

Swift Observations of GRB 070419A

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1 Introduction

At 09:59:26 UT, on April 19, 2007, BAT triggered on GRB 070419A (trigger #276205) (Stamatikos et al., GCN Circ. 6302). This was a dim, long GRB with a T90 of 116 seconds in BAT. Swift slewed immediately allowing for XRT and UVOT follow-up observations at T+113 and T+115 seconds, respectively. Extensive international optical follow up resulted in the best afterglow position of RA, DEC (J2000) = 12h 10m 58.82s, +39d 55' 33.92" (Chornock et al., GCN Circ. 6304), which is consistent with the XRT error circle and is located ~ 1.5 arcmin from the BAT ground position. An absorption redshift of $z=0.97$ (Cenko et al., GCN Circ. 6322) resulted in a preliminary isotropic energy estimate of $\sim 1.60 \times 10^{51}$ ergs in the 15-150 keV observed (30-296 keV GRB rest frame) band pass, assuming a Λ_{CDM} cosmological model, as reported in Stamatikos et al., GCN Circ. 6326.

2 BAT Observations and Analysis

Using the data set from T-239 to T+963 seconds telemetry down links, further analysis of BAT GRB 070419A was performed by the Swift team (Stamatikos et al., GCN Circ. 6326). The BAT ground-calculated position is RA, Dec (J2000) = 182.755 deg (12h 11m 1.1s), +39.903 deg (+39d 54' 11.0") with an uncertainty of 2.3 arcmin, (radius, sys+stat, 90% containment). The coding fraction was 1. This position is ~ 1.5 arcmin from the position of the optical afterglow candidate reported by Chornock et al., GCN Circ. 6304, which was further confirmed by Cenko et al., GCN Circ. 6306.

The mask-weighted light curve (Figure 1), has a nearly symmetric, smooth profile, although a tail of emission extends to about T+160 sec. The T90 (15-350 keV) is 116 ± 6 seconds (estimated error including systematics). The time-averaged spectrum from T-35 to T+93 seconds is best fit by a simple power-law model. The power law index of the time-averaged spectrum is 2.35 ± 0.25 . The fluence in the 15-150 keV band is $5.6 \pm 0.8 \times 10^{-7}$ ergs/cm². The 1-sec peak photon flux measured from T-1.12 seconds in the 15-150 keV band is 2.8×10^{-2} photons/cm²/s. All the quoted errors are at the 90% confidence level.

Under a Λ_{CDM} cosmological model, with $H_o \sim 65$ km/Mpc/s, $\Omega_M \sim 0.30$, and $\Omega_\Lambda \sim 0.70$, the preliminary absorption redshift of $z=0.97$ (Cenko et al., GCN Circ. 6322), when coupled with the BAT fluence reported above, results in a preliminary isotropic energy emission estimate of $\sim 1.60 \times 10^{51}$ ergs in the 15-150 keV observed (30-296 keV GRB rest frame) band pass.

3 XRT Observations and Analysis

The XRT began observing the field at 10:01:18 UT, 113 seconds after the BAT trigger and found a bright, fading and uncatalogued X-ray source. Using the first ten orbits of Swift XRT data on the BAT GRB 070419A, further analysis was performed by the Swift team (Perri et al., GCN Circ. 6333). Using a 0.9 ks Photon Counting (PC) mode image, a refined XRT position, which has been astrometrically corrected by matching the UVOT images with the USNO-B1 catalog, was derived at RA, DEC (J2000) = 182.74480 deg (12h 10m 58.80s), +39.92567 deg (+39d 55' 32.4"), with an uncertainty of 2.2 arcsec (90% confidence). This is 1.4 arcmin away from the center of the refined BAT position (Stamatikos et al., GCN Circ. 6326), 5.4 arcsec away from the initial XRT position

(Stamatikos et al., GCN Circ. 6302) and 1.5 arcsec away from the best optical afterglow position (Chornock et al., GCN Circ. 6304).

The 0.3 – 10 keV X-ray light curve (Figure 2) during the first orbit from T+120s up to about T+1ks shows a rapid decay. Starting from T+1ks (last bin of first orbit) to T+69ks the curve is well fit by a power-law decline with a decay index of -1.2 ± 0.2 .

The X-ray spectrum covering the time period from T+120s to T+310s is well fit by an absorbed power-law with a photon index of 2.46 ± 0.09 and column density of $(1.9 \pm 0.2) \times 10^{21} \text{ cm}^{-2}$. We note the Galactic column density in the direction of the source is $2 \times 10^{20} \text{ cm}^{-2}$. The observed 0.3 – 10 keV flux for this spectrum is $2.1 \times 10^{-9} \text{ ergs/cm}^2/\text{sec}$.

Assuming the X-ray emission continues to decline at the same rate, we predict a 0.3 – 10 keV XRT count rate of $7 \times 10^{-4} \text{ count/s}$ at T+24hr, which corresponds to an observed 0.3 – 10 keV flux of about $2.5 \times 10^{-14} \text{ ergs/cm}^2/\text{sec}$.

4 UVOT Observations and Analysis

UVOT began settled observations of GRB 070419A at T+115 sec. The afterglow first detected by Chornock et al., GCN Circ. 6304 is weakly detected on the UVOT V-band image (Figure 3). Photometry is difficult due to the presence of a diffraction spike from a 7th magnitude star within 3 arcmin. The bright star also precluded use of the UVOT broad-band white filter. Estimated magnitudes and 3σ upper limits are given in Table 1, as reported by Landsman and Stamatikos, GCN Circ. 6340. The V band magnitudes are consistent with a brightening noted in previous reports (Williams et al., GCN Circ. 6328, Wren et al., GCN Circ. 6324 and Cenko et al., GCN Circ. 6306).

Filter	T _{Start} (sec)	T _{Stop} (sec)	Exposure Time (sec)	3σ U.L. (Magnitude)
V	115	515	394	20.2 ± 0.3
V	869	1204	330	20.0 ± 0.3
B	594	739	19	>18.7
U	569	861	58	>19.1

Table 1: Optical afterglow magnitude upper limits from UVOT observations of GRB 070419A. N.B. - The above magnitudes have not been corrected for the Galactic reddening of $E(B-V)=0.03$.

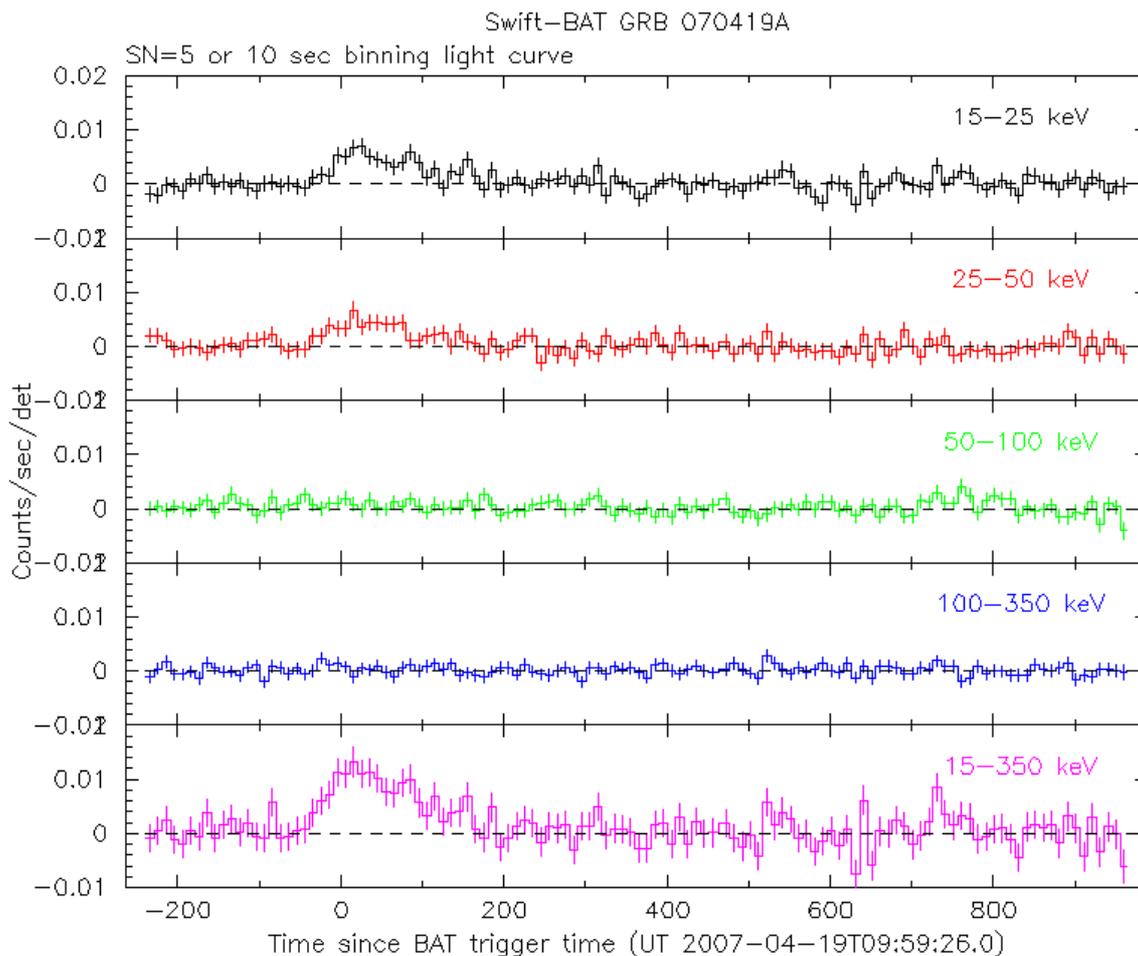


Figure 1: BAT Light curve for GRB 070419A. The mask-weighted light curve in the 4 individual plus total energy bands. The time of each bin is in the middle of the bin. The units are counts/sec/illuminated-detector and T_0 is 09:59:26 UT.

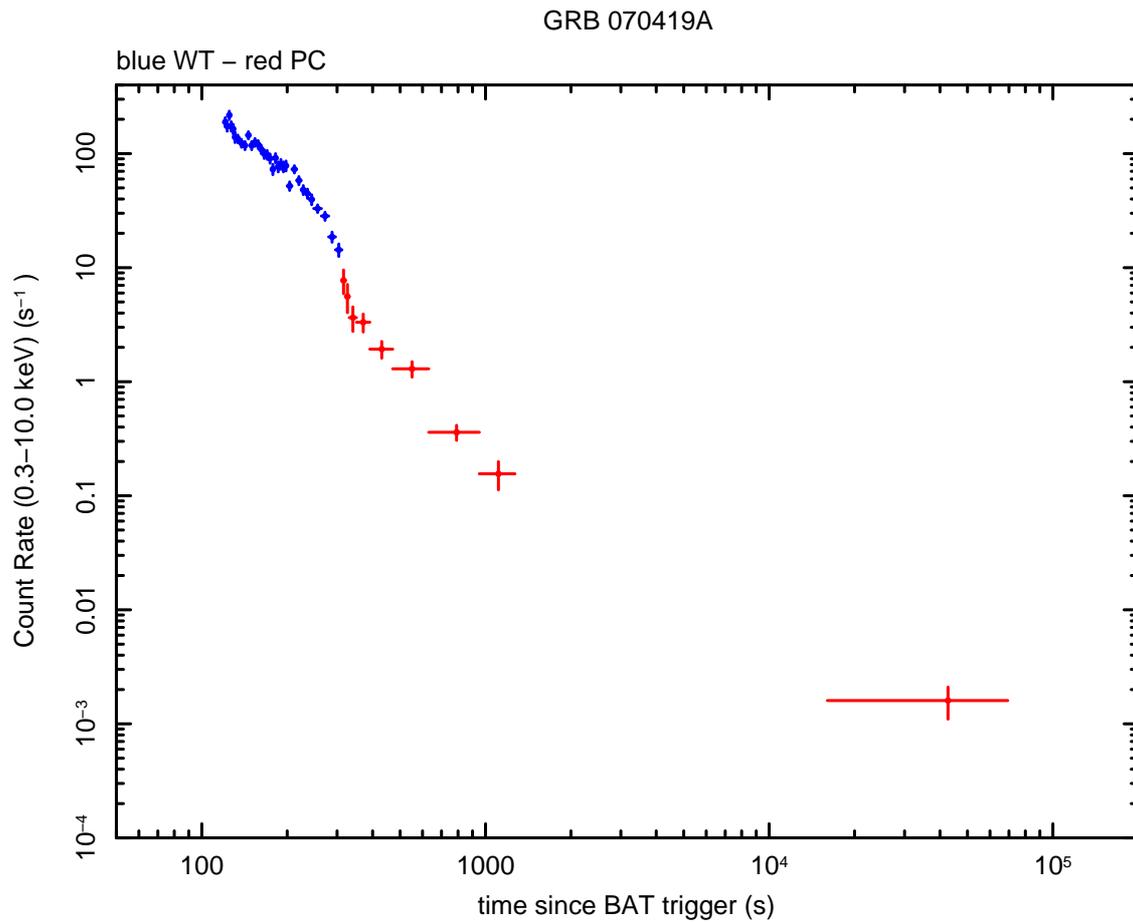


Figure 2: XRT Lightcurve for GRB 070419A. Counts/sec in the 0.3 – 10 keV band. Windowed Timing mode (blue), Photon Counting mode (red). The approximate conversion is 1 count/sec $\approx 3.5 \times 10^{-11}$ ergs/cm²/sec.

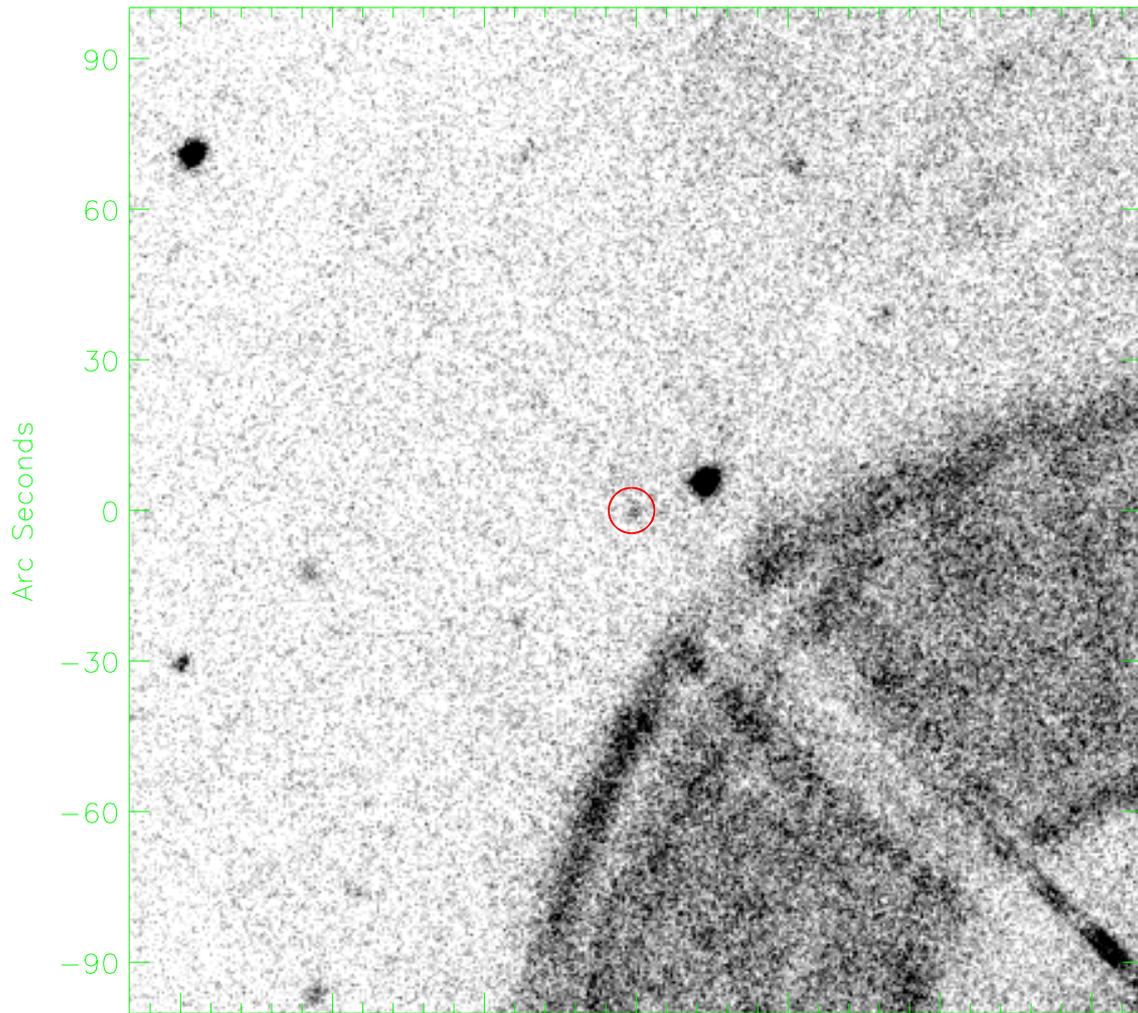


Figure 3: UVOT finding chart for GRB 070419A. The red circle indicates the afterglow position. The image is from the combined 724 second V image taken in the first 20 minutes.