Quantum Limits to Non-Equilibrium Heat Engine Cycles Resulting from Strong System-Reservoir Coupling

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We show that finite system-reservoir coupling imposes a quantum limit to the performance of discrete stroke heat engine cycles. We study a discrete stroke quantum heat engine with arbitrary system-reservoir coupling strength, operating in finite time to yield non-zero power output. We show that even in the limit of slow isentropic strokes for which quantum friction is negligible, finite system-reservoir coupling induces correlations that result in the generation of coherences between the energy eigenlevels of the working system. Despite yielding a greater power output than its weakly-coupled counterpart, we find that the strongly-coupled engine is hampered by this distinctly quantum effect, generating a lower power output at a smaller efficiency when compared with a strongly-coupled classically stochastic engine. Strong system-reservoir coupling can thus impose a quantum limit to heat engine performance that cannot be predicted by a standard Born-Markov analysis of the system-reservoir interactions.