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The X-ray afterglow of GRB 980519

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Abstract. Over a total of 20 gamma-ray bursts localized with arcmin accuracies, GRB 980519 represents the 13th detected by the *Beppo*SAX Wide Field Cameras (WFCs). An X-ray TOO observation performed by the *Beppo*SAX Narrow Field Instruments (NFIs), starting about 9.5 hours after the high energy event, revealed X-ray afterglow emission in the $0.1-10$ keV energy range. The flux decay was particularly fast with a power-law index of $\simeq 1.8$. This is the fastest decay so far measured. Signs of bursting activity are evident. The power-law spectral index of $2.8^{+0.6}_{-0.5}$ is quite soft but not unique among GRB afterglows.

$VR_{c}I_{c}$ optical emission was detected as soon as 8 hours after the GRB and the power-law flux decay in all these bands were all consistent with $\delta \simeq 2.0$. As for the X-ray, this is the fastest of all the 9 optically identified afterglows but GRB 980326. A candidate host galaxy with magnitude $R_{c} = 26$ has been reported and variable radio emission detected.

Key words: gamma-rays: bursts — gamma-rays: observation — X-rays: bursts

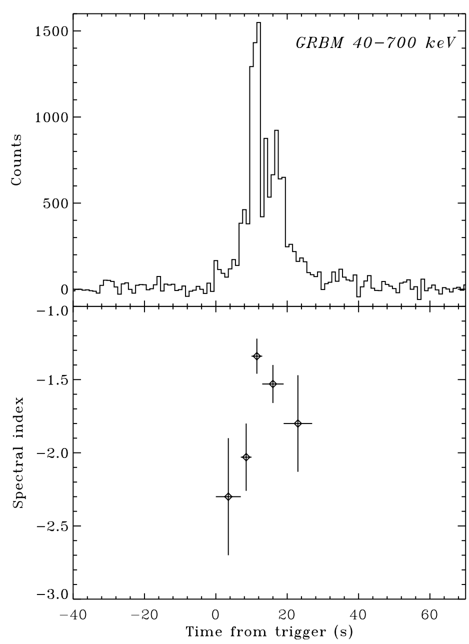

Fig. 1. The 1 s GRBM light curve of GRB 980519 and its power-law photon spectral index evolution

1. Introduction

GRB 980519 was detected on 1998 May 19, 12:20:13 UT by CGRO–BATSE and *Beppo*SAX–GRBM. It was in the field of view of the *Beppo*SAX–WFC 2, allowing an estimate of its position with a 3 arcmin error circle at R.A. $= 23^{h}22^{m}15^{s}$ Dec. $= +77°15'.0$ (J2000). The GRBM light curve (lasting $\simeq$ 30 s) together with the spectral evolution in the $40-700$ keV range is shown in Fig. 1. The soft–hard–soft evolution is evident in the plot. In the $2-27$ keV WFC band a similar behaviour is observed but the light curve is much more structured than the high energy one and it lasts for $\simeq$ 180 s; the emission starts $\simeq$ 50 s before the GRB trigger and stops $\simeq$ 130 s later (in 't Zand et al. 1998).

The average spectrum of the GRBM data can be well fitted with a single power-law with a photon spectral index ($N_{E} \propto E^{-\alpha}$) $\alpha = 1.62 \pm 0.10$ with $\chi^{2} \simeq 1$. The $40-700$ keV fluence (over 27 s) is $F_{\gamma} = (8.1 \pm 0.5)$

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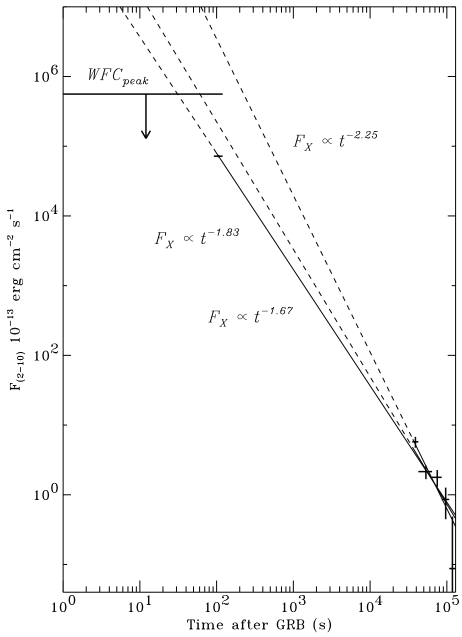

Fig. 2. 2 − 10 keV X-ray flux decay as seen by the *Beppo*SAX MECS. The upper limit to the flux during the burst and the last WFC measured values are shown. Three possible fitted power-law decays are reported

10^{-6} erg cm^{-2} and the hardness ratio $f_{100-300/50-100} = 2.2 \pm 0.2$. Description of the method adopted for GRBM spectra deconvolution is reported by Amati et al. (this workshop).

2. BeppoSAX NFIs observation and discussion

A follow-up observation performed with the *Beppo*SAX NFIs started less than 10 hrs after the trigger and a weak, rapidly decaying X-ray source was detected (Nicastro et al. 1998a). The decay was not monotonic, but the low counting rate did not allow us to reconstruct a detailed light curve.

Figure 2 shows the 2 − 10 keV (MECS) flux decay and three possible power-law decay fits $F_x \propto t^{-\delta}$. It can be seen that constraining the fit to connect with the last part of the WFC detected flux, gives a *minimum* decay slope $\delta = 1.67 \pm 0.03$. On the other hand, if the first point of the NFIs observation is *not* a peak superimposed to the monotonic decay, then we have $\delta = 2.25 \pm 0.22$. This can be considered a *maximum* decay slope. It is realistic to suppose that the *real* slope is close to $\delta = 1.83 \pm 0.30$ obtained excluding the first NFIs point from the fit. In any case, this is the most rapid decay for all the 13 GRB afterglows detected so far, typical values ranging between $1.1 \div 1.4$.

Spectral fitting of the 0.1 − 10 keV LECS+MECS data using an absorbed power-law gave a quite soft photon index of $2.8^{+0.6}_{-0.5}$ and $N_{\rm H}$ in the range $0.3 - 2\ 10^{22}$ cm^{-2} (see Fig. 3). The 0.1 − 2 keV flux is $(7.9 \pm 2.5)\ 10^{-14}$ erg cm^{-2} s^{-1} while the 2 − 10 keV flux is $(1.4 \pm 0.3)\ 10^{-13}$ erg cm^{-2} s^{-1}. Further details are given in Nicastro et al. (1998b).

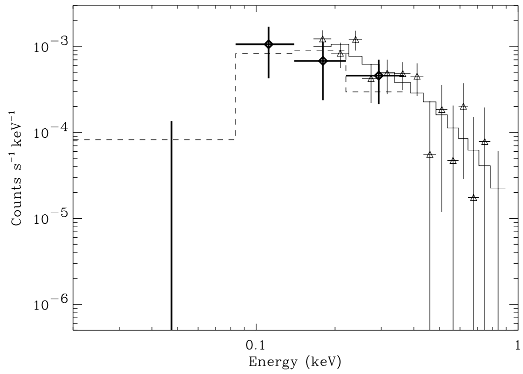

Fig. 3. LECS+MECS 0.1 − 10 keV spectrum of the GRB afterglow. It is $\alpha = 2.8^{+0.6}_{-0.5}$ and $N_{\rm H} \approx 0.3 - 2\ 10^{22}$ cm^{-2}

Optical observations, started as early as 8 hours after the GRB, resulted in the detection of the afterglow (OT) in $VR_{\rm c}I_{\rm c}$ bands. The power-law decays in all these bands were all consistent with $\delta \simeq 2.0$. Deep observations performed $\simeq$ 66 days after the burst with the 6-m telescope of the SAO–RAS revealed that at the position of the OT there is a faint object, possibly a galaxy, of magnitude $R_{\rm c} \simeq 26$ (Sokolov et al. 1998b). It is worth to note that for all 9 optically identified GRBs, there are indications of the presence of an underlying host galaxy (Hogg & Fruchter 1998; Sokolov et al. 1998a).

The afterglow was also detected in the radio band by the VLA (Frail et al. 1998) at R.A. = $23^{\rm h}22^{\rm m}21\overset{\rm s}{.}49$, Dec. = $+77°15'43\overset{''}{.}2$ (J2000, $\pm 0\overset{\rm s}{.}1$).

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