Symmetry-breaking as a tool for increasing power and efficiency in thermal-to-electric energy conversion

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Thermoelectric systems, which can directly convert a heat gradient into electric current, typically operate in the linear regime described by a well-defined Seebeck coeficient and figure of merit ZT. In this limit, the ratio of actual maximum power relative to the ideal maximum power, the so-called fill factor (FF), is one quarter. By increasing the FF one can potentially drastically increase the maximum power, but this is only possible in the nonlinear regime of transport and has previously rarely been considered. Fundamental symmetry considerations show that the leading order non-linear terms that can increase the FF require devices with broken spatial symmetry. To experimentally demonstrate such a system, we studied nonlinear, thermoelectric transport across an asymmetric energy barrier epitaxially designed in a single semiconductor nanowire and show that we can use symmetry breaking to both increase and decrease the fill factor.

The results will be presented in the context of longterm work to use mesoscopic energy filtering to increase the performance of thermoelectric energy conversion, and I will highlight the potential use of these results in hot-carrier photovoltaics.

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[1] J. Fast, H. Lundström, S. Dorsch, L. Samuelson, A. Burke, P. Samuelsson, H. Linke, cond-mat arXiv:2304.01616