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An Effective Field Theory of 21 cm Radiation with Redshift Space Distortions

Tuesday, 9 May 2023 18:00 (15 minutes)

With the prospect of detecting the cosmological 21 cm signal from the epoch of reionization just over the horizon, methods for extracting maximal cosmological information from this signal are increasingly timely. I will discuss recent work to further develop the effective field theory (EFT) for the 21 cm brightness temperature field during the epoch of reionization, incorporating renormalized bias and a treatment of redshift space distortions. To validate our theoretical treatment, we fit the predicted EFT Fourier-space shapes to the Thesan suite of hydrodynamical simulations of reionization at the field level, where the considerable number of modes prevents overfitting. We find agreement at the level of a few percent between the 21 cm power spectrum from the EFT fits and simulations over the wavenumber range $k < 0.8$ h/Mpc and neutral fraction $x_{\rm HI} > 0.4$ that is imminently measurable by the Hydrogen Epoch of Reionization Array (HERA). The ability of the EFT to describe the 21 cm signal extends to simulations that have different astrophysical prescriptions for reionization as well as simulations with interacting dark matter. We provide physical interpretations for the various bias parameters and test these interpretation against the different simulations, and find that simulations with the largest bubble sizes are perturbative over the smallest ranges of $x_{\rm HI}$.

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