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(Quantum)-Thermodynamics at strong coupling and its implications for Stochastic Thermodynamics

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The case of strong system-environment coupling plays an increasingly seminal role when it comes to describe systems of small size which are in contact with an environment. The commonly known textbook situation refers solely to a weak coupling situation for which the equilibrium state of the system is described by a Gibbs state. This situation changes drastically, however, when strong coupling is at work; then, the interaction energy can be of the order of the (sub)-system energy of interest [1]. Let us consider first an overall thermal equilibrium of a total setup composed of a system Hamiltonian H_S, coupling Hamiltonian H_{int} and a bath Hamiltonian H_B.

Based on an explicit knowledge of the so termed *Hamiltonian of mean force* [2], the classical statistical mechanics and, as well, the quantum thermodynamics of open systems which are in contact with a thermal environment – at arbitrary strong interaction strength – can be formulated. Yet, even though the Hamiltonian of mean force uniquely determines the thermal phase space probability density (or the density operator, respectively) of a strongly coupled open system, the knowledge of this quantity alone is *insufficient* to determine the Hamiltonian of mean force itself; the latter must be known for constructing an underlying Stochastic Thermodynamics. This fact presents a major stumbling block for any classical Stochastic Thermodynamics scenario which solely builds upon the knowledge of (observed or calculated) open system trajectories. – In the classical case we demonstrate that under the assumption that the Hamiltonian of mean force is known explicitly, an extension of thermodynamic structures from the level of averaged quantities to *fluctuating* objects (such as internal fluctuating energy, heat, entropy, or free energy); i.e., a Stochastic Thermodynamics, is possible. However, such a construction is by far not unique but involves a vast ambiguity.

Generally, however, the situation becomes a No-Go if we consider an initial nonequilibrium where even the concept of a Hamiltonian of mean force does not exist [1, 3].

[1] P. Talkner and P. Hänggi, Open system trajectories specify fluctuating work but not heat, Phys. Rev. E 94, 022143 (2016).

[2] M. Campisi, P. Talkner, and P. Hänggi, Fluctuation theorem for arbitrary open quantum systems, Phys. Rev. Lett. 102, 210401 (2009).

[3] H. Grabert, P. Talkner, and P. Hänggi, Microdynamics and Time-Evolution of Macroscopic Non-Markovian System, Z. Physik B 26, 389–395 (1977).

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