Probing the Nature of Short Swift Bursts via Deep INTEGRAL Monitoring of GRB 050925

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Abstract. We present results from *Swift*, *XMM-Newton*, and deep INTEGRAL monitoring (AO-5 key program data) in the region of GRB 050925. This short *Swift* burst is a candidate for a newly discovered soft gamma-ray repeater (SGR) with the following observational burst properties: 1) galactic plane (b=-0.07°) localization, 2) 150 msec duration, and 3) a blackbody rather than a simple power-law spectral shape. We will show a possible X-ray counterpart of GRB 050925, and also the results of searching $\sim$ 1 Msec INTEGRAL data for persistent hard X-ray emission from this SGR candidate source.

Keywords: gamma ray: bursts
PACS: 98.70.Rz

INTRODUCTION

The origin of the short (< 2 seconds) class of gamma-ray bursts (GRBs) is receiving huge attention in the field of high-energy astrophysics. Thanks to the rapid position notice and response by *HETE-2* and $Swift$, the afterglow emissions have been found for handful of short GRBs [e.g., 1]. Less than arc-second positions which are provided by X-ray and Optical afterglows enable us to study the host galaxy of short GRBs. Surprisingly, unlike the long duration GRBs which always have host galaxies with a high star forming rate [2], short GRBs emerge from both star-forming and non-star forming galaxies [e.g., 3]. This suggests that a substantial range of lifetime is needed for the progenitor of short GRBs. This discovery tightens the case for a different origin for short and long GRBs.

On the other hand, some fraction of short bursts might be from the local and extra galactic flares of soft gamma-ray repeaters (SGRs). SGRs are believed to be highly magnetized isolated neutron stars [4]. They produce short spikes (a few tens of milliseconds) [5] and sometimes a giant flare [6, 7] in γ-rays. Although the probability of observing a giant flare from an extragalactic SGR is still in debate [e.g., 7, 8], a small flare from a previously unknown SGR in the galaxy might be detected as a short burst in γ-rays.

GRB 050925

Swift/BAT Prompt Emission

On 25 September 2005, the *Swift* Bust Alert Telescope (BAT) instrument detected GRB 050925 which only lasted for $\sim$ 150 ms (Figure 1). The BAT ground analysis position of this burst is (R.A., Dec.) = (20^{h} 13^{m} 57.6^{s}, 34° $19'$ 44^{s}) (J2000) [9]. Its location is in the galactic plane ($b = -0.07^{\circ}$). The fluence and the peak photon flux in the 104 ms time window in the 15-150 keV band are 7.6×10^{-8} ergs cm^{-1} and 9.6 ph cm^{-1} s^{-1}. As seen in Figure 2, the prompt emission spectrum of this burst shows a better fit to a blackbody spectrum with a temperature of 15.1 $\pm$ 0.5

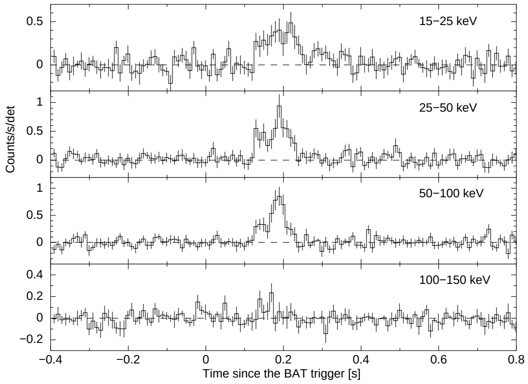

FIGURE 1. The BAT four channel light curves in 10 msec binning.

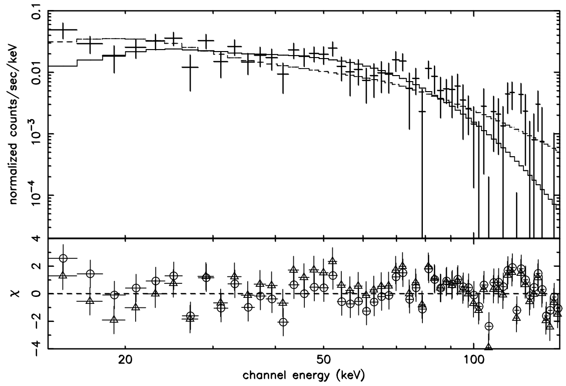

FIGURE 2. The BAT time-integrated spectrum of the burst (100 msec duration). The best fit with a blackbody model is shown in a solid line (upper) with circles in a residual panel (bottom), whereas, the best fit with a simple power-law model is shown in a dashed line (upper) with triangles in a residual panel (bottom).

keV (χ^2/dof = 69.6/57) over a simple power-law spectrum (χ^2/dof = 88.4/57). A blackbody with a temperature of $\sim$ 10 keV is a typical spectral model for short SGR bursts in the BAT energy range [e.g., 10, 11]. GRB 050925 belongs to a softer region comparing to the short GRBs detected by BAT in the hardness-duration plot (Figure 3).

X-ray Observations

The *Swift* X-ray Telescope (XRT) started observing the BAT error circle about 100 seconds after the burst with a net exposure of 30 ksec. XRT found two very weak sources near the BAT error circle (left panel of figure 4). The positions of these two sources are coincident with sources in the guide star catalog (GSC) version 2.2 (N033223385350 and N033223389), and also detected by *Swift* UV-optical telescope (right panel of Figure 4). These X-ray sources showed no statistically significant variability in this XRT observation, and also these sources are outside of the BAT refined ground position of GRB 050925. Therefore, they are unlikely to be associated with GRB 050925.

The *XMM-Newton* observed the field of GRB 050925 starting from 17 days after the BAT trigger for 26.6 ksec [12]. Although there is no bright variable X-ray source inside the BAT ground position, we do notice that there is a weak X-ray source inside the BAT error circle in both images of the *Swift* XRT and the *XMM-Newton* (arrow of right and middle panel of Figure 4). Further analysis of the source is underway to identify the association with GRB 050925.

Search for Persistent Hard X-ray Emission by INTEGRAL

The *INTEGRAL* AO5 key program ISGRI data of the Cyg region have been analyzed. The exposure time of the location for GRB 050925 was 1.42 Msec. The intensity and significance maps of the *INTEGRAL* ISGRI instrument are shown in Figure 5 and 6 in four different energy bands. The persistent hard X-ray emission has not been detected at the location of GRB 050925.

SUMMARY

The prompt emission properties observed by *Swift* BAT favor a new SGR scenario for GRB 050925. There is a possible X-ray counterpart inside the BAT refined ground error circle observed both by *Swift* XRT and *XMM-Newton*. No persistent hard X-ray emission has been found at the location of GRB 050925 in the *INTEGRAL* data. The analysis

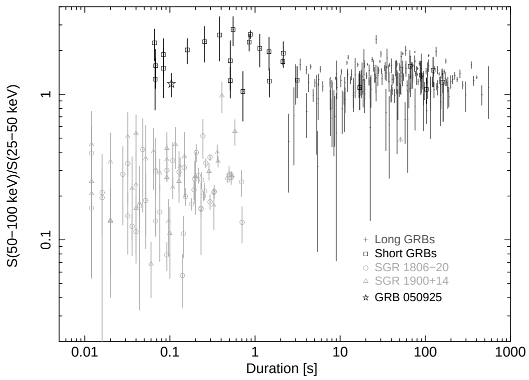

FIGURE 3. The BAT fluence ratio between the 50-100 keV and 25-50 keV band vs. burst duration. The long GRBs, short GRBs, short bursts from SGR 1806-20, short bursts from SGR 1900+14 and GRB 050925 are shown in crosses, squares, circles, triangles, and a star, respectively.

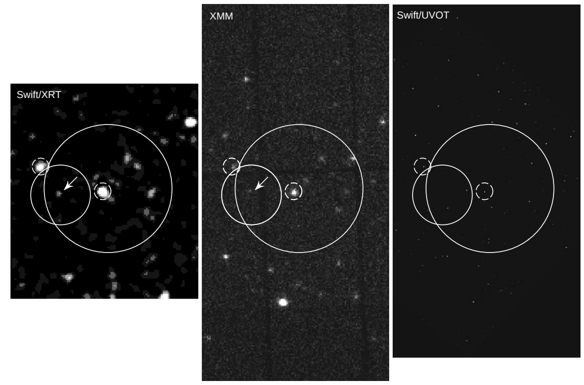

FIGURE 4. The X-ray and B band images of the field of GRB 050925 (left: *Swift* XRT, middle: *XMM-Newton*, and right: *Swift* UVOT B filter). The larger solid circle is the BAT flight error circle and the smaller solid circle is the BAT refined error circle.

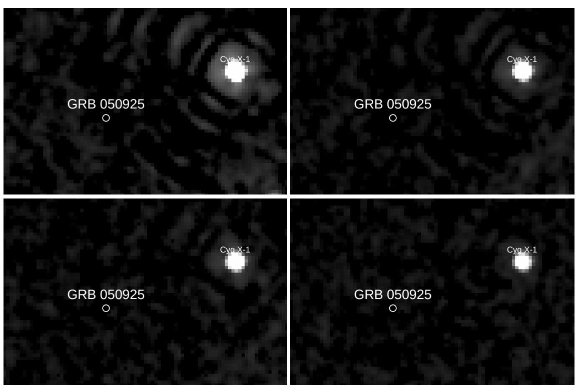

FIGURE 5. The intensity maps of *INTEGRAL* ISGRI in the 20-40 keV (upper left), the 40-60 keV (upper right), the 60-100 keV (lower left), and the 100-200 keV (lower right) bands. The location of GRB 050925 is shown in the open circle.

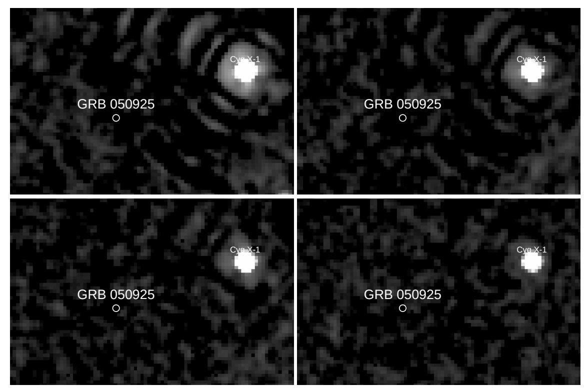

FIGURE 6. The significance maps of *INTEGRAL* ISGRI in the 20-40 keV (upper left), the 40-60 keV (upper right), the 60-100 keV (lower left), and the 100-200 keV (lower right) bands. The location of GRB 050925 is shown in the open circle.

of 1) a possible X-ray counterpart of GRB 050925, 2) the archival *INTEGRAL* data of the field GRB 050925, and 3) search for another short GRB from the location of GRB 050925 using the *INTEGRAL* data are in progress.

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