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Measuring secondary halo bias using nearest neighbor distributions

Dark matter haloes in a given mass range are expected to cluster differently based on secondary halo properties such as concentration or spin, a behaviour known as secondary halo bias. While secondary halo bias has been quantified in simulations, observational uncertainties in halo properties make it difficult to measure the signal in data using only two-point clustering. The k-Nearest Neighbour Cumulative Distribution Functions (kNN-CDFs) are sensitive to all N-point correlation functions of the underlying field and are more potent as summary statistics to study clustering. In this talk, I present my work on measuring the secondary bias due to concentration in *cluster-sized* haloes taken from the Quijote simulations. I quantify the clustering of the *cluster-sized* haloes using their *auto-correlation* as well as their *cross-correlation* with *galaxy-sized* haloes and demonstrate that the kNN-CDFs provide a much larger signal-to-noise than the 2PCF in each case. The kNN-CDFs can detect a statistically significant secondary bias signal even in the cluster auto-correlation, where the 2PCF does not see any signal. I discuss the effect of introducing numerical scatter in the halo concentration to mimic observational uncertainties and demonstrate that the kNN-CDFs are more robust to noise, giving a statistically significant signal even at large scatter values.

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