Swift Observation of GRB 061019

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1 Introduction

BAT triggered on GRB 061019 at 04:19:07.0 UT (Trigger 234516) (Guidorzi, *et al.*, *GCN Circ.* 5278). This was a 4.096 sec rate-trigger on a long burst with $T_{90} = 191$ sec. Swift could not slew immediately because of the Earth observing constraint. XRT observations began at $T + 2800$ *sec* and discovered the X-ray afterglow. UVOT began observing at $T + 2790$ *sec* and did not find any counterpart down to V$\sim$ 19 mag. Our best position is the XRT location RA($J2000$) = 91.62804 $deg(06h06m30.73s)$, Dec($J2000$) = +29.56958 $deg(+29d34'10.5'')$ with an error of 6.7 arcsec (90% confidence, including boresight uncertainties).

2 BAT Observation and Analysis

Using the data set from $T - 240$ to $T + 963$ *sec*, further analysis of BAT GRB 061019 has been performed (Sakamoto, *et al.*, *GCN Circ.* 5732). The BAT ground-calculated position is RA($J2000$) = $91.631deg$ $(06h06m31.5s)$, Dec($J2000$) = $+29.545deg(+29d32'43.3'') \pm 1.8$ $arcmin$, (radius, systematic and statistical, 90% containment). The partial coding was 5%.

The mask-weighted lightcurves (Fig.1) show two peaks. The first (pre-trigger peak), started $T-170$ *sec* and lasted for ~ 20 *sec*. The second peak (the triggering peak) rises a little faster than decaying. It starts at $\sim T - 4$ *sec*, peaks at $T + 4$ *sec*, and ends at $\sim T + 30$ *sec*. The second peak is a little brighter than the first. There is a hint of on-going emission between the two peaks. Because of a s/c slew terminating the data collection, we can not say if there is any further emission past $T + 60$ *sec*. T90 is 191 ± 3 *sec* (estimated error including systematics).

For the second (triggering peak), the time-averaged spectrum from $T - 4.0$ to $T + 27.7$ *sec* is best fit by a simple power-law model. The power law index of the time-averaged spectrum is 1.85 ± 0.26. The fluence in the 15-150 keV band is $(1.7 \pm 0.2) \times 10^{-6}$ $erg\ cm^{-2}$. The 1-sec peak photon flux measured from $T + 3.57$ *sec* in the 15-150 keV band is (2.2 ± 0.6) $ph\ cm^{-2}\ sec^{-1}$.

For the first (pre-trigger peak), the time-averaged spectrum from $T - 175$ to $T - 150$ *sec* is best fit by a simple power-law model. The power law index of the time-averaged spectrum is 2.17 ± 0.40. The fluence in the 15-150 keV band is $(7.3 \pm 1.9) \times 10^{-7}$ $erg\ cm^{-2}$.

The total fluence (both peaks) is $(2.4 \pm 0.3) \times 10^{-6}$ $ergs\ cm^{-2}$. All the quoted errors for both fits are at the 90% confidence level.

3 XRT Observations and Analysis

Using the data from the first three orbits of XRT data of GRB 061019 (6.5 *ksec* in Photon Counting mode), the refined XRT position is RA($J2000$) = $91.62804deg$ $(06h06m30.73s)$, Dec($J2000$) = $+29.56958$ deg $(+29d34'10.5'') \pm 6.7$ $arcsec$ (90% confidence, including boresight uncertainties). This position is within 4.2 *arcsec* of the initial XRT position (Guidorzi *et al.*, *GCN Circ.* 5729), and 3.2 *arcsec* from the K-band afterglow candidate reported by Covino *et al.*, *GCN Circ.* 5730 and confirmed by Cobb *et al.*, *GCN Circ.* 5734.

The $0.3 - 10$ keV light curve shows an initial slope of 0.7 ± 0.4, with possible break around 10^4 *sec*

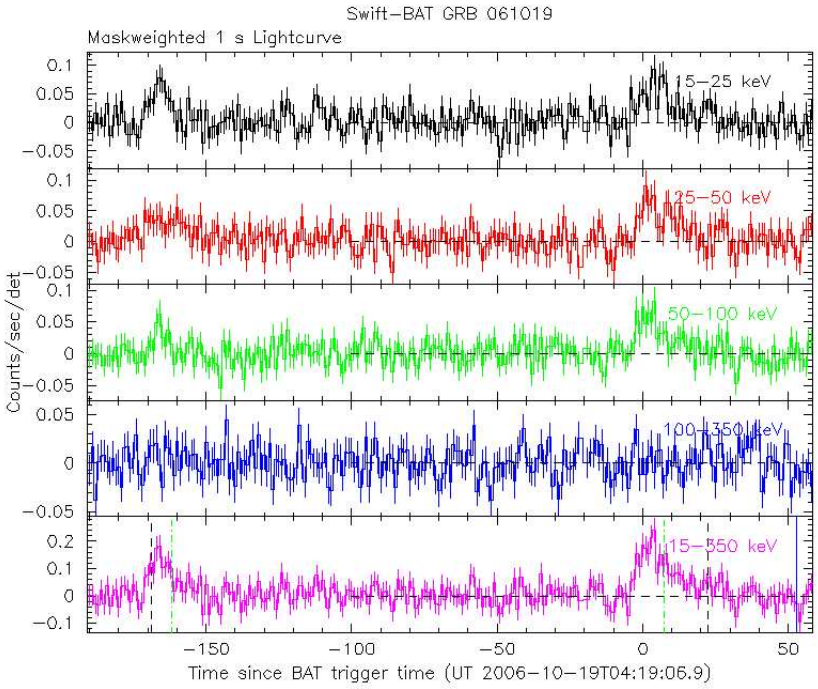

Figure 1: BAT Light curve. The mask-weighted light curve in the 4 individual plus total energy bands. The units are counts/sec/illuminated-detector (note illum-det = 0.16 cm^2) and T_0 is 04:19:06.9 UT.

after the burst to an almost flat decay. Alternatively, it can be fit with a single power law with slope 0.56 ± 0.10. Further data will help clarify this ambiguity.

The time-averaged spectrum (from $T+2.8$ ks to $T+17$ ks) can be fit with an absorbed power-law with a photon index of 2.1 ± 0.3 (90%) and an absorption column of $(9 \pm 2) \times 10^{21}$ cm^{-2} (90%), significantly in excess of the Galactic value in the direction of the burst (4.8×10^{21} cm^{-2}). The mean observed (unabsorbed) flux in the $0.3 - 10$ keV energy band is 4.2×10^{-12} (9.2×10^{-12}) erg cm^{-2} sec^{-1}.

Further analysis of the XRT observations of GRB 061019 has revealed in the first three orbits a diffuse X-ray halo centred around the afterglow position (Romano *et al.*, *GCN Circ.* 5737). The halo has the form of a complete ring which increases in radius through the observation and reached the distance of ≥ 100 $arcsec$ from $T + 2.8$ ks to $T + 17$ ks. We can exclude it is due to instrumental effects. During the observation the halo follows the expected behaviour of a "light-echo" as X-rays are scattered by dust in our Galaxy.

GRB 061019 is in the direction (Galactic) $l = 181.74$, $b = 4.26$ degrees, in which the density of the interstellar medium is quite high as testified by both the HI column density reported above and the optical extinction E(B-V)=1.144 (A_B=4.939).

4 UVOT Observation and Analysis

The Swift UVOT began observing the GRB 061019 field 2790 *sec* after the BAT trigger (Marshall *et al.*, *GCN Circ.* 5735). Exposures were taken with the V, B, U, W1, M2, and W2 filters. No new source was detected within the XRT error circle. The effects of a nearby bright star complicate the analysis, but we estimate a 3-sigma upper limit of $\sim 19^{th}$ magnitude at the position of the optical afterglow for the initial exposure with the V filter.

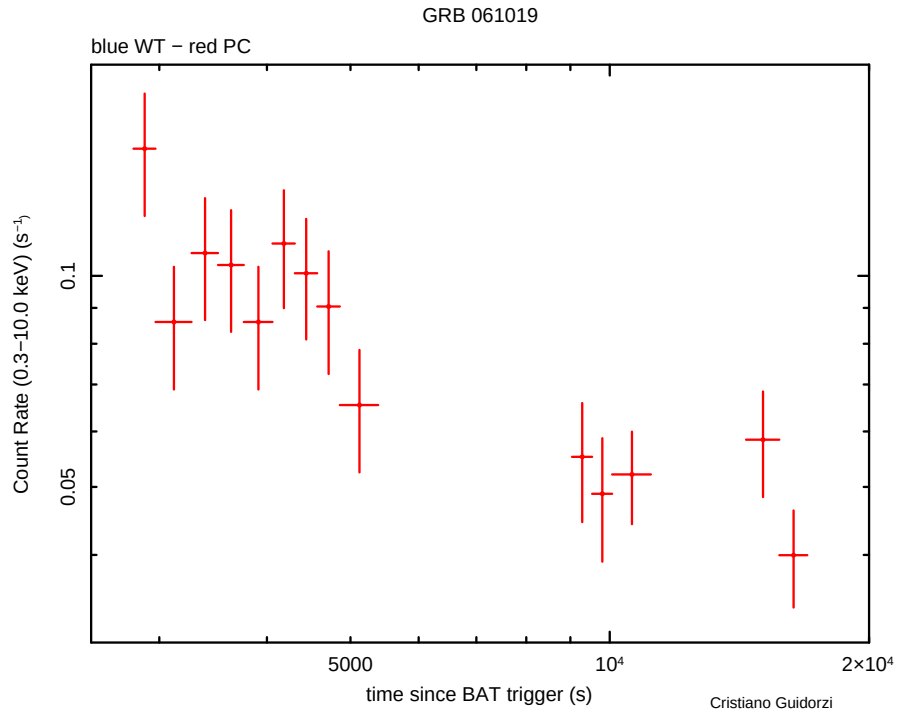

Figure 2: XRT Lightcurve. Counts/sec in the 0.3-10 keV band: Window Timing mode (black), Photon Counting mode (red). The approximate conversion is 1 count/sec $\sim 6.4 \times 10^{-11}$ $erg\ cm^{-2}\ sec^{-1}$.