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On the recoverability of the BAO signal on BINGO HI IM simulations

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A new and promising technique for observing the Universe and study the dark sector is the intensity mapping of the redshifted 21-cm line of neutral hydrogen (HI). The Baryon Acoustic Oscillations [BAO] from Integrated Neutral Gas Observations (BINGO) radio telescope will use the 21-cm line to map the Universe in the redshift range $0.127 \leq z \leq 0.449$, in a tomographic approach, with the main goal of probing BAO.
This work presents the forecasts of measuring the transversal BAO signal during the BINGO Phase 1 operation. We use two clustering estimators: the two-point angular correlation function (ACF), in configuration space, and the angular power spectrum (APS), in harmonic space, and a template-based method to model the ACF and APS estimated from simulations of the BINGO region and extract the BAO information. The tomographic approach allows the combination of redshift bins to improve the template fitting performance. We compute the ACF and the APS for each of the 30 redshift bins and measure the BAO signal in 3 consecutive redshift blocks (lower, intermediate and higher) of 10 channels each. Robustness tests are used to evaluate several aspects of the BAO fitting pipeline for both clustering estimators.
We find that each clustering estimator shows different sensitivities to specific redshift ranges, although both of them perform better at higher redshifts. In general, the APS estimator provides slightly better estimates, with smaller uncertainties and larger probability of detection of the BAO signal, achieving $\sim 90\%$ at higher redshifts. We investigate the contribution from instrumental noise and residual foreground signals and find that the former has the greater impact, getting more significant as the redshift increases, in particular the APS estimator. Indeed, including noise in the analysis increases the uncertainty up to a factor of ~ 2.2 at higher redshifts. Foreground residuals, in contrast, do not significantly affect our final uncertainties. In summary, our results show that, even including realistic systematic effects, BINGO has the potential to successfully measure the BAO scale in radio frequencies.

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