U10b Fast method for generating mock line intensity maps based on hydrodynamical simulations

Rui Lan Zhang, Kana Moriwaki (UTokyo)

Large-scale structure provides information that allows us to constrain the cosmological model. For accurate constraints to be obtained, large volumes need to be mapped to reduce cosmic variance. In contrast to galaxy surveys which detect individual galaxies, line intensity mapping measures the emission of spectral lines from many sources collectively, thus providing a much faster way to map the universe. Its ability to detect contributions from faint galaxies undetected in galaxy surveys also means that deeper redshifts can be probed. In order to analyse the intensity mapping observations, it is necessary to generate many independent realisations of mock intensity maps to evaluate statistical uncertainties and systematic errors.

We develop a new method for generating mock data using a dark matter halo catalogue generator, PINOCCHIO, based on Lagrangian Perturbation Theory, allowing it to be faster than a conventional N-body simulation. We find a correlation between halo mass and SFR in hydrodynamical simulations, EAGLE and TNG. We use this and the halo occupation distributions to assign emission lines to halos. This enables the rapid generation of many mock intensity maps, with cubic volumes as large as 2Gpc on a side at redshift ~ 2. Using the same method, galaxy catalogues can also be generated, allowing cross-correlation predictions between future galaxy surveys and intensity maps, such as JWST and SPHEREx. These mock catalogues can be used for estimating uncertainties in future constraints as well as training machine learning models for data analysis.