PHYSICS

DISAT - Non-equilibrium coherent thermal effects in quantum systems

Funded By	Dipartimento DISAT
Supervisor	DOLCINI FABRIZIO - fabrizio.dolcini@polito.it
Contact	GIROLAMI DAVIDE - davide.girolami@polito.it
Context of the research activity	The research area is Theoretical Physics of Matter, with a focus on Quantum Physics, and it involves ingredients of Statistical Physics, Condensed Matter Physics, Quantum Information, Field Theory Progetto PRIN 2022 - 1191/2023 Non-equilibrium coherent thermal effects in quantum systems - CUP E53D23001650006
Objectives	“Non-equilibrium coherent thermal effects in quantum systems” (NEThEQS) is a project in Theoretical Physics of Matter that has been recently financed by the Italian Ministry of University and Research, involving a collaboration between staff of the “Nanophysics and Quantum Systems” group at Politecnico di Torino and the NANO-CNR Institute of Nanoscience in Pisa. The project aims to investigate the interplay between quantum coherent phenomena and non-equilibrium thermal effects, addressing some specific open problems in the rapidly growing field of quantum thermodynamics, with a balance between fundamental questions of quantum thermal engines and some of their implementations. To a more fundamental level, the goal is to investigate a quantum system operating as a heat engine between two reservoirs and converting a temperature gradient into work. In particular we shall address whether and how entanglement and other kinds of quantum correlations can improve the efficiency of a quantum thermodynamic cycle. To a more applicative level, we shall study specific implementations of thermal engines in quantum technologies. Focussing on topological materials (e.g. quantum Hall or quantum Spin Hall systems), possibly coupled to superconductors, we plan to investigate whether their phase-coherent transport can be exploited to control their thermoelectric response through electron quantum interference, to clarify the relation between entanglement and thermoelectric effects, and to compute the correlations of charge, heat and spin currents. Moreover, the project aims to explore the heat dynamics in the far from equilibrium regime in order to understand how it is affected by the presence of topological states. The Ph.D. candidate is expected to combine analytical and numerical

	methods, and to actively cooperate across the two project units. Fundings are also available for missions in Italy and to support other international collaborations related to the project topics.

Skills and competencies for the development of the activity	Quantum Mechanics, Statistical Physics, Condensed Matter Physics, Quantum Information, Out of Equilibrium Physics, Field Theory