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Foreground removal and angular power spectrum estimation of 21 cm signal using harmonic space ILC method

Tuesday 15 October 2024 14:15 (15 minutes)

Mapping the distribution of neutral atomic hydrogen (HI) in the Universe through its 21 cm emission line provides a powerful cosmological probe to map the large-scale structures and shed light on various cosmological phenomena. The Baryon Acoustic Oscillations at low redshifts can potentially be probed by sensitive HI intensity mapping experiments and constrain the properties of dark energy. However, the 21 cm signal detection faces formidable challenges due to the dominance of various astrophysical foregrounds, which can be several orders of magnitude stronger. Our current work introduces a novel and model-independent Internal Linear Combination (ILC) method in harmonic space using the principal components of the 21 cm signal for accurate foreground removal and power spectrum estimation. We estimate the principal components by incorporating prior knowledge of the theoretical 21 cm covariance matrix. We test our methodology by detailed simulations of radio observations, incorporating synchrotron emission, free-free radiation, extragalactic point sources, and thermal noise. We estimate the full sky 21 cm angular power spectrum after application of a mask on the full sky cleaned 21 cm signal by using the mode-mode coupling matrix. These full sky estimates of angular spectra can be directly used to measure the cosmological parameters. For the first time, we demonstrate the effectiveness of a foreground model-independent ILC method in harmonic space to reconstruct the 21 cm signal.

Track type

Cosmology

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