FUNDAMENTAL RESTRICTIONS ON COHERENT WORK EXTRACTION IN OPEN QUANTUM SYSTEMS

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As the miniaturization of thermal machines is currently advancing towards ever-smaller scales [2], the question arises how quantum phenomena such as coherence will impact their performance, see for example [3, 4, 5]. Here, we systematically investigate this problem for cyclic heat engines operating under weak-coupling conditions.

To address this question, we introduce a universal scheme to divide the total power output into a classical part and one stemming solely from quantum coherence. Focusing on Lindblad-type dynamics, we derive a general condition necessary for quantum effects to be exploitable for power enhancement. We first identify different classes of systems for which this criterion is not fulfilled, that is, coherence can only *decrease* the total power. In doing so, we recover previously obtained results for the linear response regime [6]. Second, by working out a simple but paradigmatic example, we show that if our condition is met, coherence effects can indeed increase the total power.

Our general results are valid for arbitrarily strong driving and rely only on the assumption of weak system-reservoir coupling. Our analysis paves the way for future investigations of the role of quantum effects for the performance of devices subject to strong-coupling and non-Markovian effects.

References

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