Condensed Matter > Statistical Mechanics

Simulating rare events in dynamical processes

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Atypical, rare trajectories of dynamical systems are important: they are often the paths for chemical reactions, the haven of (relative) stability of planetary systems, the rogue waves that are detected in oil platforms, the structures that are responsible for intermittency in a turbulent liquid, the active regions that allow a supercooled liquid to flow... Simulating them in an efficient, accelerated way, is in fact quite simple.

In this paper we review a computational technique to study such rare events in both stochastic and Hamiltonian systems. The method is based on the evolution of a family of copies of the system which are replicated or killed in such a way as to favor the realization of the atypical trajectories. We illustrate this with various examples.

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