Q 19: Cold atoms IV - topological systems (joint session A/Q)

Time: Monday 16:15–17:30 Location: K 0.011

Q 19.1 Mon 16:15 K 0.011

Properties of the one-particle density matrix in an interacting Chern insulator — •Andrew Hayward[1], Marie Piraud[2], and Fabian Heidrich-Meisner[2,3] — [1]LMU, Munich, Germany — [2]TU, Munich, Germany — [3]Georg-August-University Goettingen, Germany

The notion of a topological insulator is rooted in the physics of non-interacting particles but generalizes to interacting systems. Here we investigate how much the topological properties of an interacting Chern insulator are encoded in the single-particle quantities derived from the one-particle density matrix (OPDM) computed in the many-body ground state. The diagonalization of the OPDM yields the occupation spectrum and its eigenfunctions. In a concrete example we study how the occupations evolve as a function of interactions and how the eigenfunctions are deformed away from the non-interacting limit. After resolving potential ambiguities in defining OPDM eigenbands,we compute the Chern numbers for these emergent OPDM bands,which are necessarily quantized. The behavior of these quantities, occupations, OPDM eigenfunctions, and OPDM Chern numbers, across a transition into a topologically trivial phase is discussed.This research is supported by DFG Research Unit FOR2414.

Q 19.2 Mon 16:30 K 0.011

Local topological invariant of an interacting, time-reversal-symmetric Hofstadter interface — •Bernhard Irsigler, Jun-hui Zheng, and Walter Hofstetter — Institut für Theoretische Physik, Goethe-Universität, Frankfurt am Main

Two-dimensional topological insulators possess conducting edge states at their boundary while being insulating in the bulk. However, the detection of edge states remains an open question in ultracold atom setups. We propose a configuration to implement a topological interface within the experimentally realizable Hofstadter model which gives rise to a topological phase boundary at the center of the system, and investigate the influence of two-body interactions in a fermionic system. The location of the boundary can in principle be detected via the spatially resolved compressibility of the system with a quantum gas microscope. Furthermore, we compute a local topological invariant through adiabatic pumping which confirms the topological phase separation.

Q 19.3 Mon 16:45 K 0.011

Topological invariant for 2D open systems — •Jun-Hui Zheng and Walter Hofstetter — Goethe-Universität, 60438 Frankfurt am Main, Germany

We study the topology of 2D open systems in terms of the Green's function. The Ishikawa-Matsuyama formula for the integer topological invariant is applied in open systems and the equivalent descriptions through topological Hamiltonian and Berry curvature are developed separately. The invariant is well-defined iff all of the eigenvalues of the Green's function for imaginary frequency are finite nonzero numbers. Meanwhile, we define another topological invariant via the single particle density matrix, which works for general gapped systems and is equivalent to the former for the case of weak coupling to an environment. We also discuss two applications. For time-reversal invariant insulators, we explain the relation between the invariant for each spin-subsystem and the Z_2 index of the full system. As a second application, we consider the interference effect when an ordinary insulator is coupled to a topological insulator. The bulk-boundary correspondence of the open system shows new features.

Q 19.4 Mon 17:00 K 0.011

Topological phase transition in 2D interacting disordered systems — •Jun-Hui Zheng and Walter Hofstetter — Goethe-Universität, 60438 Frankfurt am Main, Germany

We study the topological phase transition and the transport properties in two-dimensional interacting disordered systems. A generalized Ishikawa-Matsuyama formula is developed as a topological index. Without considering the vertex correction of current operators, it corresponds to the Hall conductance of the system, within the dynamical mean-field approximation. As an example, we consider the spinful Haldane-Hubbard model. The averaged Hall conductance over different configurations of disorder is evaluated and the interaction effects are token into account by employing the dynamical mean-field theory. The finite size effects of the system are also discussed.

Q 19.5 Mon 17:15 K 0.011

Hidden order and symmetry protected topological states in quantum link ladders — •Lorenzo Cardarelli[1], Sebastian Greschner[2], and Luis Santos[1] — [1]Institut für Theoretische Physik, Leibniz Universität Hannover, 30167 Hannover, Germany — [2]Department of Quantum Matter Physics, University of Geneva , 1211 Geneva, Switzerland

We show that whereas spin-1/2 one-dimensional U(1) quantum-link models (QLMs) are topologically trivial, when implemented in ladder-like lattices these models may present an intriguing ground-state phase diagram, which includes a symmetry protected topological (SPT) phase that may be readily revealed by analyzing long-range string spin correlations along the ladder legs. We propose a simple scheme for the realization of spin-1/2 U(1) QLMs based on single-component fermions loaded in an optical lattice with *s*- and *p*-bands, showing that the SPT phase may be experimentally realized by adiabatic preparation.