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A GTC STUDY OF THE AFTERGLOW AND HOST GALAXY OF THE SHORT-DURATION GRB 100816A

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Abstract. We present the results from an optical monitoring campaign aimed at studying the afterglow properties of the short GRB 100816A. We implemented a new way of processing the *Swift*-BAT data, and based on it we reclassified this burst as short, discarding the initial classification as long. Observations were carried out mainly with the GTC Telescope within the four following days after the burst to investigate the optical photometry of its afterglow, and a year later to localize the host. We completed the optical imaging with the 1.23 m and 3.5 m CAHA Telescopes. We built and fitted the nIR-optical SED for the characterization of the host. The best fit of the SED (χ^2/d.o.f. = 1.656) obtained for assumed values of a solar metallicity, and an extinction of $A_V = 0.2$ mag is obtained for a starburst galaxy with a dominant stellar population aging about 360 Myr.

1 *Swift* detection of GRB 100816A

GRB 100816A was detected by *Swift*-BAT (Oates *et al.* 2010) on the 16th August 2010. The initial estimated T_{90} duration (15–350 keV) was 2.9 ± 0.6 s. A preliminary classification for this GRB based on this parameter and spectral lag analysis although inconclusive pointed out to a long burst (Kouveliotou *et al.* 1993). Assuming a redshift of $z = 0.8049$ (Tanvir *et al.* 2010) and a standard cosmology model, the isotropic energy release was estimated to be $E_{iso} = (5.8 \pm 0.7) \times$

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10^{51} erg, and the peak luminosity $(L_{iso})_{max} = (7.3\pm1.3)\times10^{51}$ erg s^{-1} (Golenetskii *et al.* 2010).

2 The *Swift*-BAT data analysis reveals a short burst

We implemented a new approach in the processing of the *Swift*-BAT data following Norris *et al.* (2010, 2011) procedures. We utilized the raw event data with better statistics (with about 3 times more count rate with non-tagged data than the mask-tagged data) and fitted locally the background at two time intervals. We found a duration over the same energy range $T_{90} = 1.99 \pm 0.02$ (1σ error). Figure 1 illustrates the *Swift*-BAT time profile summed over the canonical energy range 15–350 keV and binned to 8 ms resolution. The use of a finer binning did not reveal any additional significant feature. The burst basically consists of one episode of continuous, mostly smooth emission accompanied with several overlapping substructures with widths as narrow as ∼100 ms. We also included in the analysis the spectral lag considerations that together with duration makes GRB 100816A a candidate to short burst. More details on the procedure and *Swift*-BAT data analysis in Pérez-Ramírez *et al.* (2013).

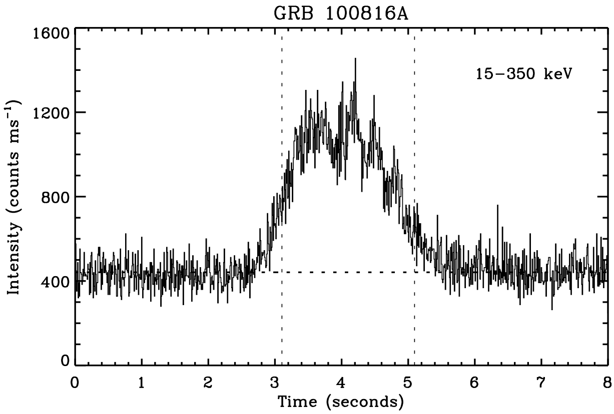

Fig. 1. The *Swift*-BAT time profile of GRB 100816A summed over the canonical energy range 15–350 keV and binned to 8 ms resolution.

3 Optical lightcurve for the GRB 100816A afterglow using the GTC and CAHA Telescopes

Once the *Swift*-UVOT detected the presence of an optical afterglow (OA), we started a monitoring campaign in two fronts: in the inmediate timescale, *i.e.* minutes after the burst when we were able to activate the modest but remotely available 1.23 m CAHA Telescope, obtaining early observations of the OA

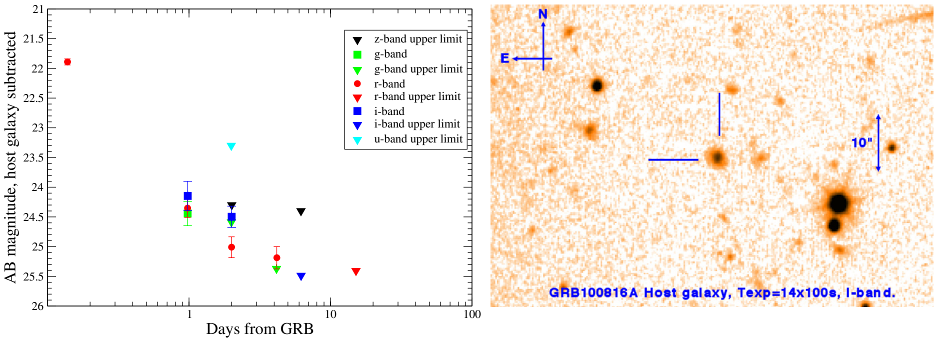

Fig. 2. a) The GTC optical light curve once the host galaxy contribution has been subtracted. **b)** *i*-band GTC deep image showing the host for GRB 100816A obtained the 8th July 2011.

(0.14 hours after the burst, Terrón *et al.* 2010). Later on, we carried out *ugriz* observations with the 10.4 m GTC equiped with OSIRIS. We observed the complete data set in the *BVRI* filters at 1.23 m CAHA Telescope. For a series of four nights, we observed the OA with the 10.4 m GTC and were able to obtain the complete lightcurve shown in Figure 2a. The OA appears in the r band about 22 mag hours after the burst, decreasing up to 25.5 within the following four days.

4 The nIR-optical SED for the GRB 100816A host galaxy

The host galaxy for GRB 100816A was detected a year later in a deep i-band image with the 10.4 m GTC (Fig. 2b). We built the Spectral Energy Distribution (SED) for the GRB 100816A based on the photometric *ugriz* points obtained with the 10.4 m GTC plus an additional nIR point, in the H-band, observed with the 3.5 m CAHA Telescope. The fit of the SED provides information on the stellar population age, the stellar mass, and on the host galaxy absolute luminosity. We based our SED fitting analysis on templates constructed adopting the metallicity derived from spectroscopic study (Z = $Z_{\odot}$). We mainly utilized synthetic templates, but checks have also been performed using observational templates (Kinney *et al.* 1996). The synthetic SED analysis is based on the code HyperZ (Bolzonella *et al.* 2000). The construction of the HyperZ templates was performed using the GALAXEV public code (Bruzual & Charlot 2003). Figure 3 shows our photometric points and the best fit obtained for assumed values of a solar metallicity, and an extinction of $A_V = 0.2$ mag. The best fit (χ^2/d.o.f. = 1.656) is obtained for a starburst galaxy with a dominant stellar population aging about ~0.36 Gyr. More details on the host in Pérez-Ramírez *et al.* (2013).

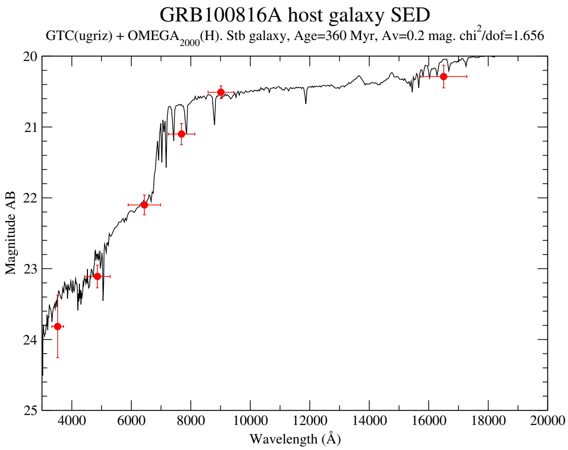

Fig. 3. The nIR-optical SED for the GRB 100816A host galaxy.

5 Conclusions

We present the results from an optical monitoring campaign with the 1.23 m and 3.5 m CAHA Telescopes, and the 10.4 m GTC Telescope aimed at studying the afterglow properties of the short-hard GRB 100816A. The GTC campaign was carried out within the four following days after the burst to investigate the optical photometry of the afterglow, and a year later, to localize the host. We built and fitted the nIR-optical SED for the characterization of the host, obtaining the best fit for a starburst galaxy with a dominant stellar population aging about 360 Myr, assuming values of a solar metallicity, and an extinction of $A_V = 0.2$ mag. We implemented on this work a new approach for the *Swift*-BAT data processing and conclude that GRB 100816A is a candidate to short burst. However, the galaxy specification and galaxy type together with inconclusive result on lag, and soft spectrum do not point out to the short nature of GRB 100816A. Comprehensive investigations are being carried out on the morphological nature of the event.

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