Fluctuation response inequality out of equilibrium

Shin-ichi Sasa[1] and Andreas Dechant[2]

[1]Department of Physics, Kyoto University, Kyoto 606-8502, Japan
[2]WPI-Advanced Institute of Materials Research, Tohoku University, Sendai, 980-8502, Japan

The close relation between the response of a system to a small perturbation and the fluctuations of the unperturbed system has previously been established through fluctuation-dissipation theorems. Here, we present an alternative approach to linear response of non-equilibrium systems in the form of a fluctuation-response inequality. We study the response of stochastic currents in an out-of-equilibrium Markovian dynamics to a small perturbation. We find that magnitude of the response is bounded from above by the fluctuations of the current in the unperturbed system times a positive quantity, which we identify as the thermodynamic cost of the perturbation. As a direct consequence of this fluctuation-response inequality, we show that for steady state particle transport, the differential mobility is bounded by the diffusivity. For a "virtual" perturbation proportional to the local mean velocity, we recover the thermodynamic uncertainty relation for steady state transport processes.