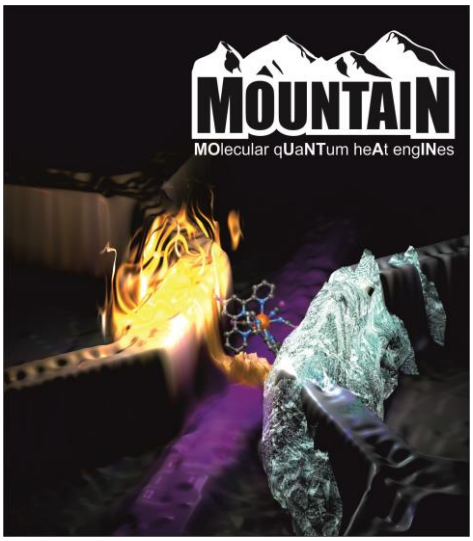
PhD project

Ultra-fast thermometry on molecular heat engines at cryogenic temperatures



Description

Heat engines are an integral part of our daily lives. They power cars or produce electricity by converting heat into work. Increasing their efficiency is very difficult and only marginal improvements have been achieved over the last decades. Thus, to reach the ambitious climate goals, it is necessary to go beyond conventional technologies. Atom-sized systems where quantum mechanical effects come into play could enable this: theory predicts that their efficiency can be boosted beyond the classical limits imposed by thermodynamics. However, so far, this has not been tested in practice due to a lack of suitable model systems.

The aim of this PhD project is to build a molecular heat engine of only a few atoms in size, with such high control over its structure and properties that these predictions can finally be tested. The engine's quantum properties will be robust at experimentally accessible temperatures, its coupling to the environment will be controllable, and electrical transport through it will be quantum coherent. We will seek to exploit the full gamut of their physical properties to boost efficiency, including spin entropy and vibrational coupling.

Practically, the PhD student will (1) fabricate single-molecule junctions with micro-heaters and ultra-sensitive superconducting thermometers, (2) perform and interpret thermal, charge transport and heat-dissipation experiments on single molecules at mK temperatures and with unprecedented precision.

The results of this PhD project will teach us about the fundamental properties of atom-scale quantum systems and heat flowing through single molecules. It will inspire new ways to increase the performance of thermoelectric applications such as waste heat harvesters, nanoscale spot-cooling devices, or even thermal rectifiers and transistors.

The Gehring-lab is one of the forerunners in molecular thermoelectrics, with extensive hands-on experience in material sciences, nanotechnology, and mesoscopic physics. Our multidisciplinary background is needed to make this ambitious project a success.

The Winkelmann-lab is expert in experiments on heat transport and dissipation in nanoelectronic devices at millikelvin temperatures, such as quantum dot junctions and superconducting hybrids. Beyond time-averaged thermal properties, we have recently moved to time-resolved studies, giving insight into fluctuations on the µs time scale.

Your thesis will be fully funded for 4 years by the ERC project MOUNTAIN. You will be working in an international environment in two of the leading research institutions of Europe, with access to the state-of-the art micro/nano fabrication and testing facilities. You will be contributing to a challenging, interdisciplinary topic in a team comprising of physicists, material scientists and electrical engineers.

What you will do

- Work in a state-of-the art clean room.
- Develop ultra-fast cryogenic thermometers.
- Fabricate nano-devices capable of measuring the thermal transport properties of single molecules.
- Cryogenic electrical/thermal quantum transport measurements.
- Hands on experience in operating dilution refrigerators.
- Cryogenic scanning probe microscopy.
- Data evaluation and modelling.
- Present your results in scientific articles and on international conferences and workshops.

Who you are

- MSc degree in Physics, Nanoscience, Materials science, engineering or a related area.
- Strong experimental and analytical skills.
- Motivated to pursue a versatile project combining hands-on work and data modelling.
- Creative and organized, with a keen interest in interdisciplinary research.
- Collaborative attitude, with good interpersonal and communication skills.
- Proficient in spoken and written English.

Conditions of employment

This PhD position is funded for 4 years. The host university is UCLouvain, Belgium. An extended part of the project (1-2 years) will be performed at the Institut Neel (Grenoble). A desired starting date is October 2022.

Environment

UCLouvain, a world-renowned university. With a rich tradition of excellence since its founding in 1425, UCLouvain today plays a leading role in the Europe of knowledge.
You will join the Gehring-Lab (www.gehring-lab.com) which is part of Nanoscopic Physics division @UC Louvain. Our lab is equipped with cryogenic scanning probe and ultra-low noise

measurement equipment. You will have access to the state-of-the-art WINFAB platform for device fabrication and characterisation.

Institut Néel is the largest condensed matter research laboratory in France, hosted jointly by CNRS and Univ. Grenoble Alpes. Located in the French Alps, Grenoble is one of the main European research hubs in fundamental and applied micro- and nanoscience. You will spend a significant part of your PhD in the Winkelmann-lab, with access to two dilution refrigerators and the NANOFAB clean room facility.

Interested?

Are you interested in joining our team and pursuing an interdisciplinary, challenging PhD project in two leading labs in the field of quantum transport? Or do you need more information?

Please contact Prof. Dr. Pascal Gehring (pascal.gehring@uclouvain.be).

To formally apply to this position, please provide the following documents by latest 19th August *2022, 5:00pm* (Brussels time):

1. **a letter of motivation in which you explain why your profile fits this position**
2. **a scientific CV**
3. **a transcript of your master's degree**
4. **the name of 3 references (senior scientists).**

The host institution has supportive policies in place to facilitate a diverse and inclusive working environment (https://uclouvain.be/en/discover/equality). We strongly encourage applications from women and under-represented groups.