

Integrating Multi-Instrument Data to Improve Gamma Ray Burst Classification and Progenitor Constraints

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Abstract

Gamma-ray bursts (GRBs) are some of the most energetic transients in the Universe and are conventionally classified into short and long populations based primarily on their observed prompt emission duration (T_{90}). However, duration-based classification alone is often ambiguous due to instrumental effects, energy-band dependence, and the presence of complex temporal and spectral features. In this work, we investigate the limitations of traditional GRB classification schemes and explore a more physically motivated framework by integrating multi-instrument observations from two key missions: *Swift* and *Fermi*. We compare prompt emission properties, such as T_{90} , spectral hardness, fluence, and variability timescales, across these instruments and identify a population of GRBs whose classifications are inconsistent or ambiguous. **We examine correlations among the various parameters and conduct a systematic analysis of the ambiguous burst population, highlighting the uncertainties in their classification. In the future, combining spectral diagnostics along with comprehensive multi-wavelength afterglow modelling of the ambiguous population would provide a more physically motivated GRB classification framework.**