CRC 1227
Designed Quantum States of Matter

GUEST LECTURE

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DQ-mat Colloquium
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(via Zoom-Meeting)

"Quantum Thermodynamics with Repeated Interactions: Thermometers, Batteries, lesser Demons"

Quantum thermodynamics bridges the gap between statistical physics and quantum information theory, reformulating the laws of thermodynamics for small open quantum systems under external control. To this end, repeated interaction (or collision) models have become a versatile theoretical framework that can be used to describe a broad class of Markovian and non-Markovian scenarios, ranging from equilibration with engineered non-thermal reservoirs to thermodynamic protocols driven by measurements and feedback operations [see e.g. 2106.11974].

For example, we can measure the temperature of a thermal reservoir by locally probing it with a stream of identically prepared ancilla systems. The interplay of the repeated probe interactions and the partial thermalisation in between boosts the temperature sensitivity beyond that of a standard equilibrium thermometer [1904.12551]. I will discuss how this can result in better temperature estimation protocols with limited measurement data.

Putting quantum coherence into the game can lead to further benefits, e.g., improved performance of thermodynamic protocols extracting useful energy (work) from thermal resources (heat). When storing the extracted work in a quantum battery, one may encode it either in the form of population inversion or in the form of coherences. I will present our recent finding that the coherent encoding allows for faster battery charging [2105.01863]. This coherent feature of our repeated-interaction model can be linked to quantum random walks.

Finally, repeated measurement-feedback channels play a role in the context of Maxwell's demon: I will discuss a self-contained model for a measurement-driven quantum engine, where the demon's access is restricted to random position measurements of a damped mechanical pointer [1908.10102]. Such a scheme circumvents the need for an explicit Landauer erasure protocol, and it operates in temperature regimes where simple quantum Otto engines would fail.

All DQ-mat members and all interested are cordially invited to attend.