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Testing Beyond-LCDM Cosmologies with Machine Learning

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Forthcoming stage-IV cosmological surveys will perform measurements with unprecedented accuracies up to non-linear scales. At this level of accuracy, limitations of our theoretical prescriptions lead to biased predictions for cosmological models. We have developed a novel machine learning approach to detect beyond-standard-model physics in the data using a Bayesian Neural Network and investigate the treatment of theoretical errors that allow the trained network to generalise to different power spectrum prescriptions. Our modelling includes baryonic effects and massive neutrinos to increase the accuracy on non-linear scales and enhance our ability to detect deviations from LCDM.

Based on the halo model reaction framework, we create non-linear dark matter power spectra for a variety of modified gravity and dark energy theories. We use these matter power spectra to train the Bayesian Cosmological Network (BaCoN) that can classify spectra into one of 5 classes: LCDM, f(R), wCDM, Dvali-Gabadaze-Porrati (DGP) gravity and a 'random' class.

Our fiducial classifier with the optimal theoretical error model achieves a total classification accuracy of ˜95%. This greatly bolsters the promise of this method to glean the maximal amount of unbiased gravitational and cosmological information from forthcoming Stage-IV galaxy surveys.

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