Human-AI Collaboration Project Plan

Project Title: The galaxy-dark matter halo connection of Lyman-break galaxies

Background: A Lyman-Break Galaxy (LBG) is galaxy for which the flux in broadband photometry experiences a 'drop-out' in the bluest bands as their radial position in redshift-space increases and features in their spectra move from blue to red through the filter set due to cosmic expansion. The reduction in flux on the blue end of the filter set is due to the attenuation of the galaxy light blueward of the Lyman-alpha and Lyman-limit frequencies caused by scattering and absorption of the UV photons by the intervening neutral hydrogen gas, i.e., the Lyman-break feature. This feature has proven to be a robust way to identify galaxies at redshifts $z > 2$ in photometric surveys, which can then be followed up with spectroscopic observations to nail down their position in redshift-space. Current and future surveys, such as the Prime Focus Spectrograph Galaxy Evolution Survey (PFS:GE), will measure the redshifts for thousands of LBGs between $2.0 < z < 4.0$ to learn more about their properties and how they trace the large-scale structure (LSS) of the universe.

Goals: In preparation for the measurement and modeling of the LBG galaxy-galaxy two-point correlation function (2PCF), we will conduct a theoretical investigation into the potential progenitors of the PFS:GS LBG target sample using the Uchuu Universe Machine mock galaxy catalog to better understand how they trace the LSS, via galaxy bias and the halo occupation distribution (HOD), as a function of redshift. Of particular interest is any sign of a galaxy assembly bias or any other nuances of the selection function that could lead to incorrect inferences of the galaxy bias (b_g) and growth-rate of LSS ($f\sigma_8$).

Methodology:

A. Measurement of HOD and galaxy bias for LBG selections as a function of redshift snapshot (3 months): Need to simulate color-selection of LBG galaxies using the Uchuu UV mag to scale an LBG SED template to the observed flux and measure relevant broadband photometry for the galaxies in the Uchuu UM snapshot box. The spectroscopic ‘selection’ will be a random downsampling of this color-mag selection. *Observed surface density of 0.2 LBGs per arcmin^2.
B. Determine impact of assembly bias on the clustering signal (2 months): Use the target sample selections simulated in the previous step to ‘erase’ the galaxy assembly bias signal present by populating the snapshot box according to the measured HOD.
C. Explore nonlinear galaxy clustering models for the LBG galaxy-galaxy autocorrelation clustering measurement (2 months): With the clustering signal from the Uchuu UM, with and without assembly bias, model the ‘observed’ clustering signal with diffHOD (Horowitz+24), galaxy power law model, and power spectrum nonlinear models (McCarthy+23), to determine the importance of the model and the presence of assembly bias in recovering the correct galaxy bias and growth-rate of LSS.