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Effects of variations in cosmological initial conditions on the Simba-C simulation

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The formation and evolution of the Universe's large-scale structure (LSS) are strongly influenced by the statistical properties of primordial density fluctuations. While cosmological hydrodynamical simulations, such as Simba-C, have become indispensable tools for modeling galaxy formation and cosmic web morphology, they generally adopt a fixed concordance Λ CDM initial power spectrum. This assumption limits exploration of how early-universe physics imprints itself on present-day structures. In this work, we systematically vary key parameters of the primordial spectrum—including the baryon density (Ω_b) and dark matter density (Ω_{dm}), and will vary the amplitude (A_s), spectral index (n_s)—to probe their impact on the evolution of halos, voids, filaments, and clustering statistics. We generate the linear matter power spectra using CLASS (Cosmic Linear Anisotropy Solving System), and initialize density fields with MUSIC (Multi-Scale Initial Conditions) for Simba-C simulations. We will utilize a set of modified runs to analyze the resultant differences in the matter power spectrum, halo mass function, two-point correlation function, and cosmic web topology, with aims to quantify the sensitivity of LSS formation to inflationary features and non-standard cosmologies.

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