

Searching for cosmological parity violation

Wednesday, 25 June 2025 09:30 (1 hour)

Axions are naturally coupled to photons through the Chern-Simons term. This coupling would open a window for us to probe the dark components and the inflation by their imprints on the visible sector. Over the past years, we have explored the cosmological signatures of axionic dark energy, dark matter, and inflaton. The axionic dark energy and dark matter can rotate the plane of polarization of propagating photons, thus converting CMB E-mode polarization into parity-odd B-mode polarization (the so-called birefringence B-mode or cosmic parity violation). In axion monodromy inflation, the backreaction to inflation induced by copious photon production due to the axion-photon coupling in a later stage of inflation beyond the slow-roll regime may lead to large non-Gaussian density fluctuations that seed primordial black holes (PBHs) and simultaneously generate gravitational waves (GWs). In particular, because of the Chern-Simons axion-photon coupling, the produced photons are one-handed; as a result, the generated GWs are chiral and the four-point function of density fluctuations is parity-violating. This chirality manifests a distinct signature of the cosmic parity violation in axion cosmology. The PBHs can be a candidate for dark matter and the chirality of the GWs can be detected by on-going and future GW experiments, such as LIGO, Virgo, KAGRA, LISA, and pulsar-timing arrays. We will discuss parity violation in axion cosmology, paying attention to on-going and future measurements of the density four-point function in CMB observations and galaxy surveys.

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Gravity & Particle Physics

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Session Classification: Keynote Talks