INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title: Interaction and disorder effects on topology in one-dimensional lattices

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Thesis Submitted to the Department/ Center	:	Physics
Date of completion of Thesis Viva-Voce Exam	:	16.02.2024
Key words for description of Thesis Work	:	Topological phase transition, Interaction effect, Disorder effect, Localization transition, Thouless charge pumping, DMRG

SHORT ABSTRACT

The topological phases and phase transitions in condensed matter is subject of great interest in the field of condensed matter physics. Starting from the first observation of the quantum Hall effect in two dimensional electron systems, study of topological phases has attracted a great deal of attention in the last several decades. Topological phases are characterised by gapped bulk spectrum and gapless or localized edge states, non-local correlations and well defined topological invariants. A class of topological phases which is known as the symmetry protected topological phases where the bulk-boundary correspondence is protected by some underlying symmetries. In general the topological character is robust to perturbation although strong perturbation such as interaction and disorder breaks down the topological nature. However, in certain cases, these perturbations can drive a topological phase transition or may induce a topological character in the system. Due to the rapid progress in the field of quantum simulations of such systems in artificial experimental setups and their relevance as effective models to some of the real materials, these systems are explored in various different contexts. Motivated by this development, we focus on the study of interaction and disorder effects on the topological character of low dimensional lattice systems in this thesis.

The content of the thesis is two-fold. In the first half we discuss the interaction mediated topological phases and transition in low dimensional lattices. In the second part we discuss the effect of quasiperiodic disorder in the system. First, we propose that in a one dimensional lattice of spinless fermions, a dimerized nearest neighbour interaction can stabilise a well-defined topological phase transition even though the system is a gapless liquid in the non-interacting limit. We then show that in a system of two-component spinless fermions, the topological character in one of the components can be induced by the density dependent hopping of the other component. We then study the topological properties of bosons on a two-leg ladder coupled by inter-leg hopping and interaction. By considering two different types of dimerizations on the legs, we have shown how interaction can mediate topological phase transitions in the many-body system. In the rest of the thesis we discuss the effect of quasiperiodic disoder on a one dimensional lattice. Before studying the effect of quasiperiodic disorder on the topological phases, we study the localization properties as a function of disorder. In this context, we obtain an interesting re-entrant localization transition in the presence of quasiperiodic disorder and a staggered local potential. Subsequently, we study the effect

of disorder on the topological properties of the system. In this context we propose a model where we have shown that a well defined topological phase transition can be established as a function of disorder and we quantify this behaviour in the context of Thouless charge pumping. All the studies in the thesis are performed using numerical methods such as the exact diagonalization and the density matrix renormalization group (DMRG) methods.