

## Swift Observations of GRB 070509

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### 1. Introduction

At 02:48:27 UT, the Swift Burst Alert Telescope (BAT) triggered and located GRB 070509 (trigger=278903, Vetere et al., GCN 6394). Swift slewed immediately to the location.

The XRT began observing the field at 02:49:35 UT, 68 seconds after the BAT trigger. XRT found a faint, uncatalogued X-ray source. The ground calculated location is RA, Dec 237.9592, -78.6511 which is

RA(J2000) = 15h 51m 50.2s

Dec(J2000) = -78d 39'04.0"

with an uncertainty of 4.6 arcsec (radius, 90% containment, including systematic uncertainty). This location is 1.8 arcmin from the BAT on-board position, within the BAT error circle.

The UVOT took a finding chart exposure of 100 seconds with the White (160-650 nm) filter starting 73 seconds after the BAT trigger, and a finding chart exposure of 400 seconds in V starting 177 seconds after the BAT trigger. No afterglow candidate has been found in the initial data products.

### 2. BAT Observations and analysis

Using the data set from T-239 to T+963 sec from recent telemetry downlinks, we report further analysis of BAT GRB 070509 (trigger #278903, Vetere, et al., GCN 6394). The BAT ground-calculated position is RA, Dec = 237.874, -78.657 deg, which is

RA(J2000) = 15h 51m 29.8s

Dec(J2000) = -78d 39' 24.0"

with an uncertainty of 1.7 arcmin, (radius, sys+stat, 90% containment). The partial coding was 92%.

The mask-weighted light curve shows a single FRED-like pulse starting at T-2 sec, peaking at T<sub>0</sub>, and ending at ~T+10 sec. T<sub>90</sub> (15-350 keV) is 7.7 +/- 0.3 sec (estimated error including systematics).

The time-averaged spectrum from T-1.1 to T+7.9 is best fit by a simple power-law model. The power law index of the time-averaged spectrum is 2.33 +/- 0.25. The fluence in the 15-150 keV band is 1.7 +/- 0.3 x 10<sup>-7</sup> erg/cm<sup>2</sup>. The 1-sec peak photon flux measured from T-0.31 sec in the 15-150 keV band is 0.7 +/- 0.1 ph/cm<sup>2</sup>/sec. All the quoted errors are at the 90% confidence level.

### 3. XRT Observations and analysis

We have analysed the first 6.2ks of Swift XRT Photon counting data. The first orbit PC mode image (1.5ks) provides a refined XRT position at RA,DEC(J200) = 237.9588, -78.6508 which is

RA(J2000) = 15h 51m 50.1s

Dec(J2000) = -78d 39' 03.1"

with an uncertainty of 4.1 arcsec (radius, 90% containment). This is 0.9 arcsec from the initial X-ray position (GCN 6394) and 1.0 arcmin from BAT refined position (Cummings et al. GCN 6397).

The XRT light curve can be modeled with a broken power law with the following parameters:

alpha1 = -0.3 +/- 0.2

tbreak = 341 +/- 120

alpha2 = -1.1 +/- 0.2

The X-ray spectrum of the first orbit PC data can be fitted with an absorbed power law (photon index = 0.8 +/- 0.2) with an absorbed column density fixed to the Galactic value (0.91e21 cm<sup>-2</sup>; Dickey &

Lockman, 1990). The absorbed (unabsorbed) 0.3-10.0keV flux for this spectrum was  $8.8\text{E-}12$  ( $9.1\text{E-}12$ )  $\text{ergs cm}^{-2} \text{s}^{-1}$ .

#### 4. UVOT Observations and analysis

We do not find any source, in any of the UVOT observations, inside the refined XRT error circle (Vetere et al., 2007 GCN Circ. 6400).

The 3-sigma upper limits for detecting a source anywhere inside the refined XRT error circle in the co-added frames are reported in Table 1. Note that the values quoted are not corrected for the expected Galactic extinction corresponding to a reddening of  $E_{\text{B-V}} = 0.14$  mag towards the direction of the burst (Schlegel et al. 1998). Start and stop times are seconds since the BAT trigger.

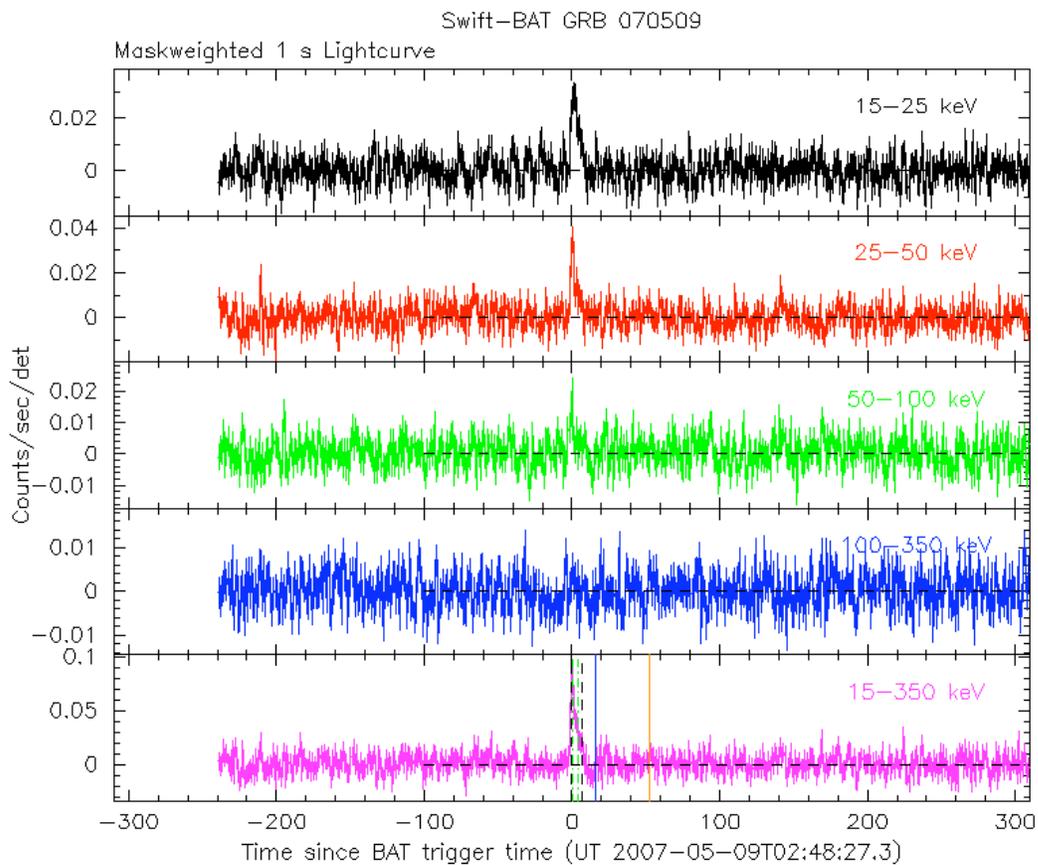


Fig.1: BAT Lightcurve. The light curve in the 4 individual plus total energy bands.

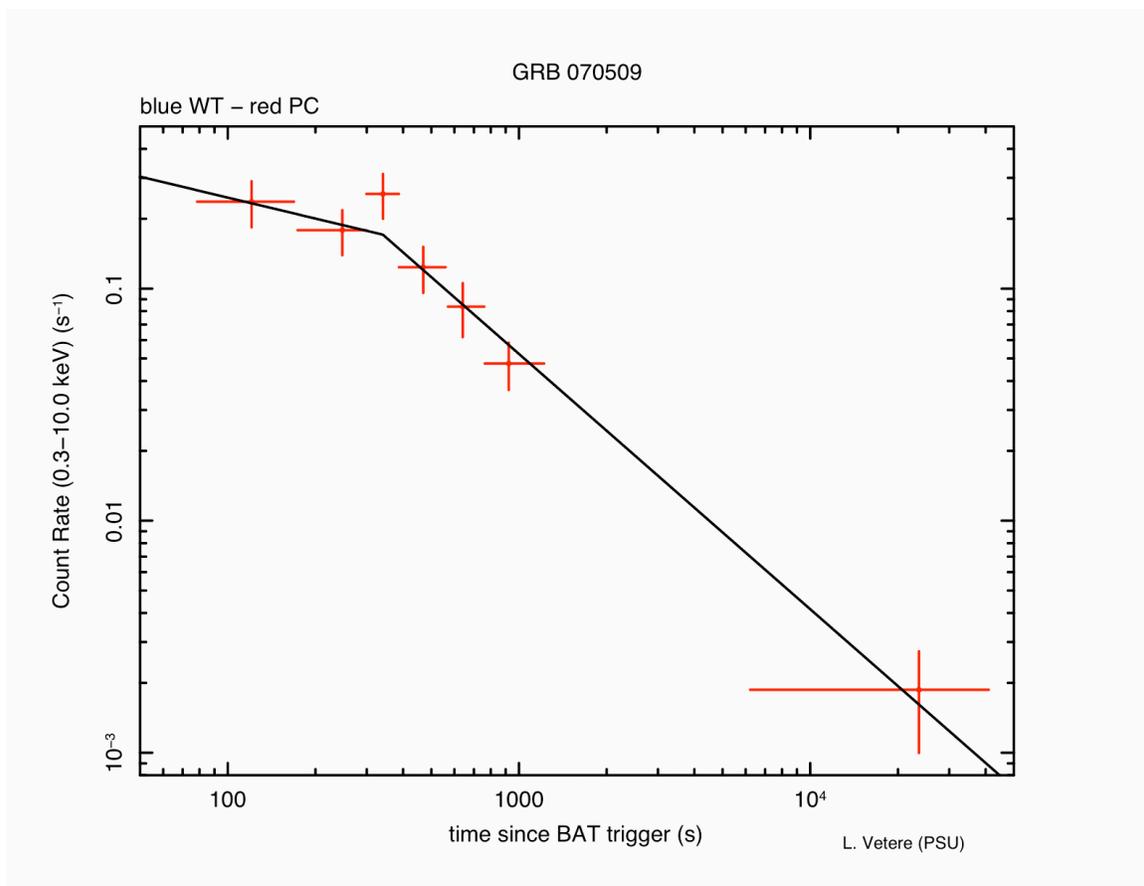


Fig. 2: XRT light curve.

Table 1: UVOT Observations.

Filter	T_start (s)	T_stop (s)	Exp (s)	Mag (3- $\sigma$ UL)
V	179	6074	1003	20.6
B	657	1468	39	18.6
U	633	1443	58	18.4
UVW1	609	1419	58	18.0
UVM2	584	6085	65	17.5
UVW2	686	5869	236	19.3
White	73	1482	225	21.1