



PhD THESIS DEFENSE: Investigations of Topological Phases for Quasi-1D Systems

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ICFO Auditorium and Online (Teams)

PhD Thesis Defense, July 13, 2020, 11:00. Online

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Quantum Optics Theory

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For a long time, quantum states of matter have been successfully characterized by the Ginzburg-Landau formalism that was able to classify all different types of phase transitions. This view changed with the discovery of the quantum Hall effect and topological insulators. The latter are materials that host metallic edge states in an insulating bulk, some of which are protected by the existing symmetries.

Complementary to the search of topological phases in condensed matter, great efforts have been made in quantum simulations based on cold atomic gases. Sophisticated laser schemes provide optical lattices with different geometries and allow to tune interactions and the realization of artificial gauge fields. At the same time, new concepts coming from quantum information, based on entanglement, are pushing the frontier of our understanding of quantum phases as a whole.

The concept of entanglement has revolutionized the description of quantum many-body states by describing wave functions with tensor networks (TN) that are exploited for numerical simulations based on the variational principle.

This thesis falls within the framework of the studies in condensed matter physics: it focuses indeed on the so-called synthetic realization of quantum states of matter, more specifically, of topological ones, which may have on the long-run outfalls towards robust quantum computers. We propose a theoretical investigation of cold atoms in optical lattice pierced by effective (magnetic) gauge fields and subjected to experimentally relevant interactions, by adding a modern numerical approach based on TN algorithms. More specifically, this work will focus on (i) interacting topological phases in quasi-1D systems and, in particular, the Creutz-Hubbard model, (ii) the connection between condensed matter and high energy physics studying the Gross-Neveu model and the discretization of Wilson-Hubbard model, (iii) implementing tensor network-based algorithms.

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Thesis Advisor: Prof Dr Maciej Lewenstein

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