Reversible work extraction in a hybrid opto-mechanical system

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With the progress of nano-technology, thermodynamics also has to be scaled down, calling for specific protocols to extract and measure work. Usually, such protocols involve the action of an external, classical field (the battery) of infinite energy, that controls the energy levels of a small quantum system (the calorific fluid). Here we suggest a realistic device to reversibly extract work in a battery of finite energy: a hybrid optomechanical system. Such devices consist of an optically active two-level quantum system interacting strongly with a nanomechanical oscillator that provides and stores mechanical work, playing the role of the battery. We identify protocols where the battery exchanges large, measurable amounts of work with the quantum emitter without getting entangled with it. When the quantum emitter is coupled to a thermal bath, we show that thermodynamic reversibility is attainable with state-of-the-art devices, paving the road towards the realization of a full cycle of information-to-energy conversion at the single bit level [1]. Applications of opto-mechanical systems as quantum heat engines will also be considered [2].
