MA 16: Topological Insulators (joint session MA/HL)

Time: Tuesday 14:00–15:15 Location: H16

MA 16.1 Tue 14:00 H16

Topological Hall effects on two-dimensional Archimedean lattices — •L.V. Duc Pham[1,2], Nicki F. Hinsche[2], and Ingrid Mertig[2] — [1]Fakultät für Chemie und Lebensmittelchemie, Technische Universität Dresden, Bergstraße 66c, 01062 Dresden, Germany — [2]Institut für Physik, Martin-Luther-Universität Halle-Wittenberg, D-06099 Halle (Saale), Germany

Archimedean lattices are a family of tilings in which the two-dimensional plane is filled with different regular polygons while maintaining the vertices configuration. Kagome, the most famous member of the Archimedean lattices familiy, was studied extensively in a wide variety of theoretical works. Another lattice of this type, the snub square lattice, was also used as an approximant for quasi crystals [1]. The rich geometry of these systems gives rise to various unconventional nano ribbon edge configurations and therewith various possible topological edge states. In this work, we calculate the band structures of all 8 pure Archimedean lattices using a tight-binding method including s and p orbitals and study topological properties of these lattices, such as topological edge states, the $\mathbb{Z}_2$ invariance and the quantum spin Hall conductivity within the Kubo formalism [2].

[1] Roy, Sumalay, et al. "The Kepler tiling as the oldest complex surface structure in history: X-ray structure analysis of a two-dimensional oxide quasicrystal approximant." Zeitschrift für Kristallographie-Crystalline Materials 231.12 (2016): 749-755

[2] Sinova, Jairo, et al. "Spin hall effects." Reviews of modern physics 87.4 (2015): 1213-1260

MA 16.2 Tue 14:15 H16

Spin topology, spin-orbit coupling and entanglement — •Gunnar Felix Lange[1], Wojciech Jankowski[2] und Robert-Jan Slager[2,3] — [1]Department of Physics, University of Oslo, Norway — [2]TCM Group, Cavendish Laboratory, University of Cambridge, UK — [3]Theoretical Physics Group, University of Manchester, UK

Topological systems with time-reversal symmetry are of great theoretical and practical interest. Theoretically, such phases often rely on studying the topology in each spin sector separately, as in the spin Hall effect.

This requires identifying the spin degree of freedom in the band structure, which is not always straightforward in the presence of spin-orbit coupling. This field has received renewed interest in recent years, leading to the concept of spin topology.

In this talk, we will discuss some recent results on spin topological phases, with a particular focus on spin-orbit coupling and its interplay with entanglement.

MA 16.3 Tue 14:30 H16

Fractionally Charged Vortices at Quantum Hall/Superconductor Interfaces — •Enderalp Yakaboylu and Thomas Schmidt — Department of Physics and Materials Science, University of Luxembourg, L-1511 Luxembourg

We investigate interface states between a type-II s-wave superconductor (SC) and a Chern insulator describing an integer quantum Hall (QH) system. We find that an effective pairing interaction at this boundary gives rise to two emergent Abelian Higgs fields, representing the two paired electrons at the SC/QH interface, coupled to a gauge field that incorporates both Chern-Simons and Maxwell terms. We use this model to investigate the effect of magnetic flux vortices in the SC on the QH system. In particular, we find vortex solutions in which the Cooper pairs give rise to topological fractionally-charged vortices localized at the interface.

MA 16.4 Tue 14:45 H16

Local and Global Topological Characteristics of Local Magnetic Moments Coupled to Chern Insulators — •Devesh Vaish and Michael Potthoff — I. Institute of Theoretical Physics, Department of Physics, University of Hamburg

A magnetic impurity, modelled as a classical spin and locally exchange coupled to a Chern insulator may cause in-gap bound states. Their nature can be very different depending on the (k-space) topological phase of the Chern insulator. Here we study several impurity spins coupled to a QWZ model and analyze, for different k-space topological phases, the additional "local" topological properties on the manifold of impurity-spin configurations (S-space). In case of $R > 1$ spins, the R-th spin-Chern number serves as a topological invariant on S-space. Varying the local exchange-coupling strength, we find local topological phase transitions and relate them to Fermi-energy crossings of in-gap states. In addition, we compute the first spin-Chern number for various physically motivated closed two-dimensional sub-manifolds of the full configuration space and relate those to the R-th spin-Chern number.

MA 16.5 Tue 15:00 H16

Non-relativistic linear Edelstein effect in noncollinear EuIn2As2 — •Adriana Nayra Alvarez Pari[1], Rodrigo Jaeschke Ubiergo[1], Atasi Chakraborty[1], Jairo Sinova[1,5], and Libor Smejkal[1,2,3,4] — [1]Institut für Physik, Johannes Gutenberg Universität, Mainz, Germany — [2]Max Plank Institute for the Physics of Complex Systems, Dresden, Germany — [3]Max Planck Institute for Chemical Physics of Solids, Dresden, Germany — [4]Institute of Physics, Academy of Sciences of the Czech Republic, Praha, Czech Republic — [5]Department of Physics, Texas A & M University, Texas, USA

Motivated by the ongoing interest in understanding the actual magnetic ground state of the promising axion insulator candidate EuIn2As2, we present here a spin symmetry analysis and *ab-initio* calculations, aiming to identify specific exchange-dominated physics that could offer insights into the current debate. We investigate two non-collinear coplanar magnetic orders reported in this compound: the *helical* and *broken-helical* phases [1]. Our symmetry analysis shows that magnetic-exchange alone results in the formation of an out-of-plane odd-wave order in momentum space in both phases. Additionally, we identify an in-plane g-wave order that emerges exclusively in the *broken-helical* phase, providing a distinguishing feature for this phase. Furthermore, we report a non-relativistic Edelstein effect with a distinct out-of-plane polarized spin density that dominates over spin-orbit coupling effects.

[1] Pari, Nayra A. Álvarez, et al. "Non-relativistic linear Edelstein effect in non-collinear EuIn2As2." *arXiv:2412.10984* (2024)