

Renormalisation Group Analysis of Noise Propagation on a Fractal Lattice

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Abstract

We consider a class of dynamical systems defined on a fractal lattice, with stochasticity arising from a noisy regularisation at the smallest scale, whose geometry induces scale-invariant interactions across scales. The self-similar structure allows us to define a renormalisation group for the lattice dynamics, whereby each application of the renormalisation group map introduces an additional scale into the system. The analysis proceeds via a first-order perturbative expansion in the small-noise regime. In this setting, the mean and covariance of the system state evolve in a tractable manner: the mean follows the deterministic dynamics up to first-order corrections in the noise amplitude, while the covariance admits a first-order approximation governed by the linearised renormalisation group dynamics, capturing the leading-order propagation and accumulation of fluctuations. These are results of ongoing research with Alexei A. Mailybaev.