Stochastic thermodynamics of a particle in a correlated field

Sarah A.M. Loos[1], Davide Venturelli[2], Benjamin Walter[3], Edgar Roldan[4], Andrea Gambassi[2]
[1]University Of Cambridge, Cambridge, United Kingdom, [2]SISSA, Trieste, Italy, [3]Imperial College, London, United Kingdom, [4]ICTP, Trieste, Italy

Stochastic thermodynamics has uncovered general laws governing the fluctuations and energetics of mesoscopic systems that even hold far from thermal equilibrium. However, little is known about systems in environments with long-ranged spatio-temporal correlations. We introduce a theoretical framework to study the stochastic thermodynamics of a mesoscopic object which is weakly coupled to a temporal-spatially correlated environment described by a fluctuating scalar field. As a particular example, we consider a particle which is dragged at a constant speed by a harmonic trap through a fluctuating Gaussian field. Using a perturbative approach, we uncover that the dissipated power exhibits three dynamical regimes with distinct scaling laws in the dragging velocity. Furthermore, when the field is close to its critical point, the spatially resolved heat dissipation of the field displays a distinct heterogeneous pattern.