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Making multi-wavelength, multi-redshift predictions for Cross-Survey Cosmological Analyses

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The standard cosmological model has been thus far successful at predicting the clustering of galaxies on large physical scales. However, the standard model has not been thoroughly tested on smaller scales, where the spatial distribution of galaxies is affected by both cosmology and the physics of galaxy formation and evolution. Measuring galaxy clustering on small scales with the next generation of spectroscopic survey will allow us to potentially explore the observational signatures of physics beyond the standard model. In addition to examining small scales, further constraints on our cosmological model can come from combining data from multiple galaxy surveys. Moreover, performing multi-redshift analyses will allow us to probe the dark energy equation of state over time. However, to fully take advantage of the next generation of cosmological survey data will require flexible models of the galaxy-halo connection that can make multi-wavelength, multi-redshift predictions in the nonlinear regime. In this talk, I will present a novel simulation-based forward model of the galaxy-halo connection, which targets multi-wavelength, multi-redshift joint analyses of large-scale structure data from multiple cosmological surveys, including cross-correlations. This forward modeling framework, Diffsky, utilizes high-resolution N-body simulations with merger trees, and includes differentiable prescriptions for smooth in-situ star formation, bursty star formation, dust attenuation, and galaxy merging. I will discuss recent applications of Diffsky in the generation of synthetic data for DESI and LSST, as well as ongoing work in cosmological forecasting and inference.

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