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A Reanalysis of BOSS Galaxy Clustering Data with a Simulation-Based Emulator of the Wavelet Scattering Transform

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Optimal extraction of the non-Gaussian information encoded in the Large-Scale Structure (LSS) of the universe lies at the forefront of modern precision cosmology. We propose achieving this task through the use of the Wavelet Scattering Transform (WST), which subjects an input field to a layer of non-linear transformations that are sensitive to non-Gaussianities through a generated set of WST coefficients. In order to assess its applicability in the context of LSS surveys, we perform the first WST application on actual galaxy observations, through a WST analysis of the BOSS DR12 CMASS dataset. We lay out the detailed procedure on how to capture all necessary layers of realism for an application on data obtained from a spectroscopic survey, including the effects of redshift-space anisotropy, non-trivial survey geometry, the shortcomings of the dataset through a set of systematic weights and the Alcock-Paczynski distortion effect. Using the suite of Abacus summit simulations, we construct an emulator for the cosmological dependence of the WST coefficients and perform a likelihood analysis of the CMASS data to obtain the marginalized errors on cosmological parameters. The WST is found to deliver a substantial improvement in the values of the predicted 1σ errors compared to the regular galaxy power spectrum. Lastly, we discuss recent progress towards applying these techniques in order to fully harness the constraining power of upcoming spectroscopic observations by Stage-IV surveys such as DESI and Euclid.

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