Fluctuation Theorems for Non-Thermal, Strongly-Coupled Environments

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Based on the theory of full-counting statistics and cumulant generating functions, we propose a novel form of symmetry for the derivation of fluctuation theorems that only requires the assumption of an initial local thermal state of the subsystem of interest[1]. Specifically, it does not rely on the usual concepts of microscopic time-reversibility or thermal environments. Moreover, these theorems apply regardless of the Markovianity of the subsystem or of the strength of its coupling to the environment. In the context of laser cooling of trapped ions, experimentally confirmed deviations from weak-coupling thermalization have been successfully treated with this perspective[2]. These deviations are often detrimental for the thermodynamic function as we have shown with help of Floquet-Markov-based simulation methods, due to the appearance of polaronic, correlated dynamics between the subsystem and its environment[3].

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