U23a Understanding the star formation rate-weighted galaxy power spectrum: halo exclusion, scale-dependent shot noise, and secondary bias

Rui Lan Jun (UTokyo), Tom Theuns (ICC, Durham), Kana Moriwaki (UTokyo), Sownak Bose (ICC, Durham)

We present a physically motivated model for the power spectrum of galaxies weighted by their star formation rates (SFR), decomposing it into a 1-halo and 2-halo term while incorporating key effects such as scale-dependent shot noise and halo exclusion. This framework is directly applicable to line-intensity mapping (LIM) experiments, which typically target emission lines that are closely linked to star formation activity. Our model reproduces the IllustrisTNG power spectrum to within a few percent across all scales. We find that omitting satellite galaxies leads to an underestimation of the large-scale bias and the mean intensity by approximately 30% each at $z \sim 1.5$. Additionally, we investigate the impact of secondary bias – the correlation of SFR with halo bias at fixed halo mass – revealing systematic errors of $\sim 5\%$ in the 2-halo term and $\sim 10\%$ in the 1-halo term. These results highlight the importance of properly modelling halo-scale physics for accurate large-scale structure analyses in LIM surveys.