TT 64: Topology: Other Topics

Time: Friday 9:30–11:30 Location: HSZ 201

TT 64.1 Fri 9:30 HSZ 201

Fermi arc reconstruction in synthetic photonic lattice — •Duy Hoang Minh Nguyen[1], Chiara Devescovi[1], Dung Xuan Nguyen[2], Hai Son Nguyen[3,4], and Dario Bercioux[1,5] — [1]Donostia International Physics Center, 20018 Donostia-San Sebastian, Spain — [2]Center for Theoretical Physics of Complex Systems, Institute for Basic Science (IBS), Daejeon, 34126, Republic of Korea — [3]Univ Lyon, Ecole Centrale de Lyon, CNRS, INSA Lyon, Universite Claude Bernard Lyon 1, CPE Lyon, CNRS, INL, UMR5270, Ecully 69130, France — [4]Institut Universitaire de France (IUF), F-75231 Paris, France — [5]IKERBASQUE, Basque Foundation for Science, Euskadi Plaza, 5, 48009 Bilbao, Spain

The chiral surface states of Weyl semimetals are known for having an open Fermi surface called Fermi arc. At the interface between two Weyl semimetals, these Fermi arcs are predicted to potentially deform into unique interface states. In this work, we numerically study a one-dimensional (1D) dielectric trilayer grating where the relative displacements between adjacent layers play the role of two synthetic momenta. The lattice is described by an effective Hamiltonian whose spectral properties coincide closely with rigorous electromagnetic simulations. Our trilayer system is a simple but versatile platform that emulates 3D crystals without time-reversal symmetry, including Weyl semimetal, nodal line semimetal, and 3D Chern insulator. It allows us to not only observe phenomena such as the phase transition between Weyl semimetal and Chern insulator but also confirm the Fermi arc reconstruction between two Weyl semimetals.

[1] arXiv:2211.07230

TT 64.2 Fri 9:45 HSZ 201

Electronic correlations and pseudo Fermi arcs due to geometry of the Fermi surface in semimetals — •Elena Derunova — IFW, Helmholz str.20, Dresden

Moving forward from topological theory I present a geometrical approach to analyze the bandstructures and Fermi surfaces. Particularly, the effect of hyperbolic geometry of the Fermi surface on the Fermi liquid breakdown and correlated transport effects will be presented. As a mechanism for realizing these correlations, I introduce pseudo Fermi arcs connecting separate pockets of hyperbolic Fermi surface. A breakdown of time-reversal symmetry via tunneling through those pseudo arcs is referred as Fermi Surface Geometry Effect (FS-GE). The predictable power of FS-GE is tested on the spin and anomalous Hall effects, traditionally associated with intrinsic time-reversal symmetry breaking. An index, H_F, quantifying FS-GE in a particular direction, shows a universal correlation ($R^2 = 0.97$) with the experimentally measured intrinsic anomalous Hall conductivity in that direction, of 16 different compounds spanning a wide variety of crystal, chemical, and electronic structure families, where the topological methods give just $R^2 = 0.52$. This raises a question about the principal limits of topological physics, dominating now the predictions of non-trivial electron transport, and its transformation into a wider study of bandstructures' and Fermi surfaces' geometries, opening a horizon for the prediction of phenomena beyond topological understanding.

TT 64.3 Fri 10:00 HSZ 201

Markers in Landau levels for topological transitions in Bernal bilayer graphene — •Nils Jacobsen[1], Anna Seiler[1], Zhiyu Dong[2], Thomas Weitz[1], and Leonid Levitov[2] — [1]1st Physical Institute, Faculty of Physics, University of Göttingen, Göttingen, Germany — [2]Department of Physics, Massachusetts Institute of Technology, Cambridge, USA

This talk will discuss Landau levels in an electron band that exhibits the topological Lifshitz transition. We focus on Bernal-stacked bilayer graphene, a system that has drawn a lot of attention recently. A dual gated experimental setup allows to tune the out-of-plane displacement field and the charge carrier density independently, giving insights in exotic correlation effects [1]. Depending on the charge carrier density its Fermi surface changes its topology, that is, four disconnected pockets merge together to form one connected Fermi sea [2].

This topological transition results in a complex series of Landau levels which are not valley-symmetric and, as a result, change their order and degeneracy when the magnetic field is varied. These effects are added to the degeneracies that are already present due to valley and spin degrees of freedom. By virtue of numerical diagonalization methods based on a realistic tight binding model, we extract this Landau level sequence and directly relate it to transport measurements. Our model allows us to access the range of parameters of interest where the topological Lifshitz transition can occur.

[1] A. M. Seiler et al., Nature 608, 298 (2022)
[2] E. McCann et al. Rep. Prog. Phys. 76, 056503 (2013)

TT 64.4 Fri 10:15 HSZ 201

Topological classification of single-particle Green functions and effective Hamiltonians for interacting systems — Maximilian Kotz[1] and •Carsten Timm[1,2] — [1]Institute of Theoretical Physics, TU Dresden, 01062 Dresden, Germany — [2]Würzburg-Dresden Cluster of Excellence ct.qmat, TU Dresden, 01062 Dresden, Germany

The single-particle Green function for any interacting-electron system can be written as the resolvent of a generally frequency-dependent and non-Hermitian effective Hamiltonian. Both these properties together allow for 54 instead of ten global-symmetry classes. The absence of Hermiticity also requires to reconsider the concept of a spectral gap. If the limits of the effective Hamiltonian for frequency $\omega \to \pm\infty$ coincide one can compactify the frequency axis and consider winding in $(d+1)$-dimensional momentum-frequency space. We derive a complete list of the homotopy groups for the 54 classes and spatial dimensions d, for the cases without and with frequency dependence.

TT 64.5 Fri 10:30 HSZ 201

Solitons and topology: Observation of cnoidal wave localization in non-linear topolectric circuits — •Hendrik Hohmann[1], Tobias Hofmann[1], Tobias Helbig[1], Hauke Brand[2], Lavi K. Upreti[1], Alexander Stegmaier[1], Alexander Fritzsche[1], Tobias Müller[1], Ching Hua Lee[3], Martin Greiter[1], Laurens W. Molenkamp[2], Tobias Kiessling[2], and Ronny Thomale[1] — [1]Institute for Theoretical Physics and Astrophysics, University of Würzburg, D-97074 Würzburg, Germany — [2]Physikalisches Institut, Universität Würzburg, 97074 Würzburg, Germany — [3]Department of Physics, National University of Singapore, Singapore, 117542

Topological phases have been realized in a variety of classical metamaterials. They provide easily accessible platforms to study topology in regimes beyond experimental limitations of real materials.

While most implementations are limited to the linear regime, investigating non-linear effects promises to reveal a plethora of new phenomena, such as solitons and chaos.

To study the intertwining of topology and non-linearity we engineered a topolectric circuit reminiscent of the Su-Schrieffer-Heeger (SSH) model with added tunable onsite non-linearity. We observe the localized cnoidal (LCn) state which maintains the spatial exponential localization of the SSH edge mode while distorting a sinusoidal input into eccentric waves in time domain.

In this talk, we complement the non-linear differential equations with the theory of topological localization and develop an analytic description of the LCn state.

TT 64.6 Fri 10:45 HSZ 201

Non-Hermitian diamond chain — •Carolina Martinez Strasser[1], Miguel Ángel Jimenez Herrera[1], and Dario Bercioux[2] — [1]Donostia International Physics Center (DIPC), 20018 Donostia-San Sebastián, Spain — [2]Ikerbasque, Basque Foundation for Science, Plaza Euskadi 5 48009 Bilbao, Spain

We investigate the spectral properties of a non-Hermitian quasi-one-dimensional lattice in several possible dimerization configurations. Specifically, we focus on a non-Hermitian diamond chain that presents a zero-energy flat band. In the Hermitian case, this flat band originates from wave interference and results in a wave function localized only on a subset of sites on the unit cell [1]. We transform the system into a non-Hermitian one by considering asymmetric hopping terms between some of the lattice sites of the chain. This leads to the accumulation of eigenstates, known as the skin effect. Despite this accumulation of eigenstates, we can characterize the presence of non-trivial edge states at zero energy by a real-space topological invariant known as biorthogonal polarization. We show that this invariant, evaluated using the destructive interference method, can also characterize the non-trivial phase of the non-Hermitian diamond chain [2].

[1] D. Bercioux, O. Dutta, and E. Rico, Ann. Phys. (Berl.) 529, 1600262 (2017)
[2] F. K. Kunst *et al.*, Phys. Rev. Lett. 121, 026808 (2018)

TT 64.7 Fri 11:00 HSZ 201

Direct optical probe of magnon topology in two-dimensional quantum magnets — •Michael Sentef[1], Emil Boström[1], Tahereh Parvini[2], James McIver[1], Angel Rubio[1], and Silvia Viola Kusminskiy[3] — [1]Max Planck Institute for the Structure and Dynamics of Matter, Hamburg — [2]University of Greifswald — [3]RWTH Aachen

Controlling edge states of topological magnon insulators is a promising route to stable spintronics devices. However, to experimentally ascertain the topology of magnon bands is a challenging task. Here we derive a fundamental relation between the light-matter coupling and the quantum geometry of magnon states. This allows to establish the two-magnon Raman circular dichroism as an optical probe of magnon topology in honeycomb magnets, in particular of the Chern number and the topological gap. Our results pave the way for interfacing light and topological magnons in functional quantum devices. arXiv:2207.04745

TT 64.8 Fri 11:15 HSZ 201

Inelastic topological light scattering in chiral liquids — Silvia Müllner[1], Florian Büscher[1], Angela Möller[2], and •Peter Lemmens[1] — [1]IPKM, TU Braunschweig — [2]Anorg. Chemie, JGU Mainz

Vortex beams of light contain spin (SAM, helicity) and angular momentum (OAM, chirality). However, there is a long debate whether OAM can couple to a topological system. In a recent experimental study of chiral liquid crystals we demonstrate the effect of vortex light with different topological charge. We give evidence for roton like quasiparticles with a dispersion that dominates the scattering at small and intermediate scattering vectors [1].

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[1] S. Müllner, F. Büscher, A. Möller, and P. Lemmens, Phys. Rev. Lett. 129, 207801 (2022)