Swift Observation of long GRB 090422

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1 Introduction

BAT triggered on GRB 090422 at 03:35:16 UT (Trigger 349931) (Ukwatta, et al., GCN Circ. 9185). This was a 0.064 sec rate-trigger on a long burst with $T90 = 8.5 \pm 0.4$ sec. Swift slewed immediately to the burst. Narrow field instruments started observations at $\sim T + 64$ sec, and our best position is the UVOT-enhanced XRT location RA($J2000$) = 294.74967 deg (19h38m59.92s), Dec($J2000$) = +40.38445 deg (+40d23'04.0") with an uncertainty of 1.5 arcsec (90% confidence, including boresight uncertainties), reported by Beardmore et al., GCN Circ. 9194. This burst has also been observed by Fermi GBM as reported by McBreen et al., GCN Circ. 9228.

2 BAT Observation and Analysis

Using the data set from $T - 60$ to $T + 243$ sec, further analysis of BAT GRB 090422 has been performed by BAT team (Markwardt, et al., GCN Circ. 9195). The BAT ground-calculated position is RA($J2000$) = 294.746 deg (19h38m59.1s), Dec($J2000$) = 40.398 deg (+40d23'52.1") ± 2.0 arcmin, (radius, systematic and statistical, 90% containment). The partial coding was 72% (the bore sight angle was 21.4 deg).

The mask-weighted light curve (Fig. 1) shows two main peaks at $T = 0$ and $T + 8$ sec. They are each about 1 sec wide. There is a third, weaker peak at $\sim T = 50$ sec (see Fig. 2). $T90$ (15-350 keV) is 8.5 ± 0.4 sec (estimated error including systematics).

The time-averaged spectrum from $T - 0.4$ to $T + 8.5$ sec is best fit by a simple power-law model. The power law index of the time–averaged spectrum is $1.72 \pm 0.30$. The fluence in the 15 – 150 keV band is $2.3 \times 10^{-7}$ erg cm$^{-2}$. The 1-sec peak photon flux measured from $T - 0.37$ sec in the 15 – 150 keV band is 1.7 ± 0.2 ph/cm2/sec. All the quoted errors are at the 90% confidence level.

The results of the batgrbproduct analysis are available at http://gcn.gsfc.nasa.gov/notices_s/349931/BA/

3 XRT Observations and Analysis

The XRT team has analyzed the complete data set of Swift-XRT data obtained from GRB 090422, starting from $T + 70$ s and ending at $T + 504$ ks.

The best position of the X-ray afterglow is the UVOT-enhanced XRT position (Beardmore , et al., GCN Circ. 9194) is RA($J2000$) = 19h38m59.92s Dec($J2000$)= +40d 23' 04.0"

with an uncertainty of 1.5 arcsec (radius, 90% confidence).

The 0.3–10 keV X-ray light curve (Fig. 5) is well described by a double broken power-law model with decay indices $\alpha_1 = 2.1 \pm 0.2$, $\alpha_2 = 0.4 \pm 0.3$, $\alpha_3 = 1.1 \pm 0.1$ and temporal breaks $t_1 = 354 \pm 92$ s and $t_2 = 2.4 \pm 0.5$ ks.

The average X-ray spectrum from $T + 85$ s to $T + 70$ ks is well fitted by an absorbed power-law model with a photon index of 2.5 ± 0.2 and a column density of $(2.3 \pm 0.7) \times 10^{21}$ cm$^{-2}$ in excess.
to the Galactic one in the direction of the source \((1.7 \times 10^{21}\text{cm}^{-2})\), Kalberla et al., 2005). The count-rate to observed (unabsorbed) 0.3–10 keV flux conversion factor deduced from this spectrum is \(3.6 (8.7)^{-11}\text{erg cm}^{-2}\text{count}^{-1}\).

The results of the XRT-team automatic analysis are available at http://www.swift.ac.uk/xrt_products/00349931.

4 UVOT Observation and Analysis

The Swift/UVOT observed the field of GRB 090422 starting 55 s after the BAT trigger. Settled exposures started at \(T + 74\) s with a Finding Chart (FC) in the white filter. No afterglow is detected at the enhanced position of the XRT afterglow (Beardmore, et al., GCN Circ. 9194) nor at the position of the candidate found by the Liverpool Telescope (Guidorzi, et al., GCN Circ. 9197). 3–sigma upper limits for detecting a source in the white and u FCs, and subsequent co-added images in all filters are:

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<th>Filter</th>
<th>Tstart (s)</th>
<th>Tstop (s)</th>
<th>Exposure (s)</th>
<th>Magnitude</th>
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</table>

Table 1: Magnitude limits from UVOT observations

The quoted upper limits have not been corrected for the expected Galactic extinction along the line of sight corresponding to a reddening of \(E_{B-V} = 0.198\) mag (Schlegel, et al., 1998, ApJS, 500, 525). All photometry is on the UVOT photometry system described in Poole et al.(2008, MNRAS, 383, 627).
Figure 1: The mask-weighted light curve in the 4 individual plus total energy bands. The units are counts/sec/illuminated-detector and $T_0$ is 03:35:16 UT.
Figure 2: The mask-weighted light curve in the 4 individual plus total energy bands showing a weak peak around $T + 50$ seconds. The units are counts/sec/illuminated-detector and $T_0$ is 03:35:16 UT.
Figure 3: XRT Lightcurve. Counts/sec in the 0.3−10 keV band: Window Timing mode (blue), Photon Counting mode (red). The approximate conversion is 1 count/sec $\sim 3.6 \times 10^{-11}$ ergs/cm$^2$/sec.
Figure 4: UVOT light curves.
Figure 5: UVOT finding chart image. The large red circle is the BAT error region; a small red circle is the XRT error region. The UVOT position is indicated with a red box arbitrarily sized to 5 arc sec on a side.