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Violation of TUR in a periodically driven quantum work-to-work converter

Microscopic systems driven out of equilibrium and put in contact with thermal reservoirs act as prototypes of stochastic cyclic heat engines [1,2]. In these engines, thermal fluctuations of heat, work and entropy production cannot be neglected, and the concepts of classical thermodynamics need to be generalized to microscopic nonequilibrium regime [3]. Employing the theoretical framework of Stochastic Thermodynamics (ST), in the case of autonomous steady-state thermal machines, Thermodynamics Uncertainty Relations (TUR) have been proved [4], setting a trade-off to entropy production, output power and output power fluctuations. It follows that microscopic heat engines operating at near-to-zero entropy production cannot be achieved without a divergence in the relative output power fluctuations. On the other hand, in the last decades several models of quantum heat engines and refrigerators have been devised, where the working media obey the laws of quantum mechanics. Single driven qubits [5], pairs of qubits subject to unitary gates [6], quantum dots, as well as many-body systems near criticality [7] have been considered. Many interesting results have been obtained concerning the engine efficiency at maximum power, as well as the possibility to attain Carnot efficiency at finite power. Despite all the efforts, it is rather unclear whether or not quantum heat engines could achieve enhanced performance in heat-to-work conversion with respect to their classical counterparts. In addition, the experimental realizations of these engines are still in their infancy. In this work, we study a model of simple yet nontrivial quantum system, i.e. a qubit, which is driven out of equilibrium by means of a couple of external, time-periodic fields and is permanently put in contact with a thermal reservoir, inducing dissipation and decoherence [8]. Under suitable conditions, the system acts as an isothermal steady-state work-to-work converter, i.e. it converts a given amount of work provided in the input channel to the output channel with fixed efficiency [9]. The converter operates in the absence of Time-Reversal (TR) symmetry. We combine analytical and numerical approaches to study the converter performance as function of the model parameters, without restricting our analysis to weak system-bath coupling regime. We test the validity of the recently derived dynamic TUR [10], showing that several regions of the model parameter space exist where the quantum converter does not obey TUR. We link the occurrence of the violation to the degree of quantum coherence in the converter dynamics.

[1] T. Schmiedl and U. Seifert, EPL (Europhysics Letters) 81, 2 (2007).
[2] V. Holubec, Journal of Statistical Mechanics: Theory and Experiment 5, P05022 (2014).
[3] U. Seifert, Rep. Prog. Phys. 75, 126001 (2012).
[4] P. Pietzonka and U. Seifert, Phys. Rev. Lett. 120, 190602 (2018).
[5] Gelbwaser-Klimovsky, D. and Alicki, R. and Kurizki, G., Phys. Rev. E 87, 012140 (2013).
[6] M. Campisi, J. Pekola and R. Fazio, New Journal of Physics, 17, 3, 035012 (2015).
[7] M. Campisi and R. Fazio, Nature Communications 7, 11895 (2016).
[8] L. M. Cangemi, V. Cataudella, G. Benenti, M. Sassetti and G. De Filippis, arXiv:2004.02987, (Submitted to Physical Review B) (2020).
[9] M. Carrega, M. Sassetti and U. Weiss, Phys. Rev. A 99, 062111 (2019).
[10] T. Koyuk and U. Seifert, Phys. Rev. Lett. 122, 230601 (2019).

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