The quantum Fokker-Planck equation of stochastic inflation

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We derive the stochastic description of a massless, interacting scalar field in de Sitter space directly from the quantum theory. This is done by showing that the density matrix for the effective theory of the long wavelength fluctuations of the field obeys a quantum version of the Fokker-Planck equation. This equation has a simple connection with the standard Fokker-Planck equation of the classical stochastic theory, which can be generalised to any order in perturbation theory. We illustrate this formalism in detail for the theory of a massless scalar field with a quartic interaction.