

# 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,  $\log(T_{90})$ . This might not be an adequate model. An analysis of  $\log(T_{90})$  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,  $\log(T_{90})$ - $\log(H_{32})$ , 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  $T_{90}$ - $H_{32}$ - $F_{\text{tot}}$ - $P_{256}$ , 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  $T_{90}$ - $F_{\text{tot}}$ - $P_{256}$  and  $T_{90}$ - $F_{\text{tot}}$ - $E_{\text{peak}}$ - $\alpha$ - $\beta$  (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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