Postdoctoral Fellow in Quantum Thermodynamics

Thu, 2019-10-31 12:20 - Gabriele De Chiara [1] **At:** Queen's University Belfast
Deadline: 3 January, 2020

Location

Queen's University Belfast Belfast United Kingdom
See map: Google Maps [2]

A postdoctoral research position to undertake theoretical research on “Quantum Thermodynamics” for 30 months from 01/05/2020 to 31/10/2022 is open for applications [3] until 03/01/2020. This post will be funded by an EPSRC grant entitled “Quantum Many-Body Engines” awarded to Dr. Gabriele De Chiara. The project will be conducted in collaboration with experimental groups working on ultracold atomic setups with the aim of designing and realising experimentally quantum thermodynamic machines. More details are available here [4].

Thanks to the tremendous advance in the experimental realisations of quantum technologies applications of thermodynamics with quantum devices are foreseeable in the near future. In the new emerging field of quantum thermodynamics a considerable effort is being devoted to the design and analysis of thermal machines and refrigerators operating at the quantum level and the theoretical foundation of thermodynamics from quantum principles, including the definition of thermodynamic quantities like heat and work, with inputs from quantum information theory.

There are currently several attempts at realising quantum machines, capable of producing work, with a few degrees of freedom, e.g. a single particle. Although quantum thermodynamics is developing very fast, it is not yet clear how to scale up such machines to systems composed of many quantum particles. This achievement would enable practical applications of quantum machines as autonomous devices capable of correcting errors and imperfections in quantum simulators and quantum computers as well as serving as assemblers of quantum materials at the nanoscale.

The overarching challenge of this project is to theoretically design thermal machines, that use as working substance an ensemble of many interacting quantum particles. More specifically, we will consider a network of interacting quantum particles, quantum harmonic oscillators and localised spins, externally driven and coupled to thermal and non-equilibrium reservoirs. The network will be arranged in order to transform heat into mechanical work, thus operating as a thermal engine, or to employ external work to extract heat from a cold reservoir for the realisation of a refrigerator. As a further step, we will optimise the geometry and architecture of the network itself to deliver work and refrigeration with the largest power and efficiency. Since it would be a formidable task to optimise all the tens of parameters of the Hamiltonian, we will employ machine learning techniques to this end. Finally, an important fraction of the project will be done in collaboration with two experimental groups working on ultracold atoms with the aim of designing thermal machines that can be realised with their current experimental setups. In collaboration with J. Sherson (Aarhus) we will design an engine whose working substance and reservoirs are realised with ultracold atoms in optical lattice potentials. In collaboration with T. Donner (Zürich) we will design a refrigerator made of two atomic Bose-Einstein condensates that interact with the common mode of an optical cavity.

- Postdoc [5]

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