TT 28: Transport (joint session TT/DY)

Time: Friday 13:30–15:00 Location: H6

TT 28.1 Fri 13:30 H6

Spin-relaxation in superconducting graphene systems — •Michael Barth, Jacob Fuchs, Andreas Costa, Klaus Richter, Jaroslav Fabian, and Denis Kochan — Universität Regensburg

The spin-relaxation time τ_s is a fundamental quantity as it determines how long spins can propagate before they relax. For quasi-particles in s-wave superconductors that scatter off magnetic impurities this quantity is expected to decrease by lowering the temperature, known as the Hebel-Slichter-effect [1]. We have shown that this decrease of the spin-relaxation time does not happen generally in all superconductors [2]. A completely opposite behavior can be observed, if Yu-Shiba-Rusinov (YSR) states develop deeply inside the superconducting gap, since then the magnetic moments energetically decouple from the coherence peaks what in turn weakens an exchange interaction with quasi-particles. By employing analytical and numerical methods we have shown that such deep lying in-gap YSR states are formed if a system with magnetic impurities is doped to resonances. As an explicit example we will present results for graphene and bilayer graphene decorated with light magnetic impurities as hydrogen and fluorine.

[1] L. C. Hebel and C. P. Slichter, Phys. Rev. 113, 1504 (1959)
[2] D. Kochan, M. Barth, A. Costa, K. Richter, J. Fabian, Phys. Rev. Lett. 125, 087001 (2020)

TT 28.2 Fri 13:45 H6

Aharonov-Bohm Oscillations in Minimally Twisted Bilayer Graphene — Christophe De Beule[1], Fernando Dominguez[2], and •Patrik Recher[2,3] — [1]Department of Physics and Materials Science, University of Luxembourg, L-1511 Luxembourg, Luxembourg — [2]Institute for Mathematical Physics, TU Braunschweig, 38106 Braunschweig, Germany — [3]Laboratory for Emerging Nanometrology, 38106 Braunschweig, Germany

We investigate transport in the network of valley Hall states that emerges in minimally twisted bilayer graphene under interlayer bias. To this aim, we construct a scattering theory that captures the network physics. In the absence of forward scattering, symmetries constrain the network model to a single parameter that interpolates between one-dimensional chiral zigzag modes and pseudo-Landau levels. Moreover, we show how the coupling of zigzag modes affects magnetotransport. In particular, we find that scattering between parallel zigzag channels gives rise to Aharonov-Bohm oscillations that are robust against temperature, while coupling between zigzag modes propagating in different directions leads to Shubnikov-de Haas oscillations that are smeared out at finite temperature.

TT 28.3 Fri 14:00 H6

Spin interference effects in quantum rings in the presence of SU(2) fields — Alberto Hijano[1,2,3], Tineke van den Berg[3], Diego Frustaglia[4], and •Dario Bercioux[3,5] — [1]University of the Basque Country, UPV/EHU, Bilbao, Spain — [2]Centro de Física de Materiales (CFM-MPC) Centro Mixto CSIC-UPV/EHU, E-20018 Donostia-San Sebastián, Spain — [3]Donostia International Physics Center, Paseo Manuel de Lardizbal 4, E-20018 San Sebastián, Spain — [4]Departamento de Física Aplicada II, Universidad de Sevilla, E-41012 Sevilla, Spain — [5]IKERBASQUE, Basque Foundation of Science, 48011 Bilbao, Spain

We present a theory of conducting quantum networks that accounts for Abelian and non-Abelian fields acting on spin carriers [1]. We apply this approach to model the conductance of mesoscopic spin interferometers of different geometry (such as squares and rings), reproducing recent experimental findings in nanostructured InAsGa quantum wells subject to Rashba spin-orbit and Zeeman fields [2,3] (as, e.g., the manipulation of Aharonov-Casher interference patterns by geometric means). Moreover, by introducing an additional field-texture engineering, we manage to single out a previously unnoticed spin-phase suppression mechanism. Our approach can also be used for the study of complex networks and the spectral properties of closed systems.

[1] Hijano *et al.*, Phys. Rev. B **103**, 155419 (2021)
[2] Nagasawa, *et al.*, Nat. Commun. **4**, 2526 (2013)
[3] Wang *et al.*, Phys. Rev. Lett. **123**, 266804 (2019)

TT 28.4 Fri 14:15 H6

Length dependent symmetry in narrow chevron-like graphene nanoribbons — •Koen Houtsma[1], Mihaela Enache[1], Remco Havenith[1,2], and Meike Stöhr[1] — [1]Zernike Institute for Advanced Materials, University of Groningen, 9747AG Groningen, the Netherlands — [2]Stratingh Institute for Chemistry, University of Groningen, 9747AG Groningen, the Netherlands

Graphene nanoribbons (GNRs) are an exciting material due to their excellent and tunable electronic properties. For instance, GNRs with armchair edges possess a width-dependent band gap, whereas zigzag GNRs are expected to host spin-polarized edge states and be semimetallic [1]. Previously, narrow chevron-like GNRs, which host a combination of zigzag and armchair edge terminations, were fabricated on a Au(111) substrate from the prochiral precursor 6,12-dibromochrysene through a combination of Ullmann-type coupling and cyclodehydrogenation [2]. Depending on the number of monomer units the ribbons are made of, an even and an odd number lead to a mirror and a point symmetric ribbon, respectively. Using scanning tunneling spectroscopy we investigated the potential effect of this length dependent symmetry on the electronic properties. In addition, bends are formed in these ribbons through a common coupling defect. We characterized these bends using a combination of high-resolution scanning tunneling microscopy and spectroscopy. The bends are based on the formation of both a five- and six-membered ring and their electronic properties are altered.

[1] K. Nakada et al., Phys. Rev. B 54, 17954 (1996)
[2] T.A. Pham et al., Small 13, 1603675 (2017)

TT 28.5 Fri 14:30 H6

Thermal fluctuations of two-dimensional crystalline membranes: a scale-invariant but nonconformal field theory — •Achille Mauri and Mikhail I. Katsnelson — Radboud University, Institute for Molecules and Materials, Nijmegen, The Netherlands

Statistical fluctuations of two-dimensional membranes have been the subject of extensive investigations, from string theories to biological and condensed matter systems such as graphene and other atomically-thin 2D materials. In the case of solid layers subject to vanishing external tension, the interplay of thermal fluctuations and anharmonic phonon-phonon interactions gives rise to a crucial renormalization of the elastic constants: as a result, the long-wavelength behavior of phonon fluctuations is scale-invariant and it is controlled by an interacting fixed point of the renormalization group (RG). In this contribution, we argue that, in contrast with several other field-theories, the emergent dilatation symmetry is not enhanced to the full conformal invariance. We analyze in particular, the structure of the energy-momentum tensor $T_{\mu\nu}$ within an ϵ-expansion, after extension of the problem from the physical dimension $D = 2$ to a non-integer dimensionality $D = 4 - \epsilon$. The trace $T_{\mu\mu}$ reduces, at the fixed point, to the total divergence of a non-trivial virial current, implying the absence conformal invariance.

TT 28.6 Fri 14:45 H6

Viscous, elastic and ballistic shear response of electron fluids probed through optical spectroscopy — •Davide Valentinis[1,2], Jan Zaanen[3], Dirk van der Marel[4], and Joerg Schmalian[1,2] — [1]Institut für Quantenmaterialien und Technologien, Karlsruher Institut für Technologie, 76131 Karlsruhe, Germany — [2]Max Planck Institute for Solid State Research, Heisenbergstra{\ss}e 1, D-70569 Stuttgart (DE) — [3]Department of Quantum Matter Physics, University of Geneva, 24 Quai Ernest-Ansermet, 1211 Geneva 4, Switzerland — [4]Institute-Lorentz for Theoretical Physics, Leiden University, PO Box 9506, NL-2300 RA Leiden, The Netherlands

Can optical spectroscopy provide complementary and unambiguous fingerprints of spatial nonlocality in bulk and layered materials, and under which conditions? To answer these questions, we investigate the nonlocal current response of 3D charged Fermi liquids, and 2D isotropic and anisotropic metals, taking into account momentum-conserving collisions and momentum-relaxing scattering in kinetic-theory approaches. In strongly interacting Fermi liquids, a propagating shear mode of Fermi-surface deformation, analogous to transverse sound in liquid helium, determines characteristic oscillating patterns of the thin-film transmission as a function of radiation frequency. We develop a kinetic theory for the distribution function of 2D Fermi gases with arbitrary electronic dispersion relation, using a collision operator formalism. The skin depth and surface impedance are shown to qualitatively depend on the shape and orientation of the polygonal Fermi surface.