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Gamma Ray Burst Data Analysis: Algorithms and Procedures

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Abstract. In Gamma Ray Burst experiments it is very important to obtain realistic and accurate estimates of the Burst parameters, viz. the event trigger time, the duration, peak hardness ratio, peak fluxes and fluences in different energy bands. Several algorithms and procedures have been developed independently from first principles. One of these is described.

Keywords : GRBs–algorithms.

1. Introduction

In the present paper we describe an algorithm to determine the duration of a GRB and its error. The T_{90} (Kouveliotou et al 1993) duration of a GRB is defined as the time interval during which the integrated burst counts rise from 5% to 95% of the total.

2. The T_{90} Algorithm

First an accurate estimate of the detector background (that changes with time) is obtained in the given energy interval. The time bin (p) in which the burst peaks and the signal to noise ratio in this bin are determined. Following this, successive time bins are added, one at a time, that have occurred earlier and each time the integrated signal to noise ratio is calculated. This procedure is continued till the earliest time bin for which the integrated S/N ratio continues to increase and starts decreasing beyond it. Let this be the Lth bin. The same procedure is carried out for time bins that occurred later. Let the right limit be denoted by the Rth bin. The total burst counts is calculated as

$$S = \Sigma_{i=L,R}(C_i - B_i) \tag{1}$$

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$l_1 = 0.05S$ and $l_2 = 0.95S$ are the lower and upper limits to be used for the T_{90} calculation. Starting from the Lth bin the background subtracted burst counts are added to determine the time s at which it just becomes equal to l_1. If this happens to be in the middle of a bin, linear interpolation is used to determine the fraction (f_s) of an integration time (τ) that is to be included. Similarly, starting from the Rth bin, the background subtracted burst counts are added to determine the time e at which it just reaches l_1 (from the right). Again, linear interpolation is used to determine the fraction (f_e) of an integration time that is to be included. The value of T_{90} is given by the following expression

$$T_{90} = (e + 1 - s + f_s + f_e)\tau \ . \tag{2}$$

The error on the T_{90} value is

$$\text{Error } T_{90} = (\delta s^2 + \delta e^2 + \delta f_s^2 + \delta f_e^2)^{0.5}\tau \tag{3}$$

where δs, δe, δf_s and δf_e are respectively the uncertainties in s, e, f_s and f_e. The entire procedure is repeated by rebinning the time history and new values of T_{90} and its error are calculated. Finally, a consistent value of T_{90} is reached.

3. Discussion and Conclusion

It is to noted that the duration algorithm applied as such to an event gives the duration of only the strongest episode and not of the entire transient, if there are episodes of emission separated by time intervals where the signal is either absent or insignificant (this is also true for the BATSE T_{90} algorithm, cf. Koshut et al 1996). The main difference between the BATSE T_{90} algorithm and the present algorithm is that the present one is more useful for small detectors for which the S/N ratio of detection is low. The given expression may be used to estimate only the statistical error. This algorithm may be used to estimate the duration of any high energy transient event in which the data are available as photon counts as a function of time.

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References

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