Swift Observation of INTEGRAL GRB 070707
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1 Introduction

GRB 070707 triggered INTEGRAL at 16:08:21 UT on July 07, 2007 (Beckmann et al., GCN Circ. 6605, Gotz et al., GCN Circ. 6607), resulting in a localization of R.A. DEC (J2000) = 267.7506 deg, -68.9144 deg with an uncertainty of 2.1 arcmin (90% c.l.). Refined analysis by the INTEGRAL team shows that this burst was composed of a single spike lasting about 1.1 s, with a spectrum well fit to a power law of slope of 1.4, indicating a rather hard spectrum. (Gotz et al., GCN Circ. 6607).

This burst also triggered Konus-Wind at $T_0 = 16:08:42.823$ UT. The Konus-Wind (20 keV - 2 MeV) spectrum of the burst from $T_0$ to $T_0 + 0.256$ sec is well fitted by a power law with exponential cutoff model where $\alpha = 0.57$ (-0.59, +0.43) and $E_p = 427$ (-144, +374) keV, classifying it as a short, hard GRB (Golenetskii et al., GCN Circ. 6615).

Since this burst was outside BAT’s FOV, there was no Swift trigger for GRB 070707 and thus immediate Swift afterglow measurements were not possible. However, Swift did slew to the location of GRB 070707 as a ToO some 8.8 hours after the INTEGRAL trigger time. We report on the XRT and UVOT afterglow observations made after this time. While the XRT did detect a fading source (Beardmore et al., GCN Circ. 6610, 6626) within the INTEGRAL error circle, no afterglow candidate was found in the UVOT data (Schady et al., GCN Circ. 6611).

Optical afterglow emission was detected within the XRT error circle by D’Avanzo et al., (GCN Circ. 6609, 6613) and Piranomonte et al., (GCN Circ. 6612) in R band images made using the FORS1 camera on the ESO-VLT telescope. A single source with R ≈ 23.0 was detected in the first observation at $T_0 + \approx 11$ hours. A follow-up observation (D’Avanzo et al., GCN Circ. 6613) was performed with the same instruments at $T_0 + \approx 33$ hours and revealed that this object had faded by about 0.7 ± 0.1 mag, indicating that it was the optical afterglow of GRB 070707.

2 BAT Observation and Analysis

No immediate BAT observations were made for this GRB, since the burst was outside the BAT FOV. Upon later examination of the BAT data, a short BAT rate trigger (#284062) with an excess of 461 counts in 0.384 sec was discovered at a time coincident with the burst trigger time and is thus presumably due to GRB 070707. Considering Swift’s pointing direction at the trigger time, photons from GRB 070707’s location must have entered BAT through the backside of the BAT array.

3 XRT Observations and Analysis

On 2007 Jul 08 00:57:50 UT ($T_0 + 31.8$ ks) the Swift XRT started observing the field of the INTEGRAL burst GRB 070707 (Beckmann et al., GCN Circ. 6605, Gotz et al., GCN Circ. 6607). In a 3.8 ks exposure, photon counting mode image, XRT detected a source at RA, Dec = 267.7437, -68.9242, which is

RA(J2000) = 17h 50m 58.49s
Dec(J2000) = -68d 55m 27.0s

with an uncertainty of 5.4 arcsec (90% containment). This is 36.3 arcsec from the position reported by (Gotz et al., GCN Circ. 6607), and within their error circle.
Using a circular extraction region of 10 pixels radius, XRT scientists observed 26 total counts. Together with an estimated background level of 1.0 count in the extraction region, we find the 99.73% Bayesian confidence level on the source count rate was 0.003 to 0.011 count s\(^{-1}\).

The Swift XRT obtained further follow-up observations of GRB 070707. In an 11.1 ks exposure photon counting mode image taken from 325.1 ks to 516.6 ks after the trigger, and using the same 10 pixel radius extraction region as before, XRT found a 3 sigma upper limit to the observed count rate at 0.0011 count/s. When compared with the initial XRT detection (Beardmore et al., GCN Circ. 6610) of 0.0066 ± 0.0013 count/s (where the error bar is a 1 sigma estimate) we conclude the source has faded and that it was the X-ray counterpart to the GRB (Beardmore et al., GCN Circ. 6610, 6626).

An absorbed power law fit to the photon energy distribution of the source observed during the first XRT observation (from 31.8 ks to 54.1 ks after the trigger), using Cash statistics and with the \(N_H\) value fixed at the (Dickey and Lockman) Galactic value of 6 x \(10^{20}\) cm\(^{-2}\), gave a power law index of 2.7 ± 0.6. The observed 0.3 - 10 keV flux was 2.4 (+2.0, -1.4) x \(10^{-13}\) ergs cm\(^{-2}\) s\(^{-1}\).

4 UVOT Observation and Analysis

The Swift/UVOT observed the field of the INTEGRAL burst GRB070707 starting 8.8 hrs after the INTEGRAL trigger (Beckmann et al., GCN Circ. 6605), but did not find a new source inside the refined INTEGRAL error circle in any of the UVOT observations (Schady et al., GCN Circ. 6611) or XRT error circle (Beardmore et al., GCN Circ. 6610).

The 3-sigma upper limits for detecting a source inside the refined XRT error circle in the initial data products are:

<table>
<thead>
<tr>
<th>Filter</th>
<th>(T_{\text{mid}}) (s)</th>
<th>Exp(s)</th>
<th>Mag (3 (\sigma) upper limit)</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>53885</td>
<td>543</td>
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</tr>
<tr>
<td>B</td>
<td>31910</td>
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<td>U</td>
<td>47905</td>
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<tr>
<td>UVW2</td>
<td>53182</td>
<td>1800</td>
<td>20.51</td>
</tr>
</tbody>
</table>

Where \(T_{\text{mid}}\) is the weighted mid time of the coadded exposure. The values quoted above are not corrected for the expected Galactic extinction corresponding to a reddening of \(E_{B-V} = 0.08\) mag in the direction of the burst (Schlegel et al.1998).