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Does the light cone effect make reionization HI 21-cm power spectrum anisotropic?

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Abstract. Redshifted HI 21-cm signal from the reionization epoch evolves considerably along the line of sight direction of any observed volume. Using simulations we investigate this so-called 'light-cone' effect on the HI 21-cm power spectrum. In particular, we investigate whether the effect introduces anisotropies in the power spectra and could not find any.

1. Introduction

The first generation of low-frequency radio telescopes (e.g. GMRT, LOFAR, MWA, PAPER) aims to measure the power spectrum of the HI 21-cm brightness temperature fluctuations. However, the evolution of the HI 21-cm signal along the line-of-sight direction of any observed volume will influence the 3D power spectrum. Therefore, it is important to understand this so-called 'light-cone' effect on the observed 21-cm power spectrum (Datta et al. 2012; La Plante et al. 2013). Here we use the largest radiative transfer simulation of the reionzation to date to study whether the LC effect introduces any anisotropy in the HI 21-cm power spectrum.

2. Simulation

We first use the CubeP^{3}M N-body code which simulates the dark matter (DM) density field and also give us the DM halo locations and masses. Assuming that the baryons trace the DM density field and we assign an ionizing photon luminosity to each halo

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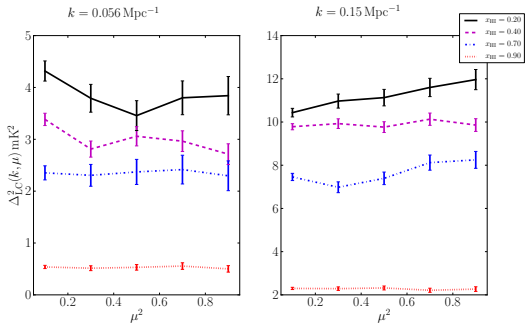

Figure 1. The dimensional power spectrum $\Delta^2_{\rm LC}(k,\mu)$ with the LC effect. The k-mode is fixed for each panel.

proportional to the halo mass. The radiative transfer code C^2-RAY (Mellema et al. 2006) is then used to simulate ionzation cubes at different redshifts covering the entire reionization epoch (see Iliev et al. (2013) for details about the particular simulation used here) . We then calculate the expected HI brightness temperature maps and include the LC effect following the method described in Datta et al. (2012). We do not include the peculiar velocity effect in the signal.

3. Results and conclusions

Figure 1 shows the dimensionless powerspectrum $\Delta^2_{\rm LC}(k,\mu)$ as a function of μ^2 for a fixed k-mode for different neutral fractions $x_{\rm HI}$, where $\mu = k_\parallel/k$ and $k_\parallel$ is the line-of-sight component of the Fourier mode $\mathbf{k}$. We find that $\Delta^2_{\rm LC}(k,\mu)$ does not change systematically as a function μ^2. We therefore conclude that LC effect either does not make the power spectra anisotropic i.e. a function of μ^2 or this dependence is so weak that it is buried in the sample variance (see Datta et al. (2014) for more details).

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References

Datta K. K., Mellema G., Mao Y., et al., 2012, MNRAS, 424, 1877
Datta K. K., Jensen H., Majumdar S., et al., 2014, submitted, arXiv:1402.0508
Iliev I. T., Mellema G., Ahn K., et al., 2013, arXiv:1310.7463 Jensen H., Datta K. K., Mellema G., et al., 2013, MNRAS, 435, 460
La Plante P., Battaglia N., Natarajan A., et al., 2013, arXiv:1309.7056
Mellema G., Iliev I. T., Alvarez M. A., Shapiro P. R., 2006, New Astronomy, 11, 374