MA 29: Topological Insulators I (joint session TT/MA)

Time: Wednesday 11:45–13:00 Location: A 053

MA 29.1 Wed 11:45 A 053

Towards universal Hong-Ou-Mandel correlations in topological insulators — •Andreas Bereczuk, Juan Diego Urbina, Cosimo Gorini, and Klaus Richter — Institut für Theoretische Physik, Universität Regensburg, Germany

The quantum-classical transition of the transmission probability for two fermions propagating through a quantum point contact is a known manifestation of the celebrated Hong-Ou-Mandel (HOM) effect [1] in electron quantum optics [2]. As shown in [3], universal HOM correlations are expected by substituting the quantum point contact by a chaotic cavity in a mesoscopic regime [3], where universality appears due to universal correlations of the scattering matrix entries at different energies. Here we present an analytical and numerical study of these correlations and propose electron quantum optics with cavities as complex beam splitters and edge states as waveguides as a candidate to observe universal HOM correlations in topological insulators.

[1] C. K. Hong, Z. Y. Ou, L. Mandel, PRL **59**, 2044 (1987)
[2] E. Bocquillon et al., Annalen der Physik **526**, 1 (2014)
[3] J. D. Urbina et al., Phys. Rev. Lett. **116**, 100401 (2016)

MA 29.2 Wed 12:00 A 053

Effects of local approximations on topological phases — •Thomas Mertz, Karim Zantout, and Roser Valenti — ITP, Goethe University, Frankfurt am Main

We investigate the self-energy dispersion of topological models and its effect on the topological classification in terms of invariants computed in the framework of the so-called topological Hamiltonian, an auxiliary Fermi-liquid like theory. The concept of topology in physics has matured as a non-interacting theory, most of its properties deeply intertwined with the conventional band theory of solids. Recently, a lot of interest has shifted towards interacting systems, which have not been studied extensively from a topological point of view. Since the topological Hamiltonian is determined by the zero-frequency value of the self-energy only, which has been studied using local theories, we focus on the explicit momentum-dependence captured by methods such as TPSC and CPT.

MA 29.3 Wed 12:15 A 053

Spin-phonon scattering in edge states of two-dimensional topological insulators — •Solofo Groenendijk, Giacomo Dolcetto, and Thomas Schmidt — Physics and Materials Science Research Unit, University of Luxembourg, L-1511 Luxembourg

We study theoretically the effect of electron-phonon scattering in 2D topological insulator (2DTI) edge states. Due to the spin-momentum locking in helical edge states, dynamical deformations of the edge modify the spin texture of the electronic edge states. In our work, we show that the resulting spin-phonon coupling ultimately leads to backscattering.

For a short channel, we compute the temperature-dependent conductance in the linear regime ($\beta eV < k_B T$) using the Kubo formula, and find $\delta G \propto T^5$ for the backscattering conductance. In the limit of a long edge channel, transport becomes diffusive and we compute the resistivity ρ using the semi-classical Boltzmann equation. In particular we find a metallic Bloch-Grüneisen behaviour for chemical potentials near the Dirac point.

Since this spin-phonon coupling arises even in ideal samples and since further imperfections (e.g. Rashba impurities, charge puddles, electron-electron interactions etc.) can only increase backscattering, our results impose a fundamental upper limit on the conductivity of 2D TI edge states.

MA 29.4 Wed 12:30 A 053

Topological invariants for Floquet-Bloch systems with chiral, time-reversal, or particle-hole symmetry — •Bastian Höckendorf, Andreas Alvermann, and Holger Fehske — Institut für Physik, Ernst-Moritz-Arndt-Universität Greifswald, Greifswald, Germany

We introduce $\mathbb{Z}_2$-valued bulk invariants for symmetry-protected topological phases in $2+1$ dimensional driven quantum systems. These invariants adapt the W_3-invariant, expressed as a sum over degeneracy points of the propagator, to the respective symmetry class of the Floquet-Bloch Hamiltonian. The bulk-boundary correspondence that holds for each invariant relates a non-zero value of the bulk invariant to the existence of symmetry-protected topological boundary states. To demonstrate this correspondence we apply our invariants to a chiral Harper, time-reversal Kane-Mele, and particle-hole symmetric graphene model with periodic driving, where they successfully predict the appearance of boundary states that exist despite the trivial topological character of the Floquet bands. Especially for particle-hole symmetry, combination of the W_3 and the $\mathbb{Z}_2$-invariants allows us to distinguish between weak and strong topological phases.

[1] B. Höckendorf, A. Alvermann, and H. Fehske, J. Phys. A 50, 295301 (2017).
[2] B. Höckendorf, A. Alvermann, and H. Fehske, preprint, arXiv:1708.07420 (2017).

MA 29.5 Wed 12:45 A 053

Reduced many-body formulas for the macroscopic polarization and topological charge pumping — •Ryan Requist[1] and Eberhard K. U. Gross[1,2] — [1]Max Planck Institute of Microstructure Physics, Halle, Germany — [2]Fritz Haber Center for Molecular Dynamics, Jerusalem, Israel

In ab initio materials research, topological invariants and the macroscopic polarization are usually calculated in terms of an effective single-particle Kohn-Sham band structure, an approach which may give incorrect results even if the exact exchange-correlation potential is used. We propose a simple natural orbital geometric phase formula for the macroscopic polarization and verify that it accurately reproduces the polarization in the Rice-Mele-Hubbard model in strongly and weakly correlated regimes. An analogous formula based on a one-body reduced Berry curvature very accurately predicts the critical Hubbard interaction at which Thouless charge pumping is quenched. We discuss strategies for ab initio calculations of natural orbital geometric phases and the possibility of extending the approach to other topological invariants in correlated materials.