Enhanced performance of three-terminal thermoelectric devices

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Abstract

A three-terminal device, comprising two electronic terminals and a thermal one (e.g., a boson bath, Fig. 1), is discussed. In the first part, we investigate the coefficient of performance for the joint operation of cooling one of the electronic terminals and producing electric power. Surprisingly enough, the coefficient of performance can be enhanced as compared to the case where that electronic terminal is cooled by investing thermal power (from the thermal bath) and electric power (from voltage applied across the electronic junction). We next examine the efficiency of an effective two-terminal thermoelectric device under a broken time-reversal symmetry which is derived from the three-terminal thermoelectric device. We find that breaking time-reversal symmetry can enhance the figure of merit for delivering electric power by supplying heat from a phonon bath beyond the one for producing the electric power by investing thermal power from the electronic baths. We also show that such a device cannot reach the Carnot efficiency, contrary to a recent claim.

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FIG.

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