Perturbative calculation of quasi-potential and applications to particle systems with mean-field interactions

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Abstract

Large deviations in the low noise limit describe, through Freidlin-Wentzell or Macroscopic Fluctuation Theory, a number of out-of-equilibrium systems. The Quasi-Potential is a central object of the theory which generalises the equilibrium free energy; it describes the leading-order stationary probability of observing the system in a given state. However, the Quasi-Potential can be computed explicitly only in very specific cases and there is generically no hope to calculate it for generic out-of-equilibrium systems.
In this talk we address a very natural question, surprisingly still open to the best of our knowledges: consider a system depending on a control parameter h and suppose that we are able to calculate the quasi-potential for some value of h, say h=0. The typical situation is the case where h=0 corresponds to an equilibrium dynamics. Can we build a perturbation theory to calculate the quasi-potential for small but finite values of h?
We answer to this question proving the existence of a perturbative expansion and giving explicit formulas to iteratively compute each order. These results are very general and can be applied to finite as well infinite dimensional systems.
Explicit results on a system kinetic and non-equilibrium version of the mean-field XY model will be also discussed.
The talk ends with perspectives on the application of these techniques to fluctuating hydrodynamics relevant to the description of active matter.

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