Fully autonomous model of a mechanical Maxwell demon engine

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We present a fully autonomous model of a mechanical Maxwell demon engine that converts heat absorbed by a qubit into population inversion in an attached quantum battery. A damped mechanical oscillator acts as a pointer that incorporates the essential demon function of information acquisition about the qubit state and subsequent feedback into the system dynamics, replacing external measurements and control operations. This is achieved by means of a Holstein-type Hamiltonian, which makes the pointer's equilibrium position depend on the qubit state and thereby induces a state-dependent resonance shift. The mechanism enables a selective energy transfer to an attached spin system that acts as the quantum battery. We derive both local and global Lindblad master equations for the coupled system and identify the parameter regimes in which the engine operates efficiently. The figure of merit is the resulting steady-state population inversion of the battery, quantified in terms of ergotropy. Based on these results, we discuss the necessary conditions for practical implementations of the demon engine on realistic experimental platforms.