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Theoretical developments in modeling cosmological structure formation

Thursday 7 December 2023 10:15 (45 minutes)

The evolution and growth of the skeleton of the Cosmic Web goes hand-in-hand with the evolution of gas and galaxies in the Universe and intertwines primordial physics (the details of inflation, dark matter and dark energy) with astrophysics (reionization, star formation and the growth of black holes). Untangling this correlated evolution in order to use the Cosmic Web as a cosmological probe requires a judicial use of theoretical techniques ranging from perturbation theory and non-linear analytical approximations to semi-numerical models to full-fledged numerical simulations of dark matter, gas and galaxies. Such techniques are critical in understanding the degeneracies between cosmology and astrophysics that are imprinted on any given astrophysical probe of cosmology. I will discuss some of the progress in this field over the last several years, highlighting a few different themes from the literature. At low redshifts, I will discuss the emerging importance of uncertain physical effects such as galaxy assembly bias and the role played by novel statistical probes of nonlinear structure. At high redshifts, I will briefly describe the development of accurate and fast tools for capturing the physics of reionization. Finally, I will showcase our recent efforts at distinguishing the 'standard' Lambda-CDM model from alternative theories.

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