

Boosting HI-galaxy cross-clustering signal through higher-order cross-correlations

Tuesday 15 October 2024 15:45 (15 minutes)

In the post-reionization universe ($z > 6$), large-scale structure (LSS) is traced by dense, self-shielded clumps of neutral hydrogen (HI) within galaxies. Line-Intensity-Mapping of 21cm is an effective method to probe LSS and constrain cosmology. However, auto-clustering studies of HI are hampered by survey systematics, making HI detection challenging. Cross-correlation analysis between HI and galaxies helps mitigate these systematics. Traditional two-point correlation functions (2PCFs) capture Gaussian information but miss non-Gaussian aspects, which are crucial due to the non-linear clustering of dark matter at small scales in a low redshift universe. Therefore, higher-order statistics are necessary to fully extract cosmological information from upcoming surveys.

Recently, k -nearest neighbor cumulative distribution functions (k NN-CDFs) have emerged as improved, easy-to-calculate higher-order statistics, sensitive to all N -point functions of the underlying field. The k NN-Field framework is particularly effective in identifying cross-clustering patterns even in noisy data. Despite a few direct detections of HI clustering around galaxies using 2PCFs, a more robust technique is needed due to the weak HI signal and significant foreground and thermal noise contamination.

In this talk, I'll present our work on developing a pipeline for robust HI clustering detection around galaxies. Using Illustris TNG300 simulation data, we found that the k NN-Field framework offers significantly higher detection rates than 2PCFs. Additionally, we demonstrate its reliability in capturing clustering patterns from a realistic T_b field, considering foreground and thermal noise effects. The results are promising for HI detection using the k NN-Field framework, even with information loss due to foreground filtering and thermal noise. Our next step involves applying this framework to the observational data (CHIME for HI and eBOSS, DESI galaxy catalogs) for robust detection and modeling the HI-galaxy cross-clustering signal in order to do cosmology.

Track type

Cosmology

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Session Classification: Parallel - Cosmology