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Decoherence of primordial perturbations in the view of a local observer

Thursday, 21 August 2025 15:00 (20 minutes)

We study quantum decoherence of curvature perturbations at superhorizon scales caused by the gravitational nonlinearities. We show that cubic gravitational couplings, constrained by the spatial diffeomorphism invariance, lead to infrared (IR) and ultraviolet (UV) divergences in the decoherence rate at one loop. These divergences arise from fluctuations of deep IR modes which look like a background mode for a local observer and violent zero-point fluctuations in the deep UV, respectively. We argue that these divergences are unobservable, as they vanish when considering proper observables. We consider correlators defined using the geodesic distance for IR divergences and time-averaged correlators for UV divergences. To account for these observer's perspectives, we propose to consider an effective quantum state, defined in terms of actual observables, as a more appropriate probe of the quantum coherence of the system measured by an observer. We then evaluate the finite decoherence rate induced by superhorizon environment during inflation and at late universe. This talk is based on the paper arXiv:2504.10472.

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