Energy dynamics, heat production and heat-work conversion with qubits

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We adopt a geometric approach to describe the performance of adiabatic quantum machines, operating under slow time-dependent driving and in contact with two reservoirs with a temperature bias during all the cycle [1]. We show that the problem of optimizing the power generation of a heat engine and the efficiency of both the heat engine and refrigerator operational modes is reduced to an isoperimetric problem with nontrivial underlying metrics and curvature. This corresponds to the maximization of the ratio between the area enclosed by a closed curve and its corresponding length. We illustrate this procedure in a qubit coupled to two reservoirs operating as a thermal machine by means of an adiabatic protocol [2].

[1] Geometric properties of adiabatic quantum thermal machines, Bibek Bhandari, Pablo Terrén Alonso, Fabio Taddei, Felix von Oppen, Rosario Fazio, Liliana Arrachea (https://journals.aps.org/prb/abstract/10.1103/PhysRevB.102.155407, arXiv:2002.02225)

[2] Geometric optimization of non-equilibrium adiabatic thermal machines and implementation in a qubit system PT Alonso, P Abiuso, M Perarnau-Llobet, L Arrachea PRX Quantum 3 (1), 010326 - arXiv preprint arXiv:2109.12648, 2021