Enabling cross-correlations by recovering the missing modes: lensing reconstruction and position-dependent power spectrum from intensity maps

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Abstract

Cross-correlations with external datasets, e.g. the cosmic microwave background (CMB) lensing at high redshift, will be crucial in building confidence in upcoming intensity mapping detections. However, these cross-correlations are often hampered by the missing k_parallel=0 Fourier modes, lost to foreground cleaning. I will show two ways of recovering these lost modes, by leveraging the couplings between small-scale and large-scale Fourier modes.
The first method uses lensing reconstruction to enable cross-correlations with CMB lensing. It offers a promising way to measure the projected matter density in the universe, out to intermediate redshifts between galaxy surveys and the CMB, without requiring to model the uncertain relation between observed line intensity and underlying matter density. Using the cosmic infrared background (CIB) as an example, I will show how to adapt the CMB lensing quadratic estimator to the case of a non-Gaussian intensity map, and quantify the corresponding additional noise and bias (https://arxiv.org/abs/1802.05706, PRD). Reducing these biases naturally leads to splitting the quadratic estimator into a shear-like and magnification-like estimators, analogous to galaxy lensing. This results in an impressive foreground reduction, with an important application in CMB lensing (https://arxiv.org/abs/1804.06403, PRL, in review).
The second method uses the nonlinear mode coupling from gravity in the Lyman-alpha forest to recover the missing modes from continuum fitting. I will present a measurement of the position-dependent power spectrum, enabling the first significant detection of a correlation between the Lyman-alpha forest and CMB lensing (https://arxiv.org/abs/1607.03625, PRL). This measurement is a useful probe of the relation between neutral gas and the matter density.

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