

Anomalous fluctuation relations

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We first review the concept of work fluctuation relations (FRs) for stochastic dynamics modeled by the ordinary Langevin equation. We then introduce to three generic types of dynamics generating anomalous diffusion: Levy flights, long-correlated Gaussian processes and time-fractional kinetics. By combining Langevin and kinetic approaches we calculate the work probability distributions in the simple nonequilibrium situation of a particle subject to a constant force. This allows us to check the transient FR for both sub- and superdiffusion. We analyze the interplay between fluctuation-dissipation relations and FRs, which yields a new form of FRs for anomalous dynamics. Analogous results are obtained for a particle in a harmonic potential dragged by a constant force. We show that these findings are important for understanding fluctuations in experimentally accessible systems such as migrating biological cells and a paradigmatic lattice gas modeling glassy dynamics.

Key words: transient fluctuation relation, anomalous dynamics, subdiffusion, superdiffusion, Levy flights, Gaussian stochastic processes, time-fractional kinetics