The minimal thermoelectric diode

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Modern electronic devices are currently operated at the nanoscale regime, where overheating becomes a problem. Controlling the undesired heat flows in a useful manner is another less explored way of improving its performance. For this, efficient thermal diodes need to be designed [1]. Usual proposals rely in nonlinear scenarios [2]; here, we identify the minimal conditions for a nanoscale device to rectify the heat and thermoelectric currents, even in the linear regime. This is achieved for asymmetric coherent conductors that allow for some local thermalization of the heat carriers. We quantify the amount of rectification achieved by this mechanism in some proposed systems composed of resonant-tunneling quantum dots and compare (and combine) it with the non-linear scenarios. Finally, we propose feasible experimental realizations of this idea in an elastic conductor where the interplay between thermalization and nonlinearities can be controlled via quantum interference [3].

References

[1] G. Benenti, G. Casati, C. Mejía-Monasterio and M. Peyrard, Springer International Publishing (Cham, Switzerland), 2016.
[2] B. Li, L. Wang and G. Casati, Phys. Rev. Lett., 93 (2004) 184301.
[3] R. Sánchez, C. Gorini and G. Fleury, Phys. Rev. B, 104 (2021) 115430.

Figures

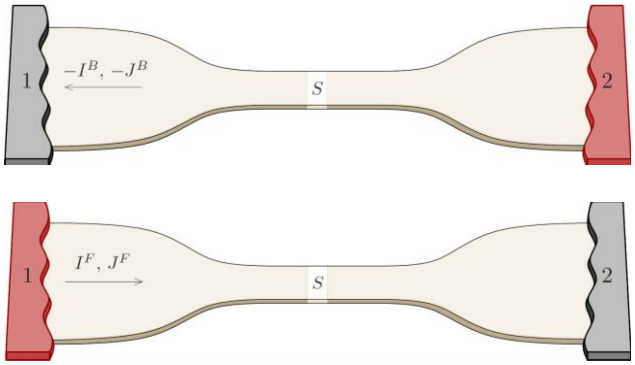

Figure 1: Sketch of the proposed system: two electronic reservoirs are connected by a coherent conductor with a scattering region. Forward and backwards particle and heat currents are represented.