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 T90 = 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 ~ 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) = 91.6311deg (06h06m31.5s), Dec(J2000) = +29.545deg(+29d32’43.3") ± 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 T − 4 sec, peaks at T + 4 sec, and ends at 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 ± 0.2) × 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 ± 1.9) × 10^{-7} erg cm^{-2}.

The total fluence (both peaks) is (2.4 ± 0.3) × 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") ± 0.7 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 $0.56 \pm 0.10$. 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 $2.1 \pm 0.3$ (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 ($4.8 \times 10^{21}$ cm$^{-2}$). The mean observed (unabsorbed) flux in the $0.3-10$ keV energy band is $4.2 \times 10^{-12}$ $(9.2 \times 10^{-12})$ 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 $\gtrsim 100$ 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$^{-1}$. 