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Brownian Heat Engines – from Leidenfrost Droplets to Nanowire Thermoelectrics

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A Brownian heat engine is a system that rectifies the flow of Brownian particles to transform local temperature variations into directed motion (work). In the context of electronics, this is the principle of thermoelectric energy conversion. For a long time it was thought that Brownian heat engines (and thermoelectric devices) are inherently irreversible and would therefore necessarily fall short of the Carnot limit for the energy conversion efficiency. I will introduce the concept of a Brownian heat engine, and will discuss how quantum energy-filtering can in fact be used to design a Carnot efficient, Brownian heat engine [1]. I will then present two experimental systems. The first, heat-propelled Leidenfrost droplets [2], is not really 'Brownian' but nevertheless a very entertaining and illustrative ratchet heat engine. The second is our experimental effort to demonstrate a near-Carnot efficient thermal-to-electric energy converter [3] based on a quantum dot embedded into a heterostructure nanowire [4]. The physics behind this novel thermoelectric system, and the status of experiments will be discussed.

[1] T. E. Humphrey, R. Newbury, R. P. Taylor, H. Linke, *Phys. Rev. Lett.* **89**, 116801 (2002).
[2] H. Linke *et al.*, *Phys. Rev. Lett.* **96**, 154502 (2006).
[3] M. O'Dwyer, T. E. Humphrey, H. Linke, *Nanotechnology* **17**, S338 (2006).
[4] M. T. Björk *et al.*, *Nano Letters* **2**, 87 (2002).