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Anatomy of Parity-violating Trispectra in Galaxy Surveys

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Parity-violating interactions are ubiquitous phenomena in particle physics. If they are significant during cosmic inflation, they can leave imprints on primordial perturbations and be observed in correlation functions of galaxy surveys. Importantly, parity-violating signals in the four-point correlation functions (4PCFs) cannot be generated by Einstein gravity in the late universe on large scales, making them unique and powerful probes of high-energy physics during inflation. However, the complex structure of the 4PCF poses challenges in diagnosing the underlying properties of parity-violating interactions from observational data. We introduce a general framework that provides a streamlined pipeline directly from a particle model in inflation to galaxy 4PCFs in position space. We demonstrate this framework with a series of toy models and the tree-level exchange-type processes with chemical-potential-induced parity violation. We further showed the detection sensitivity of these models from BOSS data and highlighted potential challenges in data interpretation and model prediction.

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