

Swift Observation of GRB 080319C

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1 Introduction

BAT triggered on the long GRB 080319C at 12:25:56 UT (Trigger 306778) (Pagani, *et al.*, *GCN Circ.* 7442), a burst with $T_{90} = 34 \pm 9$ sec. *Swift* slewed immediately to the burst. The XRT and UVOT detected the afterglows in observations starting 224 sec after the trigger. The optical afterglow was detected in early observation by the KAIT telescope (Li, *et al.*, *GCN Circ.* 74431), with Super-LOTIS (Williams, *et al.*, *GCN Circ.* 7443) and by *RAPTOR* (Wren, *et al.*, *GCN Circ.* 7477) in the R band. No radio source was detected by the *WRST* (van der Horst, *et al.*, *GCN Circ.* 7481). The burst was also detected by the *INTEGRAL* SPI Anti-Coincidence System (Beckmann, *et al.*, *GCN Circ.* 7450), by the *AGILE* Mini-Calorimeter (Marisaldi, *et al.*, *GCN Circ.* 7457), by *Konus-Wind* (Golenetskii, *et al.*, *GCN Circ.* 7487) and by the *Suzaku* Wide-band All-sky Monitor (Onda, *et al.*, *GCN Circ.* 7508). The spectroscopic redshift of this burst is $z = 1.95$, measured using the GMOS-N instrument on *Gemini-North* (Wiersema *et al.*, *GCN Circ.* 7517).

2 BAT Observation and Analysis

Using the data set from $T - 120$ to $T + 88$ sec, further analysis of BAT GRB 080319C has been performed by the *Swift* team (Stamatikos, *et al.*, *GCN Circ.* 7483). The BAT ground-calculated position is $RA(J2000) = 259.006deg$ (17h16m01.4s), $Dec(J2000) = 55.393deg$ (55d23'33.0") ± 1.0 arcmin, (radius, systematic and statistical, 90% containment). The partial coding was 30%.

The mask-weighted light curves (Fig.1) shows two (possibly three) over-lapping FRED-like peaks starting at $\sim T - 0.5$ sec, peaking at $T + 0.2$ and ending at $\sim T + 50$ sec. The event-by-event data for this mask-weighted lightcurve ends at $T + 88$ sec. The on-board raw countrate lightcurve shows no activity after the $T + 88$ sec limit of the event data, but the sensitivity is significantly less for this data product. $T_{90}(15 - 350keV)$ is 34 ± 9 sec (estimated error including systematics).

The time-averaged spectrum from $T - 0.3$ to $T + 51.2$ sec is best fitted by a simple power law model. This fit gives a photon index of 1.37 ± 0.07 . For this model the total fluence in the 15 – 150 keV band is $(3.6 \pm 0.1) \times 10^{-06} ergs/cm^2$, and the 1-sec peak flux measured from $T + 0.13$ sec in the 15 – 150 keV band is $5.2 \pm 0.3 ph/cm^2/sec$. All the quoted errors are at the 90% confidence level considering the statistical and usual systematic effects.

3 XRT Observation and Analysis

Using 595 sec of overlapping XRT Photon Counting mode and UVOT data for GRB 080319C, we find an astrometrically corrected X-ray position (using the XRT-UVOT alignment and matching UVOT field sources to the USNO-B1 catalogue): $RA(J2000) = 258.97980deg$ (17h15m55.15s), $Dec(J2000) = 55.39197 deg$ (55d23'31.1") ± 1.7 arcsec (radius, 90% confidence) (Pagani, *et al.*, *GCN Circ.* 7460).

The 0.3–10 keV light curve (Fig.2) starts at a count rate of ~ 7 counts/sec and peaks at 18 counts/sec at $T + 360$ seconds, after which the decay can be best fitted by a broken power law with initial slope

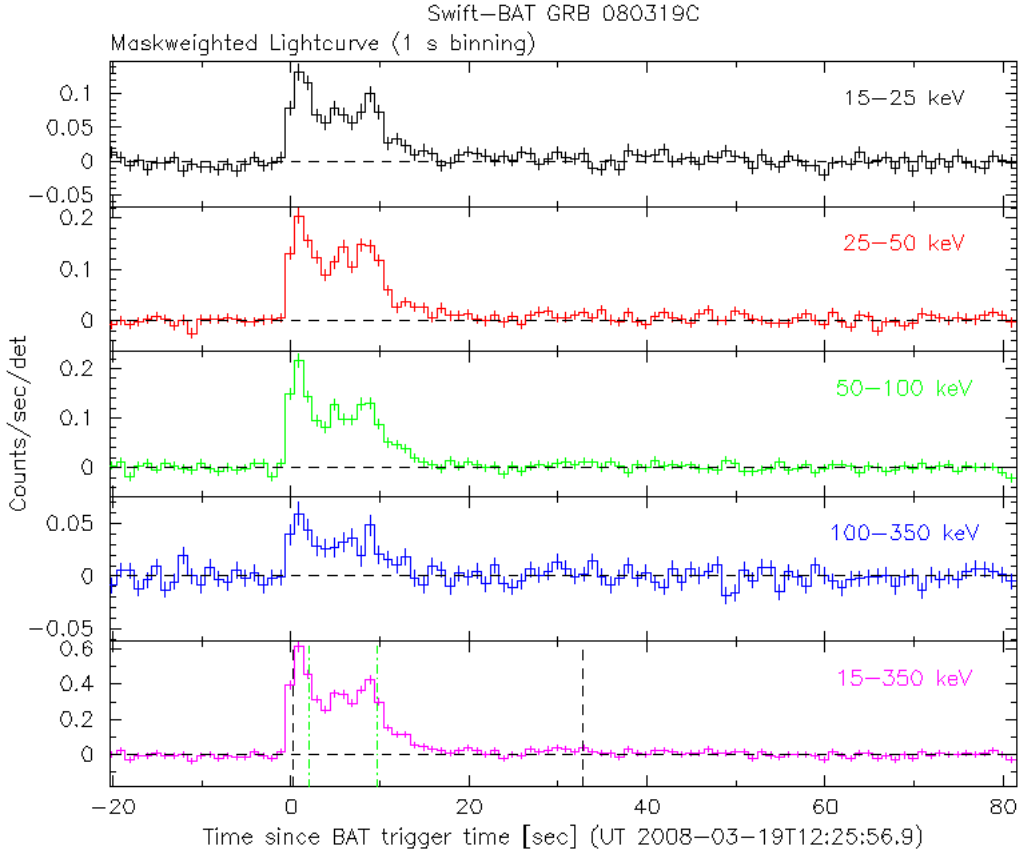


Figure 1: BAT Light curve. The mask-weighted light curve in the 4 individual plus total energy bands. The units are counts/sec/illuminated-detector and T_0 is 12:25:56.9 UT.

of $0.91_{-0.08}^{+0.08}$, followed by a steeper decay with decay index of $1.8_{-0.10}^{+0.17}$ after a break at $T + 7.5$ *ksec*

The X-ray spectrum of the first orbit of PC data from $T + 235$ *sec* to $T + 2443$ *sec* can be well fitted by an absorbed powerlaw with spectral index $1.74_{-0.06}^{+0.06}$. The NH column density is $(1.5_{-0.2}^{+0.2}) \times 10^{21} \text{cm}^{-2}$ in excess of the Galactic column density of $2.21 \times 10^{20} \text{cm}^{-2}$ in that direction. The average unabsorbed flux over $0.3 - 10$ *keV* for this spectrum is $1.06 \times 10^{-10} \text{ ergs/cm}^2/\text{sec}$, which corresponds to an unabsorbed flux of $1.31 \times 10^{-10} \text{ ergs/cm}^2/\text{sec}$.

4 UVOT Observation and Analysis

The UVOT began observing the field of GRB 080319C 210 *sec* after the BAT trigger (Holland *et al.*, *GCN Circ.* 7497). The afterglow is detected at the location of the KAIT optical afterglow (Li, *et al.*, *GCN Circ.* 7441) in the v, b, u and white filters. The UVOT source position is

RA(J2000) = 258.98121deg (17h15m55.49s)

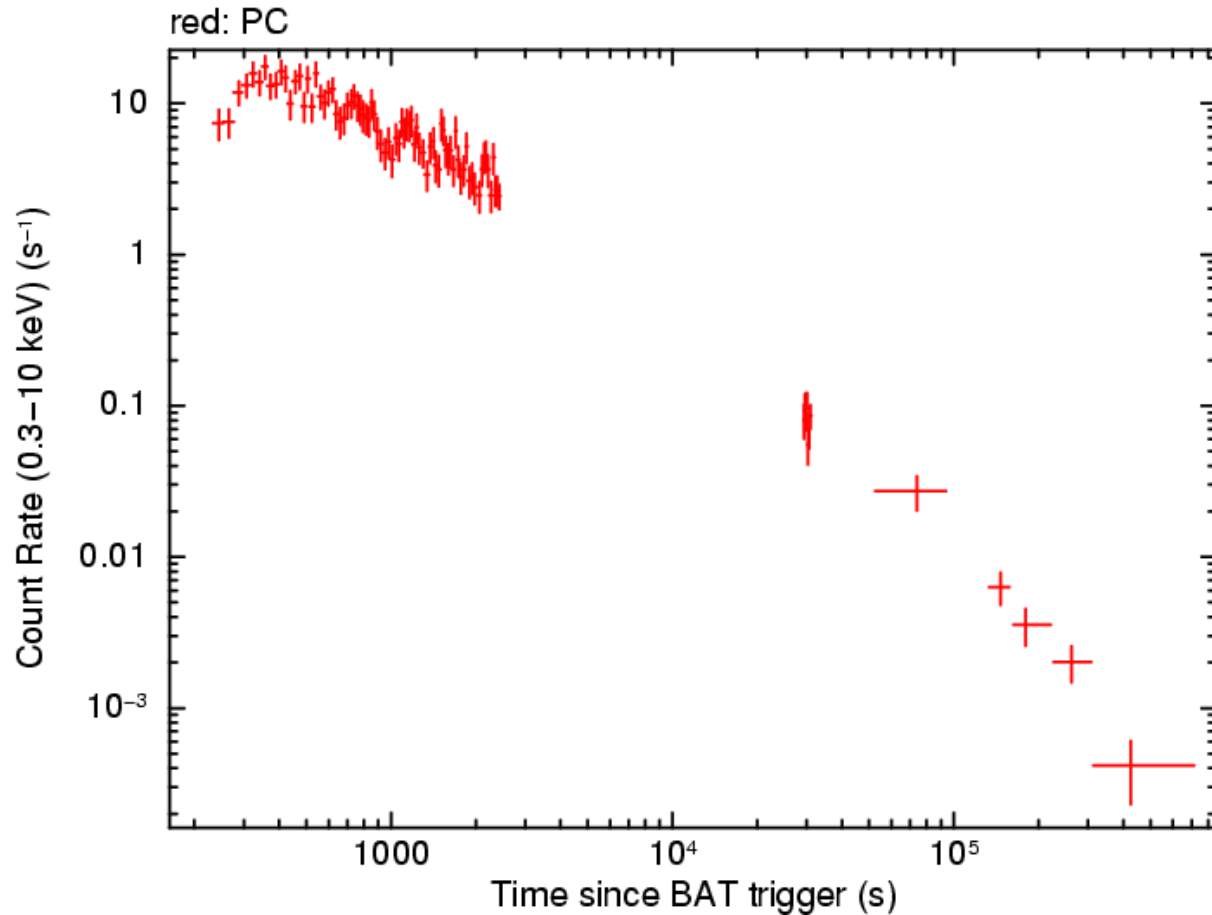


Figure 2: XRT Lightcurve. Counts/sec in the 0.3-10 keV band: Photon Counting mode. The approximate conversion is 1 count/sec = $\sim 4.3 \times 10^{-11}$ ergs/cm²/sec.

Dec($J2000$) = 55.39183deg (55d23'30.6")

with an estimated uncertainty of ± 0.5 arcsec (radius, 90% confidence).

Magnitudes and upper limits are summarized in Table 1. These values are not corrected for the Galactic extinction corresponding to a reddening of $E_{B-V} = 0.03$ mag (Schlegel *et al.*, *ApJ*. 500:525-553, 1998). The photometry is on the UVOT flight system described in Poole *et al.* (2008, *MNRAS*, 383,627). The UVOT magnitudes have not been corrected for contamination from the SDSS galaxy 587725503411782247, which is located 1.35 ± 0.86 arcsec from the afterglow. We find white = 22.9 ± 0.1 for this galaxy.

Filter	T_{start}	T_{stop}	Exposure	Mag	Err	Comment
V	334	353	19	18.5	0.4	
B	433	443	10	18.7	0.4	
U	408	733	58	19.5	0.3	
UVW1	383	2410	214	> 20.0		3σ <i>UL</i>
UVM2	358	2385	175	> 19.6		3σ <i>UL</i>
UVW2	463	2336	175	> 19.9		3σ <i>UL</i>
White	227	327	98	18.8	0.1	

Table 1: Magnitudes and upper limits from UVOT observations