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Auxiliary field loop expansion of the effective action for stochastic partial differential equations

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We present an alternative to the perturbative diagrammatic approach for studying stochastic dynamics. Our approach relies on an auxiliary field loop expansion for the path integral representation for generating functional of the noise-induced correlation functions. We determined two different effective actions, one based on the Onsager-Machlup (OM) approach, and the other on the Martin-Siggia-Rose (MSR) response function approach. Specifically, we determined the leading order approximation for the effective action and potential for arbitrary spatial dimensions for several simple systems. These include the Kardar-Parisi-Zhang (KPZ) equation, the chemical reaction annihilation, and diffusion process A+A -> 0 and the Ginzburg-Landau (GL) model for spin relaxation. We demonstrate how to obtain an effective potential of the OM approach from the effective potential in the MSR approach. We show how to obtain some of the renormalization group flows directly from the effective potential and compare our results with exact and perturbative results.

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