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Constraining the number of classes of gamma-ray burst: multidimensional modelling with skewed distributions

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Two classes of gamma-ray bursts (GRBs), short and long, have been confidently identified thus far and are prescribed to different physical scenarios. A third class, intermediate in duration, was suggested to be present in various catalogues based on a mixture-modelling with two or three Gaussian distributions of the log-durations, log(T90). This might not be an adequate model. An analysis of log(T90) from CGRO/BATSE, Swift/BAT, and Fermi/GBM revealed that mixtures of skewed distributions with only two components are a better description than a three-component Gaussian mixture. The same results were obtained by analysing a duration-hardness ratio plane, log(T90)-log(H32), for BATSE and Fermi GRBs. Similar results were obtained for Swift, Konus-Wind, RHESSI, and Suzaku/WAM. This implies that the presumed intermediate class of GRBs is unnecessary to explain the observations. A comprehensive, multivariate analysis, performed on various sets of BATSE parameters, including several three-dimensional spaces, and reaching up to a four-dimensional space of T90-H32-Ftot-P256, gave inconclusive results of 2-4 components, depending on the parameter set. A similar investigation of the Fermi data in the 3D and 5D spaces of T90-Ftot-P256 and T90-Ftot-Epeak-alpha-beta (with the Band parameters) lead to 3 and 2 components, respectively. This outcome is in a sense undesired, since for the same set of GRBs one would expect to get consistent results. A Monte Carlo testing suggests that additional components might be artifacts owing to the finiteness of the data and be a result of examining a particular realisation of the data as a random sample, resulting in spurious identifications. All in all, the presumed third class of GRBs appears to be non-existent.

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