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The stochastic formalism in the presence of a curvaton

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Cosmological perturbations generated during inflation are the seeds of the inhomogeneity and anisotropy of our universe. In contrast with the usual perturbation theory explaining these perturbations at large scale well, the stochastic formalism is an effective theory of long-wavelength modes that incorporates probabilistic noise from short-wavelength modes as they exit the horizon. This is expected to have non-perturbative properties, particularly useful in the context of primordial black hole (PBH) formation. Indeed, PBHs are formed from large perturbations exceeding a threshold when they re-enter the horizon.
In this presentation, I will review the stochastic delta-N formalism, which combines stochastic inflation and the delta-N formalism to relate curvature perturbations to fluctuations in e-foldings. This framework allows us to calculate curvature perturbations from each stochastic realization using mathematical tools, particularly solving the adjoint Fokker-Planck equation. Additionally, I will demonstrate the application of the stochastic formalism for the multi-field case, especially in the presence of a curvaton, and discuss the relationship between perturbations from the inflaton and curvaton and the possibilities of PBH formation in this scenario.

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