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# Gamma-ray bursts studies with XMM-Newton and INTEGRAL

S. Mereghetti, D. Götz and A. Tiengo

IASF, Sezione di Milano "G.Occhialini", CNR, via Bassini 33, 20133 Milano, e-mail: sandro@mi.iasf.cnr.it

**Abstract.** The current availability of two major ESA satellites for high-energy astrophysics, *XMM-Newton* and INTEGRAL, offers great opportunities for the study of Gamma Ray Bursts. The INTEGRAL Burst Alert System (IBAS) is providing the fastest and most accurate GRB localizations to date and *XMM-Newton* can start follow-up observations within a few hours. This allows the study of the prompt emission and of the afterglow with unprecedented sensitivity.

**Key words.** Gamma Ray Bursts

The IBIS instrument on board INTEGRAL has a large field of view (29°×29°) and can locate sources at the arcminute level (Ubertini et al. 2003). Its lower energy range detector (ISGRI, 15 keV - 1 MeV), working in photon mode, is an ideal detector for GRBs. Since the data are continuously transmitted to ground without important delays, the search for GRBs is automatically performed at the INTEGRAL Science Data Centre. This is done by a dedicated software, the INTEGRAL Burst Alert System (IBAS, (Mereghetti et al. 2003a)), which analyses the incoming data in real time and transmits via Internet the coordinates of the GRBs it locates. IBAS has been running since the launch of INTEGRAL in October 2002. Its performances have been improved in the following months, by fine tuning of the trigger parameters as more experience was gained with the data, and by adding new detection algorithms. Thanks to IBAS, INTEGRAL is the satellite which is currently providing the most rapid and accurate GRB localizations. The coordinates of the last three detected bursts (GRB 030501, GRB 031203 and GRB 040106) were distributed respectively 30, 18 and 12 seconds after the start of the burst and had error radii as small as 4.4, 2.7, and 3.2 arc minutes.

The *XMM-Newton* and INTEGRAL satellites are based on the same spacecraft and have therefore very similar viewing constraints, thus most of the GRB detected by INTEGRAL are in regions of the sky also visible by *XMM-Newton*. From Fig. 1, which summarizes all the observations of GRB afterglows performed with *XMM-Newton*, one can appreciate the advantage of the rapid response time obtained for the INTEGRAL bursts.

The first GRB observed by both satellites was GRB 030227. The *XMM-Newton* TOO observation started 8 hours after the burst, leading to the discovery of the afterglow with a

*Send offprint requests to*: S. Mereghetti
*Correspondence to*: IASF, v.Bassini 15, I-20133 Milano

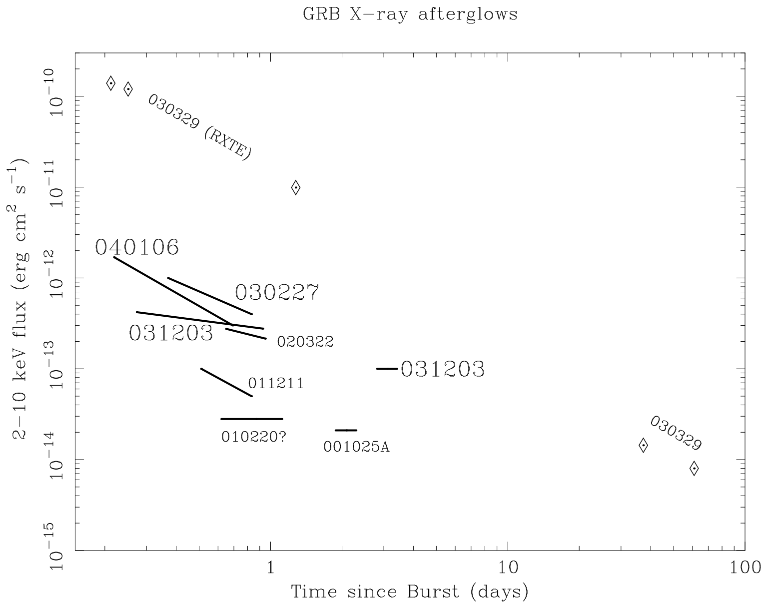


**Fig. 1.** X-ray light curves of GRB afterglows observed with *XMM-Newton*. The three bursts labeled with larger font size have been discovered with INTEGRAL and rapidly located by IBAS. All the data are from EPIC except the first 3 points of GRB 030329 which are from RXTE. The identification of the afterglow of GRB 010220 is uncertain.

0.2-10 keV flux decreasing from $1.3\times10^{-12}$ to $5\times10^{-13}$ erg cm$^{-2}$ s$^{-1}$. Significant absorption in addition to the Galactic value was required to fit the X–ray data (Mereghetti et al. 2003b). The exact value of this intrinsic absorption depends on the (unknown) redshift, but is in any case of the order of a few times $10^{22}$ cm$^{-2}$. This supports the scenarios involving the occurrence of GRBs in regions of star formation. Evidence for emission lines from light elements was found in the last part of the observation, implying a redshift z=1.39 (Watson et al. 2003), while a possible emission line at 1.67 keV, which if attributed to iron would instead require z$\sim$3, was seen in the spectrum of the whole observation (Mereghetti et al. 2003b). However, the statistical significance of these lines is not very high and their real presence is currently matter of debate.

Another obvious advantage of the *XMM-Newton* EPIC instrument is the high sensitivity. In the case of the exceptionally bright GRB 030329, it has been possible to study the afterglow at very late times after the explosion (Tiengo et al. 2003).

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