Thermodynamics of open quantum systems in the cohetent-dissipative regime

Theory – PhD position (possibly preceded by a final year Master internship)

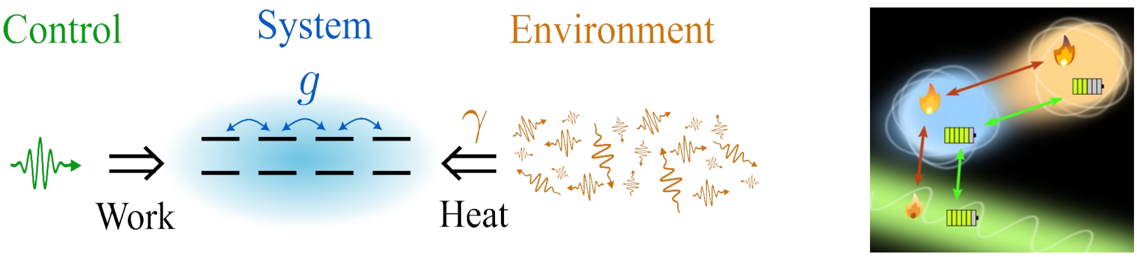

Figure : Left : *Quantum thermodynamics allows the calculation of work and heat flows received by open quantum systems (i.e., systems coupled to an environment). However, the regime where the couplings between systems and dissipation are of the same order of magnitude* $g \sim \gamma$ *is not well understood*. Right : *A recent methodology allows defining work and heat exchanged between multiple quantum systems. The goal of the project is to use it to better understand the case of open systems.*

Can we use the concepts from thermodynamics to better understand quantum phenomena ?

In the 90s, the scope of thermodynamics broadened to include small systems and far-from equilibrium transformations. Building on these advances, the emerging field of quantum thermodynamics has recently lead to breakthroughs formulating nonequilibrium thermodynamics in the quantum regime. Motivations range from the search of quantum advantages in heat engines or batteries based on quantum systems, to the expression of global constraints on many-body quantum dynamics stemming from the Second Law and the Fluctuation Theorems. However, deep quantum regimes where largest deviations from classical thermodynamics are expected remain elusive, limiting applications. In the ubiquitous case of a quantum system weakly coupled to its environment, this is the case of the coherent-dissipative regime, where coherent interaction and dissipation are equally important. Unlocking the thermodynamic description of this genuinely quantum regime is needed to unlock many applications such as evaluating the resource costs of quantum control, optimizing quantum heat engines or understand the energy transfers during a quantum measurement. Those milestones would in turn allow for important experimental developments of quantum thermodynamics in more platforms.

The goal of this theoretical PhD project is to build on recent advances in defining work and heat at the microscopic level for autonomous quantum systems to develop a thermodynamic description of quantum open systems valid in the coherent-dissipative regime. This new methodology will be used to explore the manifestation of thermodynamic laws in the deep quantum regime over a range of applications, in strong connexion with experimental groups (e.g. working with superconducting circuits).

The student will join the Dynamics and Symetry Axis of the LPCT lab in Nancy (Université de Lorraine) and will be supervised by Cyril Elouard (Junior Professor). We welcome applications of final year Master student wishing to do an internship before their PhD in the lab. The PhD is funded by the European ERC Starting Grant project "QARNOT".

The LPCT is an equal opportunity laboratory with a working environment actively promoting equality, diversity, and inclusion.

Pour more information and application, please contact : cyril.elouard[at]univ-lorraine.fr