

**Abstract for : Dr. Konstantinos Spiliopoulos
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Title: Large Deviations, Metastability and Monte Carlo Methods for Multiscale Problems with Applications

Abstract: Many randomly perturbed dynamical systems are dominated by rare but very significant transition events between stable states. These rare events are very important, for example in conformational changes of biomolecules and chemical reactions. In this talk, I will discuss large deviations, metastability and Monte Carlo methods for dynamical systems that have multiple scales and that are stochastically perturbed by small noise. Depending on the type of interaction of the fast scales with the strength of the noise we get different behavior, both for the large deviations and for the corresponding Monte Carlo methods. Using stochastic control arguments we identify the large deviations principle for each regime of interaction. The large deviations principle can then be used to study metastability for such problems, as well as asymptotic problems for related PDE's. Furthermore, we derive a control (equivalently a change of measure) that allows to design asymptotically efficient importance sampling schemes for the estimation of associated rare event probabilities and expectations of functionals of interest. Standard Monte Carlo methods perform poorly in these kind of problems in the small noise limit. In the presence of multiple scales one faces additional difficulties and straightforward adaptation of importance sampling schemes for standard small noise diffusions will not produce efficient schemes. We resolve this issue and demonstrate the theoretical results by examples and simulation studies.