SYTO 1: Topology in Condensed Matter Physics

Time: Wednesday 9:30–12:15 Location: H 0105

Invited Talk SYTO 1.1 Wed 9:30 H 0105
Beyond Topologically Ordered States: Insights from Entanglement — •B. Andrei Bernevig — Princeton University

I will discuss and show several examples where well-accepted mathematical theories of topological phases of matter need to be augmented. In topological insulators, I will show examples of very esoteric phases, realizable in materials, that are beyond the so called-K theory classification thought to be the end-all mathematical framework of band insulators. In interacting topologically ordered phases of matter, I will show that for some 3D hamiltonians the entanglement entropy has a behavior that cannot be explained by any usual Field theory approach. In several one-dimensional magnets, I will show that excited states on top of a topologically ordered ground-state coexist with thermalized states.

Invited Talk SYTO 1.2 Wed 10:00 H 0105
Topological Magnon Materials — Alexander Mook[1], Jürgen Henk[1], and •Ingrid Mertig[1,2] — [1]Martin-Luther-Universität Halle-Wittenberg, Halle, Germany — [2]Max-Planck-Institut für Mikrostrukturphysik Halle, Halle, Germany

Topology has conquered the field of condensed matter physics with the discovery of the quantum Hall effect. Since then the zoo of topological materials is steadily increasing. In this talk, we demonstrate how to realize different topological phases with magnons: the magnon pendants to topological insulators as well as Weyl and nodal-line semimetals are presented.

Magnon bulk spectra are characterized by topological invariants, dictating special surface properties. The bulk bands of topological magnon insulators (TMIs) carry nonzero Chern numbers, causing topological magnon edge states [1]. Weyl semimetals possess zero-dimensional band degeneracies. They feature "magnon arcs" connecting the surface projections of Weyl points [2]. Magnon nodal-line semimetals exhibit one-dimensional band degeneracies, i. e., closed loops in reciprocal space. Surface projections of these nodal lines host "drumhead" surface states [3].

Similar to the electronic case, the topological properties cause transverse transport, that is, magnon Hall effects.

[1] A. Mook et al., Phys. Rev. B 90, 024412 (2014);
[2] A. Mook et al., Phys. Rev. Lett. 177, 157204 (2016);
[3] A. Mook et al., Phys. Rev. B 95, 014418 (2017)

Invited Talk SYTO 1.3 Wed 10:30 H 0105
Topological Order of Interacting Polymers on a Substrate — •Vincenzo Vitelli — Physics Department, University of Chicago, 929 East 57th Street, USA

Polymer liquids at interfaces have many applications ranging from anisotropic surface reflectivity and nanowire templates to directional lubrication. However, robust nanoscale control of polymer-liquid structure remains challenging. In this talk, we demonstrate how to generate topologically protected interfacial patterns by exploiting the interplay between thermal fluctuations and strong interactions between directed polymers (subject to a spatially modulated substrate potential). Unlike other classical analogues of electronic topological insulators, here topological protection does not manifest itself in edge modes, but rather in the collective alignment of the polymer chains along selected substrate directions. This equilibrium orientation angle is proportional to a Chern number and, therefore, is topologically robust against substrate disorder. We establish this conclusion numerically and theoretically by introducing a mathematical mapping between the polymeric pattern and Thouless pumping in an imaginary-time Mott insulator. Our results highlight a general strategy to export topological protection associated with wave-like states in electronic Chern insulators (subject to Pauli exclusion principle) to soft matter systems described by the diffusion equation with the addition of strong interactions.

15 min. break.

Invited Talk SYTO 1.4 Wed 11:15 H 0105
Quantization of Heat Flow in Fractional Quantum Hall States — •Moty Heiblum — Weizmann institute

Quantum mechanics sets an upper bound on the amount of charge flow as well as on the amount of heat flow in ballistic one-dimensional channels. The two relevant upper bounds, that combine only fundamental constants, are the quantum of the electrical conductance, $G_e = e^2/h$, and the quantum of the thermal conductance, $G_{th} = \pi^2 {k_B}^2 T/3h$. Remarkably, the latter does not depend on particles charge; particles exchange statistics; and even the interaction strength among the particles. However, unlike the relative ease in determining accurately the quantization of the electrical conductance, measuring accurately the thermal conductance is more challenging. The universality of the latter quantization was demonstrated for weakly interacting particles; such as, phonons [1], photons [2], and electronic Fermi-liquids [3]. I will describe our recent experiments of heat flow in a strongly interacting system of 2D electrons in the FQHE regime. I will focus on particle-like states (Laughlin's states, v < 1/2), and on the more complex, hole-conjugate states (1/2 < v < 1) [4]. More recently, we extended our studies to fractional states in the first-excited Landau level (2<v<3). In particular, in the v=5/2 state we find a deviation from the quantization of the thermal conductance, suggesting a non-abelian behavior [5].

[1] K. Schwab, et al., Nature 404, 974 (2000)
[2] M. Meschke, et al., Nature 444, 187 (2006)
[3] S. Jezouin, et al., Science 342, 601 (2013)
[4] M. Banerjee et. al., Nature 545, 75 (2017)
[5] M. Banerjee et. al., arXiv: 1710.00492

Invited Talk SYTO 1.5 Wed 11:45 H 0105
Currents and Phases in Quantum Rings — •Kathryn Moler — Stanford University, California, USA

The current as a function of the phase across any superconducting junction or constriction is a fundamental and informative property. In junctions made of topological materials, the current could theoretically be 4pi-periodic rather than 2pi-periodic. I will report on gate-tuned current-phase relations for junctions with high transmission and few modes.