Thermoelectricity without absorbing energy from the heat sources

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Abstract

We analyze the power output of a quantum dot machine coupled to two electronic reservoirs via thermoelectric contacts, and to two thermal reservoirs (one hot and one cold). This machine is a nanoscale analogue of a conventional thermocouple heat-engine, in which the active region being heated is unavoidably also exchanging heat with its cold environment. We observe an "exotic" power generation, which remains finite even when the heat absorbed from the thermal reservoirs is zero (in other words the heat coming from the hot reservoir all escapes into the cold environment). This effect can be understood in terms of a non-local effect in which the heat flow from heat source to the cold environment generates power via a mechanism which we refer to as Coulomb heat drag. It relies on the fact that there is no relaxation in the quantum dot system, so electrons within it have a non-thermal energy distribution. More poetically, one can say that we find a spatial separation of the first-law of thermodynamics (heat to work conversion) from the second-law of thermodynamics (generation of entropy). We present circumstances in which this non-thermal system can generate more power than any conventional macroscopic thermocouple (with local thermalization), even when the latter works with Carnot efficiency. Reference : arXiv:1508.04368

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