Swift Observation of GRB 130122A

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1 Introduction

BAT triggered on GRB 130122A at 23:44:09 UT (Trigger 546731) (Lien et al., GCN Circ. 14140). This was a 12.16 sec rate-trigger on a long burst with $T_{90} = 64 \pm 36$ sec. Swift slewed to this burst immediately and XRT began follow-up observations at $T + 116.9$ sec, and UVOT at $T + 121$ sec. Our best position is the UVOT location RA(J2000) = 194.28459 deg, Dec(J2000) = -59.01487 deg, which is equivalent to
RA (J2000) = 12h 57m 08.30s
Dec (J2000) = +59d 00’ 53.5”
with an estimated uncertainty of 0.53 arc sec. (radius, 90% confidence).

The optical/NIR afterglow is also detected by the 1.0 meter T100 telescope and the Russian-Turkish 1.5-m telescope at the TUBITAK National Observatory (Sonbas et al., GCN Circ. 14141; Galeev et al., GCN Circ. 14152), the MASTER II robotic telescope (Gorbovskoy et al., GCN Circ. 14142), RATIR (Butler et al., GCN Circ. 14147), and the ISON-Kislovodsk observatory (Volnova et al., GCN Circ. 14148)

2 BAT Observation and Analysis

Using the data set from T-61 to T+242 sec from recent telemetry downlinks, the BAT team reported further analysis of GRB 130122A (Barthelmy et al., GCN Circ. 14146). The BAT ground-calculated position is RA, Dec = 194.307, 59.003 deg, which is
RA(J2000) = 12h 57m 13.8s
Dec(J2000) = +59d 00’ 09.2”
with an uncertainty of 3.0 arcmin, (radius, sys+stat, 90% containment). The partial coding was 89%.

The mask-weighted light curve (Fig. 1) shows a single roughly FRED-like peak starting at T+0 sec, peaking at T+10 sec, and ending at T+100 sec. $T_{90}$ (15-350 keV) is 64 +- 36 sec (estimated error including systematics).

The time-averaged spectrum from T-12.6 to T+67.4 sec is best fit by a simple power-law model. The power law index of the time-averaged spectrum is 1.34 \pm 0.24. The fluence in the 15-150 keV band is 7.4 \pm 1.1 \times 10^{-7}$ erg cm$^{-2}$. The 1-sec peak photon flux measured from T+10.92 sec in the 15-150 keV band is 0.4 \pm 0.1 ph cm$^{-2}$ sec$^{-1}$. 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/546731/BA/

3 XRT Observations and Analysis

Using 488 s of XRT Photon Counting mode data and 1 UVOT images for GRB 130122A, an astrometrically corrected X-ray position is found (using the XRT-UVOT alignment and matching UVOT field sources to the USNO-B1 catalogue; Beardmore et al., GCN Circ. 14143): RA, Dec = 194.28517 deg, +59.01455 deg, which is equivalent to:
RA (J2000): 12h 57m 8.44s
Dec (J2000): +59d 00' 52.4"
with an uncertainty of 1.8 arcsec (radius, 90% confidence).

Furthermore, the XRT team analyzed 9.6 ks of XRT data for GRB 130122A, from 102 s to 29.4 ks after the BAT trigger (D’Elia et al., GCN Circ. 14145). The data comprise 76 s in Windowed Timing (WT) mode (the first 8 s were taken while Swift was slewing) with the remainder in Photon Counting (PC) mode.

The light curve (Fig. 2) can be modelled with a power-law decay with a decay index of alpha=1.27 (±0.04).

A spectrum formed from the PC mode data can be fitted with an absorbed power-law with a photon spectral index of 1.67 (+0.21, -0.20). The best-fitting absorption column is 6.3 (+5.3, -4.6) ×10^{20} cm^{-2}, in excess of the Galactic value of 9.3 ×10^{19} cm^{-2} (Kalberla et al. 2005). The counts to observed (unabsorbed) 0.3-10 keV flux conversion factor deduced from this spectrum is 4.3 ×10^{-11} (4.8 ×10^{-11}) erg cm^{-2} count^{-1}.

A summary of the PC-mode spectrum is thus:
Total column: 6.3 (+5.3, -4.6) ×10^{20} cm^{-2}
Galactic foreground: 9.3 ×10^{19} cm^{-2}
Excess significance: 1.9 sigma
Photon index: 1.67 (+0.21, -0.20)

The results of the XRT-team automatic analysis are available at
http://www.swift.ac.uk/xrt_products/00546731

4 UVOT Observation and Analysis

The Swift/UVOT began settled observations of the field of GRB 130122A 121 s after the BAT trigger (Breeveld et al., GCN Circ. 14149). A source consistent with the XRT position reported in (Beardmore et al., GCN Circ. 14143) is seen in the initial exposures.

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Table 1: Magnitudes and limits from UVOT observations

The preliminary UVOT position is:
RA (J2000) = 12:57:08.30 = 194.28459 (deg)
Dec (J2000) = +59:00:53.5 = 59.01487 (deg)
with an estimated uncertainty of 0.53 arc sec. (radius, 90% confidence).

Preliminary detections and 3-sigma upper limits using the UVOT photometric system (Breeveld et al. 2011, AIP Conf. Proc. 1358, 373) for the finding chart (FC) and earliest exposures are shown in Table 1

The magnitudes in the table are not corrected for the Galactic extinction due to the reddening of
E(B-V) = 0.01 in the direction of the burst (Schlegel et al. 1998).

The UVOT light curves are shown in Fig. 3.

References

[1] Barthelmy et al. 2013, GCN Circ. 14146
[10] Lien et al. 2013, GCN Circ. 14140
[12] Sonbas et al. 2013, GCN Circ. 14141
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 23:44:09 UT.
Figure 2: XRT Lightcurve in the 0.3-10 keV band: Window Timing Setting mode (cyan), Window Timing mode (black), Photon Counting mode (red).
Figure 3: UVOT Lightcurve.