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Equilibrium theory for a particle pulled by a moving optical trap
RAYMOND DEAN ASTUMIAN, University of Maine — The viscous drag on a colloidal particle pulled through solution by an optical trap is large enough that on experimentally relavant time scales the mechanical force exerted by the trap is equal and opposite the viscous drag force. The rapid mechanical equilibritation allows the system to be modeled using equilibrium theory where the effects of the energy dissipation (*thermodynamic* disequilibrium) show up only in the coordinate transformations that map the system from the laboratory frame of reference, relative to which the particle is moving, to a frame of reference in which the particle is, on average, stationary and on which the stochastic dynamics is governed by a canonical equilibrium distribution function. The simple equations in the stationary frame can be analyzed using the Onsager-Machlup theory for stochastic systems and provide generalizations of equilibrium and near equilibrium concepts such as detailed balance and fluctuation-dissipation relations applicable to a wide range of systems including molecular motors, pumps, and other nano-scale machines.

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