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Stochastic effective theory for scalar fields in de Sitter spacetime

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The dynamics of the Higgs and other light scalar fields during inflation can have important cosmological consequences, but because of the infrared problem, they cannot be computed using perturbation theory. A powerful alternative is the stochastic Starobinsky-Yokoyama approach, which is based on the observation that on superhorizon distances the field behaves classically, with a noise term produced by subhorizon quantum modes. It has been mostly used to calculate the one-point probability distribution of the field, but its real power lies in describing the asymptotic long-distance behaviour of correlation functions through a spectral expansion. I demonstrate this by calculating isocurvature constraints for scalar dark matter models and decay rates of metastable vacua. I also show how to extend the stochastic theory beyond the overdamped approximation used by Starobinsky and Yokoyama. The parameters of this effective theory are determined at one-loop order in perturbation theory, and do not suffer from the same infrared problems as a direct perturbative computation of observables. Therefore it provides a powerful and accurate way of computing cosmological observables.

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