Thermopower and thermoelectric efficiency in systems with broken time-reversal symmetry

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We show that in systems with broken time-reversal symmetry the maximum efficiency and the efficiency at maximum power are both determined by two parameters: a ``figure of merit'' which generalizes the thermoelectric figure of merit ZT, and an asymmetry parameter, which becomes relevant when the thermopower is not an even function of the magnetic field. In contrast to the time-symmetric case, the figure of merit is bounded from above; nevertheless the Carnot efficiency can be reached at lower and lower values of the figure of merit as the asymmetry parameter increases. Moreover, the Curzon-Ahlborn limit for efficiency at maximum power can be overcome within linear response. We show that a weak magnetic field generally improves either the efficiency of thermoelectric power generation or of refrigeration, the efficiencies of the two processes being no longer equal when a magnetic field is added. Finally, we discuss the thermopower asymmetry and thermoelectric efficiency for a three-dot ring pierced by an Aharonov-Bohm flux, for random matrix models, and for more abstract transmission models.

[1] K. Saito, G. Benenti and G. Casati, *A microscopic mechanism for increasing thermoelectric efficiency*, Chem. Phys. **375**, 508 (2010)
[2] G. Benenti and G. Casati, *Increasing thermoelectric efficiency: dynamical models unveil microscopic mechanisms*, Phil. Trans. R. Soc. A **369**, 466 (2011)
[3] G. Benenti, K. Saito and G. Casati, *Thermodynamic bounds on efficiency for systems with broken time-reversal symmetry*, Phys. Rev. Lett. **106**, 230602 (2011)
[4] K. Saito, G. Benenti, G. Casati and T. Prosen, *Thermopower with broken time-reversal symmetry*, Phys. Rev. B **84**, 201306(R) (2011)
[5] V. Balachandran, R. Bosisio and G. Benenti, *Validity of Wiedemann Franz law in small molecular wires*, Phys. Rev. B **86**, 035433 (2012)
[6] M. Horvat, T. Prosen, G. Benenti and G. Casati, *Railway switch transport model*, preprint arXiv:1207.6014v1 [cond-mat.mes-hall]