Properties of Gamma Ray Bursts at different redshifts

Graziella Pizzichini(1), Elisabetta Maiorano(1) and Filip Münz(2)
(1)INAF/IASF Bologna
(2)Dept. of Condensed Matter Physics, Masaryk University Brno

Abstract: GRBs are now detected up to z=8.26 (6,7). We try to find differences in their restframe properties which could be related either to distance or to observing conditions.

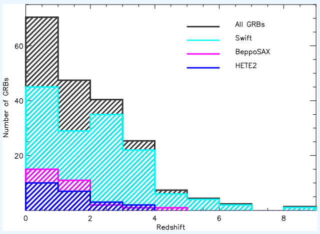
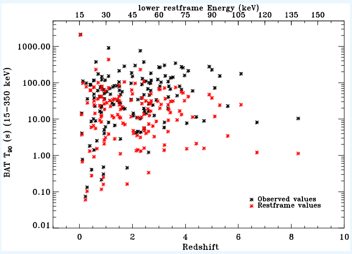


Fig.1: Histogram of all the redshifts measured for GRBs until July 15, 2009.

We try to put in evidence changes in the properties of GRBs at different redshifts which could be related to source evolution. We consider all the 149 events detected by Swift between January 26 2005 and July 15 2009 for which the redshift has been at least tentatively measured. We use the table given at *http://heasarc.gsfc.nasa.gov/docs/swift/archive/grb_table.html*
The redshift in those events goes from 0.0331 to 8.26. From that table we take also the BAT fluence (15-150 keV) and the BAT T_{90} (15-350 keV). For the above quantities we consider both the values in the observer's frame and the ones converted in the restframe. Note that the lowest value of the redshift until now is that of GRB980425 detected by *Beppo*SAX. As shown in figure 3, we also tried to compensate for the fact that the values, taken at the same energy range in the observer's frame, originate from different energy ranges in the event's rest frame. By using the Fenimore et al. (2) correlation between peak duration and energy, we take into account that, for long bursts, the duration normally decreases with energy .



a) Swift: 15-350 keV

b) SAX: E>20 keV

c) HETE2: 6-80 keV

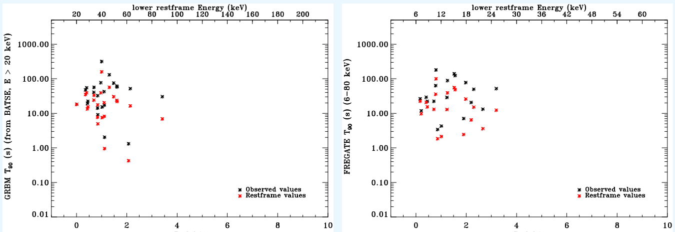
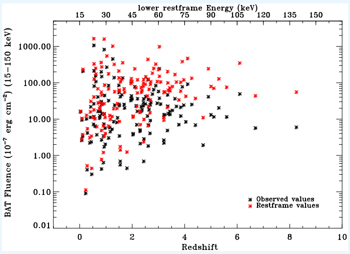


Fig.2 (a,b,c): Scatter plots of the T_{90} versus burst redshift. The T_{90} restframe values are, in first approximation, the observed ones divided by (1+z), but, we must remember that the energy ranges are also multiplied by the same value in the restframe. For comparison we show also the scatter plots of similar quantities from SAX (3) and HETE2 (5) (lower plots, left and right panels respectively). The top scale shows the lower value of the instrument energy range at that redshift.

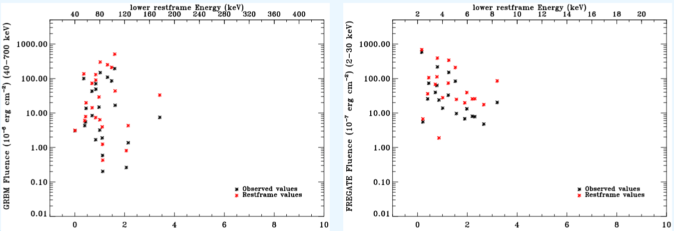
Fig.3 (a,b,c): Scatter plots of the fluence versus burst redshift. The restframe fluence values are, in first approximation, the observed ones simply multiplied by (1+z), but, as in figure 2, we must remember that the energy ranges are also multiplied by the same value in the restframe. For comparison we show also the scatter plots of similar quantities from SAX (3) and HETE2 (5) (lower plots, left and right panels respectively). The top scale shows the lower value of the instrument energy range at that redshift.



a) Swift: 15-150 keV

b) SAX: 40-700 keV

c) HETE2: 2-30 keV



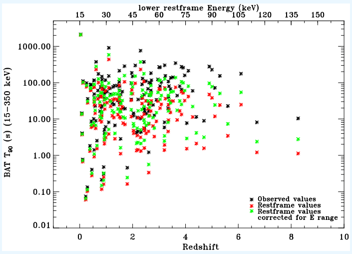


Fig.3: In order to reduce T_{90} in the restframe to the same energy range for all bursts we consider a dependence of the burst duration on the energy similar to the one given, for peaks, by Fenimore et al. (2). The figure shows the scatter plot of what would be the T_{90} distribution versus redshift in that case.

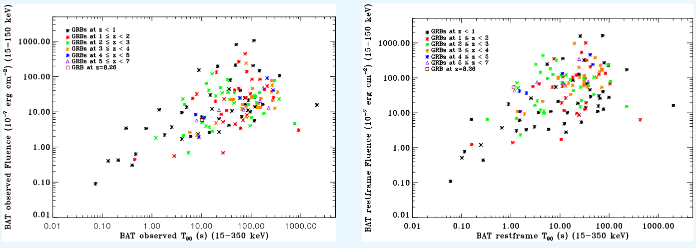


Fig.4: Scatter plot of the BAT fluence (15-150 keV) in 10^{-7} erg cm^{-2} versus BAT T_{90} (15-350 keV), color coded for six redshift intervals. Note that GRB090423 at z=8.26 (the purple empty square in both panels), falls in the middle of the distribution. Left: observed values. Right: restframe values. In the latter the correlation appears to be stronger.

Correlation coefficients:

If we use the same redshift groups as in Figure 4, we obtain the correlation coefficients for the restframe values of log Fluence and log T_{90} reported in the table. The correlation values become lower for the first groups, because points in the lower left hand corner carry higher fluence errors.

Redshift groups	0 - 1	1 - 2	2 - 3	3 - 4	4 - 5	5 - 7
Coeff.neglecting both errors	0.675 ± 0.081	0.568 ± 0.128	0.299 ± 0.156	0.657 ± 0.124	0.924 ± 0.060	0.814 ± 0.151
Coeff.including fluence errors	0.418 ± 0.123	0.271 ± 0.175	0.203 ± 0.164	0.255 ± 0.204	0.959 ± 0.033	0.807 ± 0.156

Conclusion: We considered 149 GRBs at different redshifts, all of them detected by the same experiment, Swift-BAT (1, 4), hoping to find proof of evolution with z. As it can be seen from the plots, except for the well known two groups of "short" and "long" GRBs, which appear to be a little more blurred in the restframe, no such proof is evident. The values for the events at the largest redshifts correspond in both cases to the regions of maximum number of GRBs at small z: this is likely due to the fact that the probability of having an event with those values is higher, even at large z. We conclude that no redshift selection or evolution can be inferred from our plots. In all of them, even GRB090423, the one detected at the largest z until now, lies just in the middle of the distribution. Not surprisingly, it is evident from the restframe plots (fig.4) that fluence increases with T_{90} practically for all redshifts. Bursts at large redshifts have higher fluences, but we must remember that they originate from higher energy ranges.

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GCN Circulars archive http://gcn.gsfc.nasa.gov/gcn3_archive.html
SIMBAD Astronomical Database http://simbad.u-strasb.fr/simbad/