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Decoherence of Primordial Perturbations in Geodesic Observer's View

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Supported by observational evidence indicating that cosmological scalar perturbations were nearly Gaussian at the beginning of the universe, it is anticipated that the origin of these perturbations is quantum fluctuations. Consequently, cosmic inflation provides a valuable setting for testing the quantum nature with/of gravity. Quantumness is characterized by features such as quantum coherence, quantum entanglement, and quantum incompatibility of measurements, all of which are sensitive to the specific setup of the observation. In this work, we discuss quantum (de)coherence using the off-diagonal components of the reduced density matrices for curvature perturbations and gravitons of observable scales, particularly under the specification that we are geodesic observers, a treatment referred to as the local observer's effect. As a result, we show that the decoherence rate for comoving observers is predominantly influenced by gauge artefacts vanishing in the geodesic coordinate system, leading to the implications that the primordial perturbations would retain their quantum nature for longer than previously expected.

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