# PhD THESIS DEFENSE: Optimization and Geometry for Quantum Information tasks

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December 12, 2022

15:00

ICFO Auditorium and Online (Teams)

In this thesis, we study the optimization of operational tasks that involve the manipulation of quantum resources. In most cases, such optimizations are aided by understanding the geometric properties of the physical objects involved. We split our results in a first part concerning Thermodynamics, and a second part concerning Information Theory.?

In the context of Thermodynamics, we first study the optimization of thermal machines. Tha is, we look for those periodic control protocols, performed on a quantum working fluid, tha maximize figures of merit based on power and efficiency. By making small assumptions o the dynamical regimes (of low-dissipation/slow-driving, or fast-driving), we are able t construct and characterize optimal protocols that are valid for large classes of quantum (an classical) thermal machines

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Secondly, we study how to design quantum thermal probes that optimize the precision i temperature estimation when put in contact with a thermal bath. The resulting optima configurations are simple and physically feasible, and show an Heisenberg-like scaling of th optimal sensitivity

In the context of Information Theory, initially we study how to characterize memory effect (information backflows) in the dynamics of open quantum systems, how to detect them an operationally exploit them

Furthermore, in the subfield of Nonlocality, we study relaxations and generalisation of th canonical Bell scenario, which allow us to bring the realization of nonlocal experiments close to simple, table-top quantum optics. In particular, by considering nonlocality in quantu networks, we are able to design an experiment which only involves simple passive optics an single-photon entangled states, in which it is possible to certify nonlocality withou measurement inputs. Likewise, a different relaxation consists in allowing trusted quantu inputs in a Bell experiment. This permits certifying nonlocality of any entangled state, withou trusting the measurement device. We study this measurement-device-independen framework to design simple protocols of entanglement detection for continuous-variabl states

The results of the thesis are relevant both from the theoretical point of view and for th efficient realisation of the operational tasks analysed

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