

The Gravitational-Wave Symphony of Axion-like Particles

Wednesday 12 November 2025 14:20 (20 minutes)

The early Universe offers a unique window into fundamental physics far beyond the reach of terrestrial experiments. In this talk, I will discuss how ultra-light axionlike scalar fields—ubiquitous in extensions of the Standard Model—can leave observable imprints through stochastic gravitational waves (GWs) generated by parametric resonance in the post-inflationary era. Using lattice simulations across broad parameter ranges, we find that such dynamics can produce GW signals spanning from nanohertz to kilohertz frequencies, potentially explaining recent NANOGrav results while predicting signatures for ground-based detectors such as LIGO and Cosmic Explorer. Remarkably, the same mechanisms can also account for the genesis of dark matter or dark radiation, and even realize Affleck–Dine–type baryogenesis without invoking supersymmetry. The resulting picture connects cosmic evolution, particle physics, and gravitational-wave astronomy into a unified framework—where early-universe field dynamics may soon become experimentally testable across multiple frontiers.

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