 at 21:08:56 UT (trigger=352648) (Perri et al., GCN Circ. 9400). Swift slewed immediately to the burst and XRT and UVOT observations of the field started 115 and 106 seconds after the trigger, respectively. The best Swift position is the XRT localization at RA(J2000)= 142.2785 deg, Dec(J2000)= 0.1802 deg, RA(J2000)= $09^{\rm h}29^{\rm m}06.85^{\rm s}$, Dec(J2000)= $+00^{\rm d}$ 10' 48.6", with an error radius of 1.5 arcsec (90% confidence).

The optical afterglow was detected from the ground by NOT (Thoene et al., GCN Circ. 9403) and GROND (Rossi et al., GCN Circ. 9400).

GROND provided a photometric redshift estimate of $z = 3.9(+0.4)(-0.7)$ (Rossi et al., GCN Circ. 9408); this value was spectroscopically confirmed and refined at $z = 3.85$ by the VLT (Levan et al., GCN Circ. 9409).

The prompt emission of GRB 090519 was also detected by the Fermi Gamma-Ray Burst Monitor (von Kienlin, GCN Circ. 9412).

2 BAT Observations and Analysis

Using the data set from T-119 s to T+276 s (Krimm et al., GCN Circ. 9406), the BAT ground-calculated position is RA(J2000)= 142.317 deg, Dec(J2000)= 0.190 deg, RA(J2000)= $09^{\rm h}29^{\rm m}16.2^{\rm s}$, Dec(J2000)= $+00^{\rm d}$ 11' 23.9", with an uncertainty of 2.0 arcmin, (radius, sys+stat, 90% containment). The partial coding was 57%.

The mask-weighted light curve (Figure 1) shows multiple overlapping peaks starting at ∼T-17 s and ending at ∼T+95 s. T_{90} (15–350 keV) is 64 ± 10 s (estimated error including systematics).

The time-averaged spectrum from T-12.4 s to T+60.4 s is best fit by a simple power-law model. The power law index of the time-averaged spectrum is 1.02 ± 0.20. The fluence in the 15–150 keV band is $(1.2 \pm 0.1) \times 10^{-6}$ erg cm^{-2}. The 1-second peak photon flux measured from T-10 s in the 15–150 keV band is 0.6 ± 0.2 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/352648/BA/

3 XRT Observations and Analysis

Swift-XRT began observing the field of GRB 090519 at 21:10:51.3 UT, 114.9 seconds after the BAT trigger (Perri et al., GCN Circ. 9400, 9411).

Using all the XRT available data, we find an astrometrically corrected X-ray position (using the XRT-UVOT alignment with 2178 seconds of overlapping time and matching UVOT field sources to the USNO-B1 catalogue): RA(J2000)= 142.2785 deg, Dec(J2000)= 0.1802 deg, RA(J2000)= $09^{\rm h}29^{\rm m}06.85^{\rm s}$, Dec(J2000)= $+00^{\rm d}$ 10' 48.6", with an uncertainty of 1.5 arcsec (radius, 90% confidence).

The 0.3–10 keV light curve (Figure 2) from T+121 s up to ∼T+25 ks can be modelled with a series of power-law decays with superimposed a flaring episode at ∼T+230 s. The initial decay index is

$\alpha_1 = 2.8 \pm 0.2$. At around T+580 s the decay flattens to a slope of $\alpha_2 = 0.6 \pm 0.3$ before breaking again at about T+2 ks to a final decay with index $\alpha_3 = 1.4(+0.3)(-0.2)$. At later times the X-ray afterglow is no longer detected by XRT.

The average X-ray spectrum (0.3–10 keV) from T+165 s up to T+27 ks is well fit by an absorbed power-law model with a photon index $\Gamma = 1.5 \pm 0.2$ and a column density in the source rest frame at $z = 3.85$ $N_H = 1.9(+1.7)(-1.6) \times 10^{22}$ cm^{-2} in excess to the Galactic one in the direction of the source ($N_H = 3.0 \times 10^{20}$ cm^{-2}, Kalberla et al. 2005).

All the quoted errors are at the 90% confidence level.

4 UVOT Observation and Analysis

The UVOT began settled observations of the field of GRB 090519 starting 123 s after the BAT trigger (Immler & Perri, GCN Circ. 9407).

The optical/UV afterglow was not detected and the corresponding 3-sigma upper limits are listed in Table 1. The values quoted are not corrected for the expected Galactic extinction in the direction of the burst corresponding to a reddening of $E_{(B-V)} = 0.04$ mag (Schlegel et al. 1998). All photometry is in the UVOT photometric system described in Poole et al. (2008, MNRAS, 383, 627).

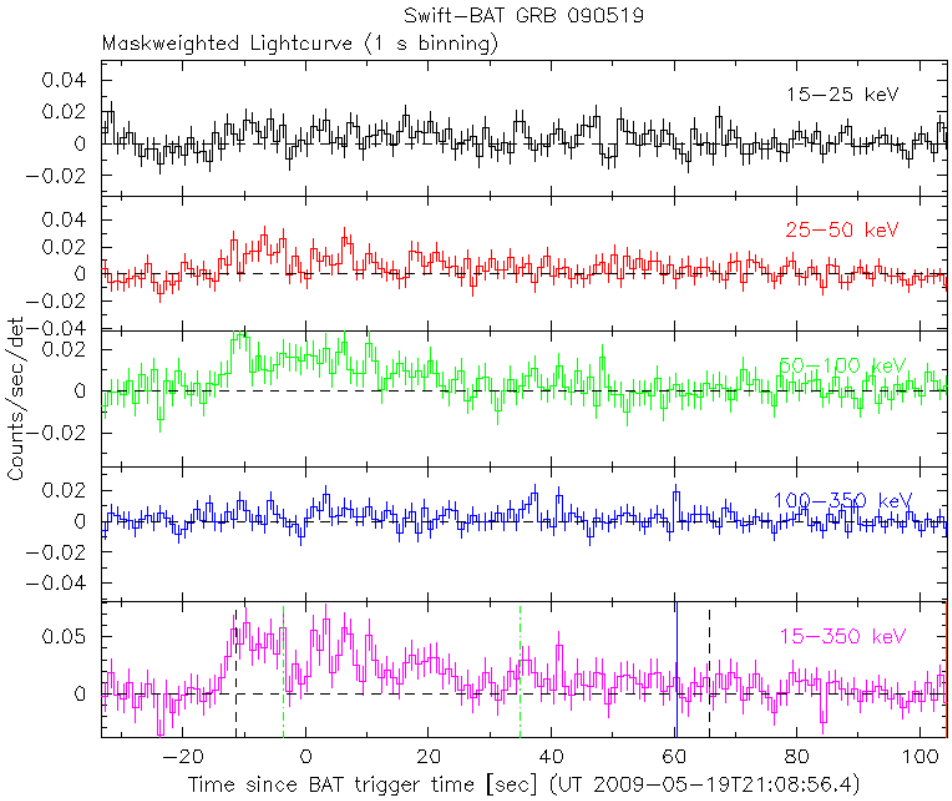

Figure 1: BAT light-curve. The mask-weighted light curve in the 4 individual plus total energy bands. Green dotted line: T_{50}, Black dotted line: T_{90}. Blue: Slew start, Orange: Slew end Time. The units are counts s^{-1} illuminated-detector^{-1} (note illum-det = 0.16 cm^2).

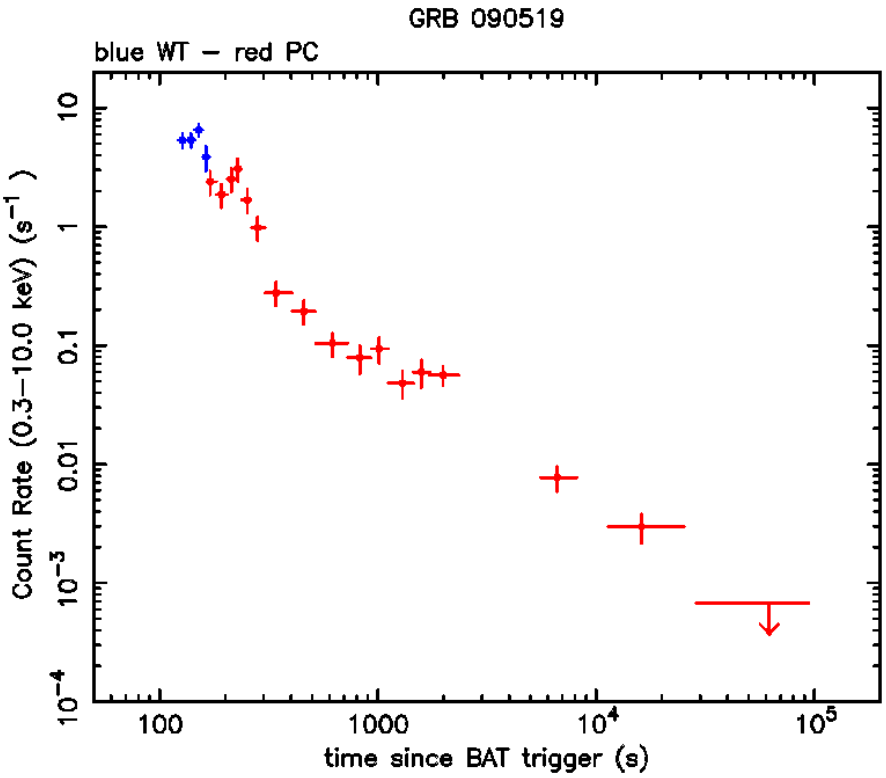

Figure 2: XRT light-curve. Count rates in the 0.3–10 keV band taken in Windowed Timing (WT) and Photon Counting (PC) mode are plotted. The approximate conversion of the 0.3–10 keV observed flux is 1 count/s $\sim 4.9 \times 10^{-11}$ erg cm^{-2} s^{-1}.

Filter	T_start (s)	T_stop (s)	Exp (s)	Mag
white	123	7430	862	> 21.5
v	106	7841	597	> 19.8
b	536	7224	568	> 20.6
u	281	7019	617	> 20.4
uvw1	662	8131	469	> 20.3
uvm2	637	8046	587	> 20.4
uvw2	588	7636	549	> 20.6

Table 1: 3-sigma upper limits from UVOT observations.