Noise induced Transitions in Confined Potentials: The Effect of Perturbed Potentials on Dynamics in Noisy Systems

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Physical systems frequently depend on multiple time or length scales, for example molecules diffusing across a surface are in turn affected by pore geometry and pellet shape, as well as the gross design of a reactor.

Making use of the information from the shortest scales to predict the behaviour of systems on longer scales is called coarse-graining and offers a route to accelerate simulation of many types of physical systems.

We study one type of system, where a particle is confined within a potential and is subject to thermal noise. This offers a model for reaction dynamics and optical systems and has been widely studied in literature.

Superimposing a periodic microscale on the potential dissipates energy and the particle's diffusion is inhibited. By homogenising the multiscale problem we can study the effective dynamics on the macroscale. In one dimension this can be done and we can obtain closed-form results for comparison, whilst in two dimensions the homogenization must be carried out numerically.

We observe that correlating the micro- and macroscales can induce transitions in the effective behaviour, leading to metastable states and bifurcations in the homogenized system which we observe through numerical studies. We find that the number of metastable states varies with the power law coupling between scales.