ANALYSIS OF THE LOG N-LOG P OF THE BATSE GAMMA-RAY BURSTS

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Abstract. The distribution of the sources of the Gamma-Ray Bursts (GRBs) recorded by the CGRO experiment is uniform for all directions in the sky, while the behaviour of the log N-log P suggests a space distribution of the events not homogeneous. The cosmological model can explain this result, but it cannot explain the presence of cyclotron lines in the burst energy spectra that has been observed by many experiments: the soviet KONUS experiment onboard VENERA probes, the Japanese GRBM experiment onboard GINGA satellite and, for only one candidate burst fortuitously observed, by the USA experiment A4 onboard HEAO1 satellite. In order to shed more light on this problem we present a new study of the log N-log P of the Gamma-Ray Bursts of the second BATSE catalogue.

Key words: Gamma-Ray Bursts-Type-Space Distribution

1. Introduction

The idea that events of different origin could occur in normal GRBs is not new. Many authors have suggested it (Lingenfelter and Higdon, 1992, Rees and Meszaros, 1992) and others found signs of bimodal behaviours, studying temporal and spectral characteristics of the bursts (Dezalay et al., 1991, Lamb et al., 1993, Kouveliotou et al., 1993) In this paper we report a new approach to this problem, consisting in analysing the events of the BATSE 2B catalogue (Fishman et al., in prep), mainly on the basis of two characteristic parameters, duration and hardness-ratio. Simply by representing the BATSE events on the plane duration hardness-ratio it has been possible to put in evidence two distinct groups of events completely separate. The properties of these two groups appear to be different enough to suggest the hypothesis of different origin (Belli, in prep.). Here we study the log N-log P's of the two groups.

2. Data Analysis

For this analysis we selected the parameters: 1) time duration T90 (Kouveliotou et al., 1993): the time during which the integral counting rate goes from to 5% to 95% of the total; 2) hardness-ratio HR: ratio of the fluences recorded in the two energy channels, 100-300 keV and 50-100 keV, which represent the intrinsic characteristic of the events and are essentially independent of their unknown distance. In the presence of cosmological redshift the duration and the hardness ratio depend on the distance of the events.

Fig.1 shows the BATSE events distribution in the plane T90-HR. This representation puts in evidence two well defined groups. We named the group...
on the right class I, constituted by Type I bursts, and the group on the left class II, constituted by Type II bursts. We draw in the plane log (T90)-log (HR) the straight line HR=0.5(T90)^{1/2}. For each HR, this line gives a maximum limit to the event duration for the class II and a minimum limit for the class I. The class I contains 300 events, while the class II contains 110 events.

We note that the hardness-ratio of the events of Type II is on average higher than the average hardness-ratio of the events of Type I and that even if they are on average shorter than the other ones are not characterized by short duration and can reach in some cases as long a duration as the events of Type I, and vice versa. An analysis of the intensity for the events of the two classes shows that they have about the same range of intensity variability, for the class I a little higher. We indicate with N the number of events which have the maximum peak photon rate in the light curve greater or equal than a P value. Figure 2 (a) shows log N-log P's for the two classes; the intensity P is given by the peak photon rate cm^{-2} s^{-1} of the event temporal history binned in time interval of 0.064 s and relative to the energy range 50-300 keV. The curve 1) relative to class II does not follow the power law with exponent -3/2, law of homogeneity and isotropy; analogously the averaged value of the ratio of peak counting rate and the respective threshold counting rate to -3/2 (<Vx/Vm>) is 0.34±0.03. The curve 2), relative to class I, in the last part presents a curvature more marked than the curve a). The part of the two log N-log P’s relative to the peak photon rate lower than 1.2 is affected by strong threshold errors and is not meaningful.