Abrupt change in thermoelectric transport due to a quantum dot's bound state

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We study a quantum thermoelectric made up of a single-level quantum dot coupled to two leads that can be described by the exactly solvable Fano-Anderson Hamiltonian [1]. We consider the case of a power-law spectral density with a band edge [2]. In this configuration, one may distinguish two regimes depending on the strength of the coupling between the dot and the reservoirs: If the coupling parameter is higher than a critical value, a bound state outside of the continuum and thus with infinite lifetime appears. We analyze the influence of the latter on the steady state of the system and show that the reduced dynamics of the dot explicitly depends on the existence of the bound state. We show that there is an abrupt change in the thermoelectric transport properties at the critical point. Typically, the thermoelectric efficiency grows as the coupling approaches its critical value, but then drops sharply at the critical point.

[1] U. Fano, Effects of configuration interaction on intensities and phase shifts, Phys. Rev. 124(6), 1866 (1961)

[2] G. Engelhardt, G. Schaller and T. Brandes, Bosonic Josephson effect in the Fano-Anderson model, Phys. Rev. A 94, 013608 (2016)

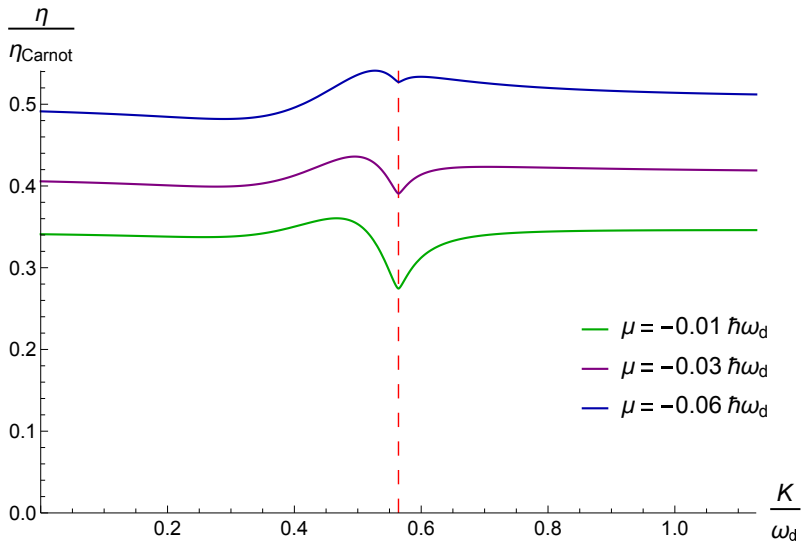

Figure 1: Efficiency of the thermoelectric as a function of the coupling between the quantum dot and the leads for various chemical potentials. The red dashed line represents the critical value of the coupling parameter. One can clearly see that the efficiency grows and then sharply drops approaching this point.