SF2A 2013
L. Cambrésy, F. Martins, E. Nuss and A. Palacios (eds)

THE SPECTRAL CATALOGUE OF *INTEGRAL* GAMMA-RAY BURSTS

Ž. Bošnjak[1,2,3], D. Götz[1], L. Bouchet[3,4], S. Schanne[1] and B. Cordier[1]

Abstract. We present a spectral catalogue of gamma-ray bursts detected by the *INTEGRAL* satellite. In the period between December 2002 and February 2012 *INTEGRAL* observed 83 GRBs. The spectral parameters were derived by combining the data from the two main instruments on board *INTEGRAL*, the spectrometer SPI (Spectrometer on *INTEGRAL*) nominally covering the energy range 18 keV - 8 MeV, and the imager IBIS (the Imager on Board the *INTEGRAL* Satellite) with spectral sensitivity in the range 15 keV - 10 MeV. In addition to the spectral analysis performed over a broad energy range for the complete sample of *INTEGRAL* GRBs, we have derived the IBIS light curves and durations for the previously unpublished 28 events observed between September 2008 and February 2012. We compare the prompt emission properties of the *INTEGRAL* GRB sample with the BATSE and *Fermi* samples.

Keywords: gamma-rays burst: general - catalogs - methods: data analysis

1 Introduction

To date the most complete catalogues of spectral GRB properties comprise the events observed by BATSE (Burst And Transient Source Experiment) on board the *Compton Gamma Ray Observatory* in operation from 1991 to 2000 (Gehrels et al. 1994), by the *Swift* satellite launched in 2004 (Gehrels et al. 2004), and by the *Fermi* satellite launched in 2008 (Gehrels & Razzaque 2013). The spectral parameters - peak energy, low- and high-energy power law indices - are associated with the parameters of the energy dissipation and the emission mechanisms of the prompt emission and provide the constraints for the gamma-ray burst models.

INTEGRAL (Winkler et al. 2003) is an ESA mission launched on October 17, 2002 dedicated to high resolution imaging and spectroscopy in the hard X-/soft γ-ray domain. It carries two main coded-mask instruments, SPI (Vedrenne et al. 2003), and IBIS (Ubertini et al. 2003). SPI is made of 19 Ge detectors, working in the 20 keV–8 MeV energy range, and is optimized for high resolution spectroscopy. IBIS is made of two pixellated detection planes: the upper plane, ISGRI – *INTEGRAL* Soft Gamma-Ray Imager (Lebrun et al. 2003), is made of 128×128 CdTe detectors and operates in the 15 keV–1 MeV energy range. The lower detection plane, PICsIT – PIxellated CsI Telescope (Di Cocco et al. 2003), is made of 64×64 pixels of CsI, and is sensitive between 150 keV and 10 MeV. In order to provide a broad energy coverage and a good sensitivity for the *INTEGRAL* GRB spectra, we combined the data from the IBIS/ISGRI and the SPI instruments for the spectral analysis. The SPI data can provide better spectral information at energies where IBIS/ISGRI effective area becomes low, and therefore are suitable to determine the GRB spectral peak energy (typically at $\sim$ a few 100 keV).

2 Spectral and temporal analysis

The spectra were analysed using the C-statistic (Cash 1979); for the C-statistic to be applied, we needed to provide on-burst spectra and background spectra separately for every GRB. This cannot be obtained by the *INTEGRAL* standard Off-line Scientifc Analysis software (OSA), and therefore we developed additional tools

[1] AIM (UMR 7158 CEA/DSM-CNRS-Université Paris Diderot) Irfu/Service d'Astrophysique, Saclay, F-91191 Gif-sur-Yvette Cedex, France
[2] Department of Physics, University of Rijeka, 51000 Rijeka, Croatia
[3] Université de Toulouse, UPS-OMP, IRAP, Toulouse, France
[4] CNRS, IRAP, 9 Av. Colonel Roche, BP 44346, F-31028 Toulouse Cedex 4, France

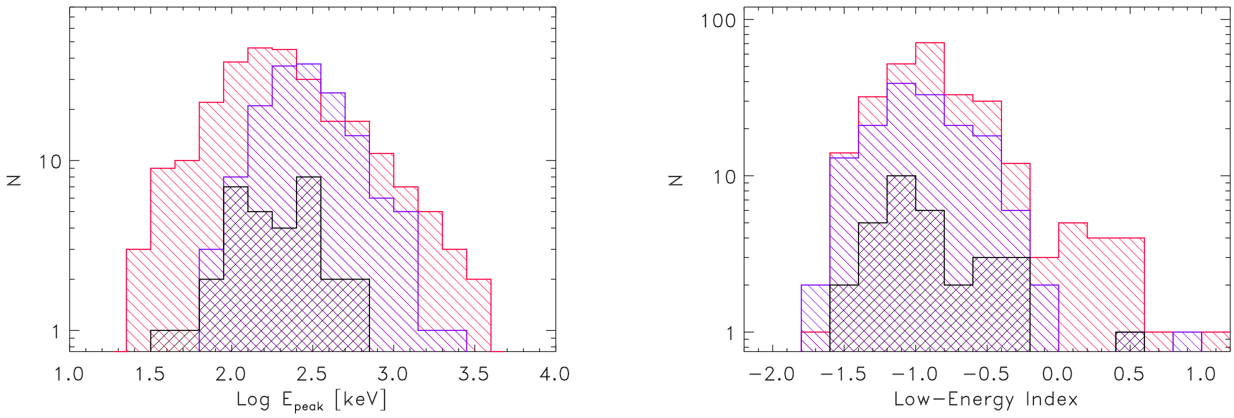

Fig. 1. Left: distribution of the spectral peak energies. **Right:** distribution of the low energy spectral power law indices. The sample of *INTEGRAL* GRBs is shown in black; BATSE results (violet) and *Fermi*/GBM results (red) of the time-integrated spectral analysis were used for the comparison. Only long events were selected, fitted with the Band or cut-off power law model, and having the fluence in the same range as *INTEGRAL* GRBs.

to extract the spectra in the required format. For the SPI instrument, a spectrum for each of the 19 (where applicable) Ge detectors was computed. The net individual GRB spectra (i.e. on-burst – off-burst spectra) have the advantage (with respect to the global spectra produced by OSA software) of being more accurate since the background spectra were computed for each GRB and each detector, taking into account the local spectral and temporal background evolution. The response function takes into account the exposed fraction of each detector given the GRB direction. For the IBIS/ISGRI spectra, we selected only the pixels that were fully illuminated by the GRB in order to compute the off-burst and on-burst spectra. A corresponding ARF was computed, taking into account the reduced ($\sim 30\%$) area of the detector plane we used. For each GRB we computed and fitted the time-integrated spectrum, using all the available SPI spectra and one ISGRI spectrum.

We report the results of the spectral anlysis for 59 out of 83 GRBs, and make a comparison of our results with the BATSE and *Fermi*/GBM samples (see Fig. 1) of gamma-ray bursts of equivalent brightness and duration. We found that *INTEGRAL* sample of GRBs has spectral peak energies consistent with the distribution obtained by *Fermi*/GBM (KS probability = 0.55), and not consistent with the distribution of BATSE GRBs (KS probability $= 6 \times 10^{-3}$) in a given fluence range. The distribution of the low energy power law slopes obtained for ISGRI/SPI GRBs is consistent with both, *Fermi*/GBM (KS probability = 0.23) and BATSE (KS probability = 0.92) GRB samples.

We determined the T_{90} duration for sample of GRBs observed after September 2008 (for the GRBs observed before September 2008, see Vianello et al. 2009). The GRB durations were determined using only the IBIS/ISGRI light curves obtained for 20–200 keV energy band (see Fig. 2). The maximum of the T_{90} distribution for *INTEGRAL* GRB sample is at ~ 30 s, which is comparable to the samples obtained by BATSE and *Fermi*/GBM. The distribution of long GRB durations from *Swift*/BAT sample is shifted towards longer times, coherently with the longer BAT triggering time scales (see Sakamoto et al. 2011). The paucity of the short events in *INTEGRAL* sample (6%) is expected for the imaging instruments, as e.g. the *Swift*/BAT, where a minimum number of counts is required to localize an excess in the derived image, making confirmation of real bursts with fewer counts difficult.

3 Conclusions

The GRB catalog we presented contains a limited number of events with respect to other missions' databases. Our results offer however an important insight in the possible instrumental biases in spectral and temporal parameters distributions, and also provide the spectral parameters for a sample of faint GRBs with good statistics.

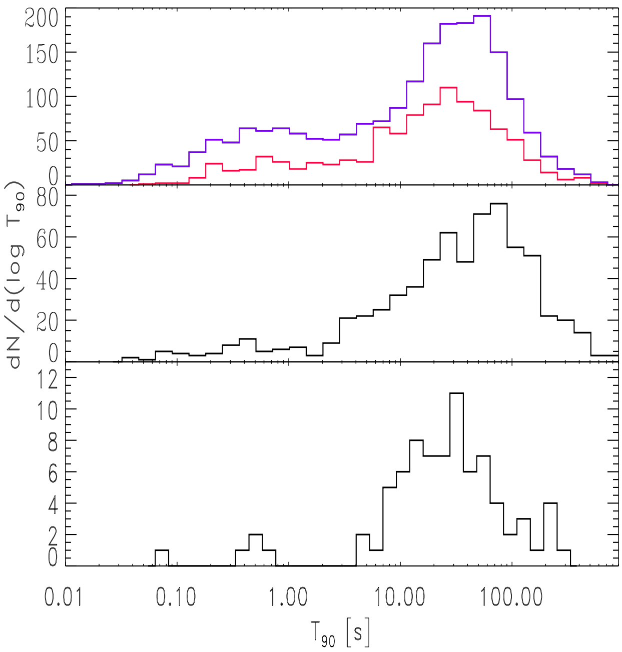

Fig. 2. Distribution of the duration T_{90}. **Top:** Distribution of durations derived from BATSE (violet) and *Fermi*/GBM (red) light curves in the 50-300 keV band (c.f. Kouveliotou et al. 1993). **Middle:** The T_{90} durations derived using *Swift*/BAT instrument on 15-150 keV (c.f. Sakamoto et al. 2011). **Bottom:** Distribution of durations for 20-200 keV light curves obtained from IBIS/ISGRI.

The authors thank Thomas Maccarone, Patrick Sizun and Fabio Mattana for discussions on data analysis. ZB acknowledges the French Space Agency (CNES) for financial support. ISGRI has been realized and maintained in flight by CEA-Saclay/Irfu with the support of CNES. Based on observations with INTEGRAL, an ESA project with instruments and science data centre funded by ESA member states (especially the PI countries: Denmark, France, Germany, Italy, Switzerland, Spain), Czech Republic and Poland, and with the participation of Russia and the USA.

References

Cash, W. 1979, ApJ, 228, 939

Di Cocco, G., Caroli, E., Celesti, E., et al. 2003, A&A, 411, L189

Gehrels, N., Chincarini, G., Giommi, P., et al. 2004, ApJ, 611, 1005

Gehrels, N., Chipman, E., & Kniffen, D. 1994, ApJS, 92, 351

Gehrels, N. & Razzaque, S. 2013, Frontiers of Physics

Kouveliotou, C., Meegan, C. A., Fishman, G. J., et al. 1993, ApJ, 413, L101

Lebrun, F., Leray, J. P., Lavocat, P., et al. 2003, A&A, 411, L141

Sakamoto, T., Barthelmy, S. D., Baumgartner, W. H., et al. 2011, ApJS, 195, 2

Ubertini, P., Lebrun, F., Di Cocco, G., et al. 2003, A&A, 411, L131

Vedrenne, G., Roques, J.-P., Schönfelder, V., et al. 2003, A&A, 411, L63

Vianello, G., Götz, D., & Mereghetti, S. 2009, A&A, 495, 1005

Winkler, C., Courvoisier, T. J.-L., Di Cocco, G., et al. 2003, A&A, 411, L1