9:12AM A25.00005: Over-damped Brownian dynamics in piecewise-defined energy landscapes* EE HOU YONG (Presenter), Nanyang Technological University, THOMAS GRAY, University of Cambridge — We study the over-damped Brownian dynamics of particles moving in piecewise-defined potential energy landscapes U(x), where the height Q of each section is obtained from the exponential distribution $p(Q) = a\beta \exp(-a\beta Q)$, where β is the reciprocal thermal energy, and $a > 0$. The averaged effective diffusion coefficient Deff is introduced to characterise the diffusive motion: $\langle x^2 \rangle = 2$ Deff t. A general expression for Deff in terms of U(x) and p(Q) is derived, and then applied to three types of energy landscape: flat sections, smooth maxima, and sharp maxima. All three cases display a transition between sub-diffusive and diffusive behaviour at $a = 1$, and a reduction to free diffusion as $a \to \infty$. The behaviour of Deff around the transition is investigated and found to depend heavily upon the shape of the maxima: energy landscapes made up of flat sections or smooth maxima display power-law behaviour, whilst for landscapes with sharp maxima, strongly divergent behaviour is observed. Two aspects of the sub-diffusive regime are studied: the growth of the mean squared displacement with time, and the distribution of mean first-passage times.

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9:24AM A25.00006: An Energy-Accuracy Tradeoff for Nonequilibrium Receptors* SARAH HARVEY (Presenter), SUBHANEIL LAHIRI, SURYA GANGULI, Applied Physics, Stanford University — Living systems constantly collect and process information about their surroundings in order to respond to changes in the environment. In particular, single cells are capable of remarkably sensitive chemical concentration sensing using membrane-bound receptors. The physical limit of this sensing capability has been studied since the Berg-Purcell limit in 1977; however, thermodynamic constraints on the design of these sensors have remained theoretically elusive. Here we discuss two novel analytical bounds on signal estimation uncertainty in different limits of the observability of the sensing system. First, we consider estimating a signal based on a fully observable system trajectory, and second we study estimation based only on the coarse-grained occupation time of a subset of states. In the second, more biophysically plausible limit, we derive an energy-accuracy tradeoff for nonequilibrium processes using stochastic thermodynamics and large deviation theory. These lower bounds, supported by numerical simulations, reveal a theoretical limit on the estimation accuracy in terms of the energy consumption of the system and the observation time.

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