

JOINT TUFTS/MIT COSMOLOGY SEMINAR

A Classical-to-Quantum Transition for Inflationary Perturbations Aurora Ireland Stanford

Inflationary perturbations are quantum in origin. When computing cosmological observables, however, it is customary to treat them as classical stochastic fields. This practice is justified by a "quantum-to-classical" transition that occurs on superhorizon scales during slow-roll inflation. At the closed-system level, the success of this transition relies on the suppression of the decaying mode (or equivalently, strong squeezing in the Schrödinger picture).

Of course, many well-motivated inflationary scenarios deviate from slow roll. In particular, models seeking to enhance small-scale power (e.g. for primordial black hole formation) generically rely on a revival of the decaying mode. One may wonder to what extent a stochastic description can still be employed in such a scenario, given the potential for interference effects between the growing and decaying modes.

Employing the EFT of inflation and working to all orders in perturbation theory in the decoupling limit, we analyze the dynamics of quantum fluctuations in various constant-roll backgrounds. In the far superhorizon limit, we construct the Wigner function W for the curvature perturbation and its conjugate momentum, whose positivity serves as a diagnostic for the validity of a stochastic description. We find that W becomes highly oscillatory and negative in certain regions of phase space — a hallmark of quantum interference and non-classicality. These findings indicate that squeezing, or equivalently the size of the linear theory growing and decaying modes, is not necessarily a reliable indicator of classicality.

Tuesday, November 4, 2025, 2:30 pm

Cosman Seminar Room

Center for Theoretical Physics

Building 6C, Room 6C-442

Massachusetts Institute of Technology