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Probing the signatures of astrophysical scatter in the EoR 21cm signal using auto-bispectrum

The high-redshift observations of galaxies with instruments like the JWST can be complemented with the upcoming SKA, which will map the early IGM via intensity mapping of the redshifted 21cm signal with improved sensitivity over the current generation of radio interferometers. These star-forming galaxies are expected to emit most of the bulk of ionizing photons during the Epoch of Reionization (EoR) and reionize the surrounding IGM while star-formation continues inside these galaxies. However, since the star-formation rates of these galaxies have an intrinsic scatter with the host halo mass, the ionizing photon flux is not perfectly correlated to it. It might affect the observable summary statistics of the 21cm signal as compared to the usual models of cosmic reionization where the ionizing photon flux is perfectly correlated with the halo mass. Using semi-numerical simulations, we find that unlike the 21cm power spectrum, where the impact of this astrophysical scatter is primarily limited to only 5 percent and up to 10-15 percent, the 21cm auto-bispectrum captures the small-scale ($k \sim 2.55$ Mpc^{-1}) non-Gaussinaties induced by the astrophysical scatter in the highly non-Gaussian 21cm signal with high-statistical significance ($> 5\sigma$ at $\overline{x}_{\rm H\,I} > 0.81$), while the impact ranges from 20 to 100 percent. However, the detectability of the bispectrum at these scales is beyond our reach considering SKA1-Low observations. Therefore, the large-scale 21cm auto-bispectrum is primarily unaffected by the astrophysical scatter and requires no additional modeling; however, any future generation of radio interferometers might aid in unveiling the information at the smaller length scales.

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