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Constraints on Cosmological Parameters Using a Large Sample of Gamma-Ray Bursts with their redshift derived by Machine Learning

Various empirical correlations between observable and derived parameters have been proposed to use Gamma-Ray Bursts (GRBs) as standard candles similar to Type Ia supernovae (SNe Ia) for measuring cosmological distances. The Yonetoku relation, which connects the intrinsic peak energy to the isotropic peak luminosity, stands out as a promising tool. In this work, we present results from machine learning models applied to GRBs, from the Fermi-GBM and Kouns-Wind catalogs, to estimate their redshifts. These models, based on peak-flux intervals and parameter fittings from both datasets, allow us to explore the Yonetoku correlation using GRBs with pseudo-redshifts. We focus on estimating the distance modulus and constraining cosmological parameters using this relation. Our analysis includes 1576 GRBs with pseudo-redshifts (publicly available via Zenodo) and 116 GRBs with spectroscopic confirmed redshifts from the Fermi-GBM catalog. Additionally, we incorporate recent SNe Ia samples from SNe U2.1 and the Dark Energy Survey (DES-SNe). Unlike previous studies, we perform a simultaneous calibration of the Yonetoku relation and cosmological parameters using a Markov Chain Monte Carlo (MCMC) method, applied across both the full redshift range and within specific redshift bins, assuming a flat universe within the Lambda Cold Dark Matter (ΛCDM) model. This work aims to assess the potential of leveraging a large sample of GRBs with pseudo-redshifts from the Fermi-GBM and Kouns-Wind catalogs to provide meaningful constraints on cosmological models.

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