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Magnetic-field symmetry of thermoelectric transport

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Symmetry relationships such as the Onsager relations, which are based on the principle of microreversibility, are cornerstones of physics. In the context of mesoscopic physics, symmetries of the conductance in two-terminal and multiterminal devices have been explored in great detail [1,2,3]. Here, we extend these studies to the case where combined thermal and electric (thermoelectric) biases are present. Also for this case, symmetry relations have been predicted, but it has also been predicted that these relations break down at the transition from quantum to classical behavior. An experimental test is therefore necessary. We have experimentally investigated the magnetic field dependence of thermoelectric transport properties in a four-terminal micro-junction, with heat and voltage reservoirs attached to each terminal [4,5]. The linear response thermoelectric coefficients are found to be symmetric under a simultaneous reversal of magnetic field and exchange of injection and emission terminals, confirming the generality of the magnetic-field symmetries. In the non-linear thermal bias regime we find signatures of a break-down of the symmetries, raising new fundamental questions about the mechanism of this breakdown.

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