TT 76: Poster Session: Transport 2

Time: Thursday 15:00–19:00 Location: P2-OG1

TT 76.1 Thu 15:00 P2-OG1

Vibrational lasing in a nanomechanical resonator by spin-polarized current — •Mattia Mantovani[1], Andrew Armour[2], Wolfgang Belzig[1], and Gianluca Rastelli[1] — [1]Fachbereich Physik, Universität Konstanz, D-78457 Konstanz, Germany — [2]School of Physics and Astronomy, University of Nottingham, NG7 2RD Nottingham, United Kingdom

We study the nonequilibrium dynamics of a nanomechanical resonator, realized by a suspended carbon nanotube quantum dot in contact with two ferromagnetic leads, in which the dot's spin is coupled to the vibrational flexural modes [1, 2]. We show that, for an appropriate configuration of the two dot's spin levels and orientation of the magnetization in the leads, the system encodes a single-atom laser [3] where the mechanical vibration plays the role of the cavity, with frequency equal to the Zeeman splitting of the two levels. Moreover, such a system has unique features, as one can not neglect the effects of: (i) finite temperature for such low-frequency resonators ($<$ 100 MHz) and (ii) the nonlinear forces for strong, amplified amplitudes of oscillation. To understand how these effects modify the physics of the single-atom laser, we solve numerically the associated Lindblad equation to compute the average phonon occupation, the Fano factor and the spin-polarized current as a function of the bias voltage and other parameters. We show that the lasing threshold is within the experimental range for magnetic polarization and spin-vibration coupling strength.

[1] P. Stadler et al., PRL 113, 047201 (2014); PRB 91, 085432 (2015)
[2] A. Pályi et al., PRL 108, 206811 (2012)
[3] Y. Mu, M. Savage, PRA 46, 5944 (1992).

TT 76.2 Thu 15:00 P2-OG1

Violation of the Cauchy-Schwarz inequality in two microwave cavities coupled to two parallel quantum dots — •Felicitas Hellbach, Fabian Pauly, Wolfgang Belzig, and Gianluca Rastelli — Fachbereich Physik, Universität Konstanz, D-78457 Konstanz, Germany

Since the realization of high quality superconducting microwave cavities [1], the so-called "circuit quantum electrodynamics" enables the possibility to investigate the coherent interaction of light and matter. Artificial atoms can be realized with quantum dots, and experiments have already proved strong coupling between a quantum dot and a microwave cavity [2]. We study two parallel quantum dots arranged in the geometry of an Aharonov-Bohm interferometer (ABI) [3]. Each dot is capacitively coupled to a microwave cavity. We explore how quantum correlation and entanglement between the two cavity fields is generated by the coherent transport of a single electron traveling in two different paths of the ABI. We calculate the second-order coherence function by use of a diagrammatic perturbative expansion (Keldysh Green's functions) to the fourth order in the dot-cavity coupling constant, taking into account vertex corrections. Ultimately, we test the Cauchy-Schwarz inequality for varying magnetic flux.

[1] A. Wallraff et al., Nature 431, 162 (2004)
[2] M. R. Delbecq et al., Nat. Commun. 4, 1400 (2013)
[3] A. W. Holleitner et al., Phys. Rev. Lett. 87, 256802 (2001)

TT 76.3 Thu 15:00 P2-OG1

Entanglement in propagating two-mode squeezed microwave states — •B. Ghaffari[1,2], K. G. Fedorov[1,2], S. Pogorzalek[1,2], P. Yard[1,2], P. Eder[1,2,3], M. Fischer[1,2,3], J. Goetz[1,2], E. Xie[1,2,3], A. Marx[1], F. Deppe[1,2,3], and R. Gross[1,2,3] — [1]Walther-Meißner-Institut, Bayerische Akademie der Wissenschaften, 85748 Garching, Germany — [2]Physik-Department, TU München, 85748 Garching, Germany — [3]Nanosystems Initiative Munich (NIM), 80799 München, Germany

Josephson parametric amplifiers (JPAs) can be employed for the generation of itinerant quantum signals in the form of propagating two-mode squeezed states (TMSSs), which are essential for quantum communication protocols. Further applications of TMSSs include quantum information processing with continuous variables, or novel ideas of building quantum annealing networks based on JPAs. All these fields make use of multiple JPAs for entanglement generation and manipulation, and therefore require detailed knowledge of their physical properties. In our experiments, we employ two flux-driven JPAs at the inputs of an entangling hybrid ring in order to generate two-mode squeezing between the hybrid ring outputs. We perform tomography of the resulting TMSSs and experimentally investigate the robustness of the entanglement to noise and finite-time delays.

The authors acknowledge support from DFG through FE 1564/1-1, the doctorate program ExQM of the Elite Network of Bavaria, and the IMPRS 'Quantum Science and Technology'.

TT 76.4 Thu 15:00 P2-OG1

Noise spectroscopy by dynamical decoupling of a transmon qubit — •Tim Wolz, Andre Schneider, Jochen Braumüller, Martin Weides, and Alexey V. Ustinov — Institute of Physics, Karlsruhe Institute of Technology, Germany

Superconducting qubits are promising candidates as elements of quantum computers. Environmental noise limits coherence times of superconducting qubits. Improving coherence times requires a detailed knowledge about noise mechanisms. To obtain the noise power spectral density (PSD) of a qubit system, dynamical decoupling pulse sequences can be employed. Such sequences comprise several gates to refocus dephased qubits and effectively act as frequency filters. Hence, by knowing the properties of the frequency filter and measuring the qubit's state, the noise PSD can be scanned, as it was already shown for a flux qubit [1]. In this work, noise spectroscopy is performed on a tunable concentric transmon qubit [2] by using dynamical decoupling. Because of the low anharmonicity of the transmon, gate errors play a severe role in distorting the qubit's state and subsequently the noise PSD. By using DRAG [3] pulses, we are able to accomplish sufficiently precise gates, and can thus confidently extract the noise PSD. Another advantage of this method is its universality, i.e., no functional form of the PSD needs to be assumed, and hence it can also be applied to environmental magnetic field sensing.

[1] J. Bylander et al., Nature Phys. 7, 565 (2011)
[2] J. Braumueller et al., Appl. Phys. Lett. 108, 032601 (2016)
[3] F. Motzoi et al., Phys. Rev. Lett. 103,110501 (2009)

TT 76.5 Thu 15:00 P2-OG1

Superconducting microwave resonator designs for electron paramagnetic resonance at millikelvin temperatures — •Petio Natzkin[1,2], Stefan Weichselbaumer[1,2], Christoph W. Zollitsch[1,2], Rudolf Gross[1,2,3], and Hans Huebl[1,2,3] — [1]Walther-Meißner-Institut, Bayerische Akademie der Wissenschaften, Garching, Germany — [2]Physik-Department, Technische Universität München, Garching, Germany — [3]Nanosystems Initiative Munich, Munich, Germany

Superconducting coplanar microwave resonators are used in a large variety of applications, ranging from radiation detectors to experiments in quantum information processing. We use superconducting microwave resonators made from Niobium for electron paramagnetic resonance spectroscopy at millikelvin temperatures. The coplanar lumped-element design garanatees small mode volumes and large filling factors. Together with the high quality factor in the order of 10^4, this results in an increased spin sensitivity compared to conventional EPR resonators. However, the field distribution of such a quasi two-dimensional resonator is typically inhomogeneous hindering a coherent manipulation of the spin ensemble. We present the investigation of different resonator designs with particular emphasis on the homogeneity of the B_1 field. Furthermore, we compare the predictions of simple analytical models and finite element simulations with first characterization measurements of these resonator types.

The authors acknowledge financial support from the German Research Foundation (DFG) via the focus program SPP 1601 (HU1861/2-1).

TT 76.6 Thu 15:00 P2-OG1

Time-Translation Symmetry Breaking and First-Order Phase Transitions in Periodically Driven Quantum Oscillators — Jennifer Gosner[1], •Björn Kubala[1], Mark Dykman[2], and Joachim Ankerhold[1] — [1]Institute for Complex Quantum Systems and IQST, Ulm University, Ulm, Germany — [2]Department of Physics and Astronomy, Michigan State University, East Lansing, Michigan, USA

Periodically driven damped nonlinear oscillators show under sufficiently strong driving (dynamical) bifurcations. Typically the driving

is given by frequencies close to the eigenfrequency of the system or twice the eigenfrequency. Here we analyze the general situation with a drive close to the Mth overtone. We provide the relation between eigenstates in the frame rotating with the oscillator's eigenfrequency and standard M-period Floquet states, discuss time-translational symmetry breaking, and develop a detailed analysis of the phase-space structure and its symmetries.

General results are then illustrated for driving close to three times the eigenfrequency. We find that, in the presence of dissipation, a quantum oscillator can support three states of period-three vibrations that co-exist with the state of no vibrations. With varying detuning a first-order transition appears, where the populations of these states change exponentially strongly. We study the rates of switching between the stable states and their peculiar scaling behavior near bifurcation points. The results allow revealing "time crystals" in simple quantum systems, including the systems studied in circuit QED.

TT 76.7 Thu 15:00 P2-OG1

Dynamics of the pulsed central spin model and the validity of the rotating wave approximation for short pulses — •Lars B. Gravert and Götz S. Uhrig — Lehrstuhl für theoretische Physik I, Technische Universität Dortmund, Germany

We analyze the effect of different pulses and sequences to the *central spin model* (CSM), especially the influence of the pulse duration and the sequence duration. We compare different setups for the couplings between the central spin and the spin bath as well as for the couplings between bath spins. These setups address experimental systems, e. g. electron spins in quantum dots or ^{13}C in adamantane.

By utilizing the *density matrix renormalization group* (DMRG) we are able to treat larger spin baths than most other numerical approaches while retaining a full quantum mechanical description. In addition we can choose the couplings between the spin bath and the central spin arbitrarily. We employ an analytic solution for homogeneous couplings, i. e. all bath spins are coupled equally to the central spin. Small spin baths will be approached by standard techniques, e. g. *exact diagonalization* (ED).

In addition we analyze the validity of the *rotating wave approximation* (RWA) regarding composite pulses with fast alternating pulse amplitudes. For these pulses additional errors occur within the RWA due to the assumed sharp edges between the different pulse amplitudes. This error is decreased for finite rise times of the pulse amplitudes as well as for high external magnetic fields.

TT 76.8 Thu 15:00 P2-OG1

Strain Engineering of the Band Structure of HgTe Quantum Wells — •Lukas Lunczer, Philipp Leubner, Christoph Brüne, Hartmut Buhmann, and Laurens W. Molenkamp — Experimentelle Physik III, Physikalisches Institut, Universität Würzburg, Am Hubland, D-97074 Würzburg, Germany

The HgTe quantum well (QW) is a well-characterized two-dimensional topological insulator (2D TI). Its band gap E_G is relatively small (typically in the order of 10 meV), which restricts the observation of purely topological conductance to low temperatures.

Here, we utilize the strain dependence of the band structure of HgTe QWs to address this limitation. We use CdTe-$Cd_{0.5}Zn_{0.5}Te$ strained-layer superlattices (SLS) on GaAs as virtual substrates with adjustable lattice constant to control the strain of the QW.

We present magnetotransport measurements, which demonstrate a transition from a semimetallic to a 2D-TI regime in wide QWs, when the strain is changed from tensile to compressive.

Most notable, we demonstrate a much enhanced energy gap of 55 meV in heavily compressively strained QWs. This value exceeds the highest possible gap on common II-VI substrates by a factor of 2-3, and extends the regime where topological conductance prevails to much higher temperatures.

TT 76.9 Thu 15:00 P2-OG1

Separate influencing of the top and bottom surface states in the three dimensional topological insulator HgTe — •Fabian Schmitt, David Mahler, Cornelius Thienel, Kalle Bendias, Christoph Brüne, Harmut Buhmann, and Laurens Molenkamp — Physikalisches Institut, Lehrstuhl für Experimentelle Physik 3, Universität Würzburg

It has been shown, that the semimetal HgTe grown on a CdTe substrate becomes a three dimensional topological insulator due to its inverted band structure and a tensile strain induced band gap opening [1]. The magneto transport data indicates transport dominated by the two surfaces perpendicular to the magnetic field. This dominance was observed over a wide density range by the use of an Au top gate, which influences the two surfaces simultaneously and has been explained by the Dirac-screening of the surface states [2]. Now we demonstrate that the introduction of an additional back gate created by epitaxial growth on an n-doped GaAs substrate allows us to change the occupation of the top and bottom surface states individually. This can be exhibit by transport measurements at low temperatures and high magnetic fields.

TT 76.10 Thu 15:00 P2-OG1

A new wet etching method and a low-temperature gate process for fabrication of high-quality HgTe microstructures — Kalle Bendias, •Valentin Müller, Pragya Shekhar, Saquib Shamim, Hartmut Buhmann, and Laurens W. Molenkamp — EP3, Physikalisches Institut, Universität Würzburg

In recent years, HgTe has attracted much interest within basic semiconductor research due to its inverted band structure, which gives rise to intriguing topological properties. Despite the extensive research effort spent on HgTe, fabrication of microstructures still poses considerable challenges to the experimenter. The main reasons are the high volatility and reactivity of Hg, which ask for low-temperature lithography processes in combination with very specific chemicals.

Here we show recent improvements in the lithography process for gateable micro- and macrostructures. For fabrication of devices, we now use a new wet etch method in combination with a low temperature, self-aligned ALD gate process.

The high performance of the developed process is demonstrated with microscopic HgTe quantum well Hall bars, which reliably show QSHE edge channel transport. Additional measurements on macroscopic Hall bars allow for a comparison with previously used gate stacks.

TT 76.11 Thu 15:00 P2-OG1

Ohmic Contacts on HgTe Quantum wells - a SEM study — •Simon Hartinger, Johannes Kleinlein, Hartmut Buhmann, and Laurens W. Molenkamp — EP3, Physikalisches Institut, Universität Würzburg

In HgTe/CdTe quantum wells above a critical thickness one can observe the topological nature of these heterostructures, called Quantum Spin Hall Effect and, in addition, the quantum Hall effect in high magnetic fields. One crucial part to observe the QSHE and the QHE is the microscopic nature of the contact material, which, for example, can cause contact problems in high magnetic fields. In this work we focus on the interface between ohmic contacts and HgTe/CdTe based quantum wells. We show SEM images of HgTe quantum wells cross sections with different contacts prepared by Focused Ion Beam milling, to analyze the intermixing of the contact material and the Quantum Well heterostructure.

TT 76.12 Thu 15:00 P2-OG1

Topological semimetals and insulators in three-dimensional honeycomb materials — •Dennis Wawrzik, David Lindner, Maria Hermanns, and Simon Trebst — Institute for Theoretical Physics, University of Cologne, 50937 Cologne, Germany

In Fermi liquid theory, conventional metals are described via their (d-1)-dimensional Fermi surface for an electronic lattice structure in d spatial dimensions. With the discovery of Dirac matter, most prominently in graphene and on the surfaces of topological insulators, semimetals have become the subject of intense research efforts. In these semimetals, conduction and valence bands touch only at a discrete set of points or along nodal lines (for three-dimensional structures). Here we discuss a family of three-dimensional honeycomb structures that exhibit a variety of topological (semi)metals with Weyl nodes, Dirac nodal lines or flat bands arising already in simple electronic tight-binding models. In the presence of spin-orbit coupling some of these structures give rise to topological insulators. Our classification of these states can be understood from an elementary symmetry analysis of the underlying lattice structures.

TT 76.13 Thu 15:00 P2-OG1

Computing topological invariants in two-dimensional periodically driven systems — •Bastian Höckendorf, Andreas Alvermann, and Holger Fehske — Institut für Physik, Ernst-Moritz-Arndt-Universität Greifswald, Greifswald, Germany

Periodically driven systems feature topological phenomena that have no analog for systems in equilibrium. Various topological invariants have been proposed to classify these phenomena but they are in gen-

eral not easily computable. We show that these invariants can be connected to degeneracies of the time- and momentum-dependent spectrum of the time-evolution operator. By assigning a Chern number - a quantity that is numerically easily accessible - to each degeneracy and expressing the invariants as functions of these Chern numbers we can calculate the different invariants using one unifying concept. We demonstrate this approach for driven Harper, Kane-Mele and graphene models which are representatives of two-dimensional periodically driven systems with chiral symmetry, time-reversal symmetry and particle-hole symmetry, respectively. The given symmetries lock a subset of the degeneracies to symmetry points in the time-momentum space which gives each system special topological properties. We evaluate the corresponding invariants with our approach and compare them to the chiral edge states of the Floquet spectrum via the bulk-edge correspondence.

TT 76.14 Thu 15:00 P2-OG1

Phase-coherent transport in 3D topological insulators encapsulated in hexagonal boron nitride — •Shaham Jafarpisheh[1,2], Kenji Watanabe[3], Takashi Taniguchi[3], Bernd Beschoten[1,2], and Christoph Stampfer[1,2,4] — [1]JARA-FIT and 2nd Institute of Physics, RWTH Aachen University, 52074 Aachen, Germany — [2]Helmholtz Virtual Institute for Topological Insulators (VITI), RWTH Aachen, 52072 Aachen, Germany — [3]National Institute for Materials Science, 1-1 Namiki, Tsukuba 305-0044, Japan — [4]Peter Grünberg Institute (PGI-9), Forschungszentrum Jülich, 52425 Jülich, Germany

The spin-polarized current on the surface of topological insulators is a unique property which makes them promising materials for spintronic applications. However exposure to air and contaminations during the device fabrication easily destroys the surface states. This can be avoided by protecting the two surfaces of the TI layer with hexagonal boron nitride (hBN) crystals. In this work we show transport measurements in fully encapsulated BSTS layers in hBN. We fabricate Hall bars of the sandwich structures with 1-dimensional side contacts to the TI-layer. By measuring weak antilocalization (WAL) at low fields we extract phase-coherence lengths which are close to the values imposed by electron-electron interactions but limited by spin-flip scattering at temperatures below 1K.

TT 76.15 Thu 15:00 P2-OG1

Surface transport on thin semi-metallic films: The role of thickness and magnetic impurities — •Philipp Kröger, Marianna Siemens, Herbert Pfnür, and Christoph Tegenkamp — Leibniz Universität Hannover, Institut für Festkörperphysik, Appelstr. 2, 30167 Hannover

Bismuth has attracted a lot of interest because of its unique electronic properties such as low carrier concentrations and high carrier mobilities. Thereby, epitaxial growth of high-quality thin films opens new pathways to tailor the electronic properties further, e.g. by quantum confinement and alloy formation, giving rise to topologically non-trivial states in this material class. In this study we concentrate on Bi films grown on Si(111). Thin Bi(111) films become semiconducting due to the quantum-size-effect. Thus the peculiar spin texture of the surface states, induced by the Rashba effect, were studied directly by temperature and magnetic field dependent transport. Only at low temperatures (T<50 K) the conductance G turned out to be governed by surface states while at higher temperatures activated transport from bulk channels sets it. We have carefully analyzed the G(T)-behavior as a funnction of film thickness. With decreasing film thickness, the bulk gap increases, as expected due to the quantum size effect. However for thinner films the gap decreases. The reason is an interface-interface interaction which renormalizes strongly the Fermi surface.

TT 76.16 Thu 15:00 P2-OG1

Synthesis and characterization of the weak 3D topological insulator $Bi_{14}Rh_3I_9$ — •Ali Scherzad, Sebastian Witt, and Cornelius Krellner — Physikalisches Institut, Goethe University Frankfurt, 60438 Frankfurt am Main, Germany

The discovery of topological insulators generated high interests in the last decade. One of the main properties of topological insulators are surface currents and an isolated behavior inside the bulk. Motivated by recent Nobel Prize in physics for topological phases and based on previous work our goal was to synthesize novel types of topological insulators.

Here, we report the crystal growth of $Bi_{14}Rh_3I_9$ [1] in different crucible setups. Besides a larger muffle furnace, we used a vertical Bridgman furnace to obtain larger single crystals. An optimization of the crucible setup and temperature profile was necessary due to reactions of iodine with the crucible. All experiments were done under argon atmosphere and we tested Al_2O_3, quartz, Nb, graphite, and BN as crucible materials. The prepared crystals were characterized by using Laue-type diffraction, x-ray powder diffraction, EDX analysis and preliminary physical measurements down to 1.8 K.

[1] B. Rasche et al., Chem. Mater., 25, 2359-2364, (2013).

TT 76.17 Thu 15:00 P2-OG1

3D topological Kondo insulators: Slave-boson mean-field theory and fluctuations — •Soroush Arabi and Johann Kroha — Physikalisches Institut, Universität Bonn, Germany

Topological Kondo insulators (TKI) have recently been proposed as a new system where a gap at the Fermi energy and, subsequently, a non-trivial topological phase are created by strong correlations [1]. The present work investigates the influence of the finite life-time of the heavy Kondo quasiparticles on the stability of a TKI phase. Because of the strong spin-orbit (SO) coupling within the rare-earth 4f-orbitals of a heavy-fermion system, the local ground-state Kramers doublet involves mixing of spin and orbital degrees of freedom. This leads to a topological term in the hybridization of the 4f- and the conduction band [1]. Using slave-boson mean field theory [2], we calculate the band structure of a 3D bulk TKI. We then calculate the layer-dependent band structure near a 2D surface of a 3D TKI. Finite quasiparticle life-time effects are incorporated by taking bosonic fluctuations about the mean field solution into account and by calculating the corresponding selfenergies. We aim at calculating characteristic, observable quantities, like the surface conductivity, including life-time effects.

[1] M. Dzero, et al., Ann. Rev. Cond. Matt. **7**, 249-280 (2016)
[2] V. Alexandrov, et al., Phys. Rev. Lett. **114**, 177202 (2015)

TT 76.18 Thu 15:00 P2-OG1

Scattering properties of electrons on TaAs Weyl Semimetal surfaces — •Steven Rendon Restrepo, Philipp Rüssmann, Phivos Mavropoulos, and Stefan Blügel — Peter Grünberg Institut and Institute for Advanced Simulation, Forschungszentrum Jülich and JARA, D-52425 Jülich, Germany

In the field of topological materials, the recent discovery of the Type-I Weyl semi-metals TaAs, NbP, NbAs and TaP came as a breakthrough. (B.Q.Lv et al. Nat. Phys. **11**, 724 (2015); S. Souma et al.,Phys. Rev. B **93**, 161112(R) (2015); Su-Yang Xu et al. Nat Phys,**11**, 748 (2015); Xu et al. Sci. Adv. 2015;1:e1501092).

In this class of materials, the valence and conduction band in the bulk touch at generic points in the Brillouin zone (Weyl nodes) due to a nontrivial Berry curvature. The Weyl nodes, always appearing in pairs, show a linear band dispersion in all three $\vec{k}$-directions. Their topological nature ultimately leads to topological surface states that take the form of open Fermi arcs.

In this presentation, I will discuss the band structure, spin-polarization and Fermi surfaces of the non-centrosymmetric TaAs family and present the relation of these properties to the scattering properties of electrons off surface defects. The calculations were performed using the density-functional-based, full-potential relativistic Korringa-Kohn-Rostoker Green-function method for electronic structure and impurity embedding.

Computational support from the JARA-HPC Centre at the RWTH Aachen University is acknowledged.

TT 76.19 Thu 15:00 P2-OG1

Planar Hall effect and anisotropic magnetoresistance from the surface states of disordered 3D topological insulators — •Henry Legg and Achim Rosch — Institute for Theoretical Physics, University of Cologne, Zülpicher Straße 77, D-50937, Köln, Deutschland

In the presence of time-reversal symmetry electrons on the surface of a topological insulator cannot backscatter from disorder. A magnetic field parallel to the surface lifts this protection mechanism, enabling backscattering which is predominantly in the direction parallel to the magnetic field but retaining the Dirac physics of the surface. As a result the anisotropy of magnetoresistance parallel and perpendicular to **B** is a sensitive probe of the loss of topological protection when time-reversal symmetry is broken.

Using a self-consistent T-matrix approximation, including vertex corrections, we demonstrate how an in-plane magnetic field can dramatically alter the resistivity of a topological insulator's surface. We compare our theoretical results to experiments where the dependence

on gate voltage provides an especially clear experimental signature of the scattering mechanism.

TT 76.20 Thu 15:00 P2-OG1

Gigantic negative magnetoresistance in the topological insulator $TlBi_xSb_{1-x}Te_2$ — •Oliver Breunig[1], Zhiwei Wang[1], Jonathan Lux[2], Achim Rosch[2], Alexey Taskin[1], and Yoichi Ando[1] — [1]Physics Institute II, University of Cologne — [2]Institute for Theoretical Physics, University of Cologne

Recently the phenomenon of negative magnetoresistance (MR) gains increasing interest in the context of the chiral anomaly in Weyl semimetals. Here, we present a new mechanism leading to a large negative MR that is related to disorder in a compensated topological insulator. We have grown single crystals of the topological insulator material $TlBi_xSb_{1-x}Te_2$ by a modified Bridgman technique. For intermediate values x we find a bulk-insulating state and a surprisingly strong negative MR reaching 98% at low temperature and in applied magnetic fields of 14 T. Based on transport data and numerical simulations we show that the increased conductivity at high fields is due to the magnetic field-enhanced percolation of localized electronic states.

TT 76.21 Thu 15:00 P2-OG1

Dynamics of Moving Majorana States and Disorder — •Qingyufei Terenz Feng, Zala Lenarcic, and Achim Rosch — Institut für Theoretische Physik, Universität zu Köln 50937 Köln, Germany

A possible realization of quantum computers could base on the time dependent manipulation of qubits represented by Majorana states. Information stored in Majoranas is safe under manipulation in perfectly clean systems. However, this is not the case in realistic systems. We present a study of the dynamics of Majorana states operated by external gate potential in the presence of a single or multiple disorder. Our goal is to determine the limit on the velocity, at which operation can be performed. Starting from a non-interacting setup we aim to address the manipulation in interacting many-body localized systems as well.

TT 76.22 Thu 15:00 P2-OG1

Stretched exponential decay of Majorana edge modes in many-body localized Kitaev chains — •Florian Katsch[1], Leon Droenner[1], Markus Heyl[2], and Alexander Carmele[1] — [1]Institut für Theoretische Physik, Nichtlineare Optik und Quantenelektronik, Technische Universität Berlin, Hardenbergstr. 36, 10623 Berlin, Germany — [2]Max-Planck-Institut für Physik komplexer Systeme, Dynamics in correlated quantum matter, Nöthnitzer Str. 38, 01187 Dresden, Germany

We study a generic example of a system that fails to thermalize, namely a Kitaev chain with a bulk and topological edge-edge states [1, 2]. Therefore, the resilience of such Majorana modes in the presence of symmetry-breaking dissipation is investigated. Hence, both the loss and gain is described within a master equation framework, implying that the parity symmetry is violated. Considering a homogeneous system, it can be shown that the edge-edge correlation decays exponentially fast [3]. By including strong disorder to the system, the decay flattens and the Majorana mode survives longer. The result thus represents a first step to stabilize edge-edge states taking account of symmetry-breaking environments via a strong disorder mechanism closely connected to many-body localization.

[1] Pal *et al.*, Phys. Rev. B **82**, 174411 (2010)
[2] Kitaev, Phys. Usp. **44**, 131 (2001)
[3] Carmele *et al.*, Phys. Rev. B **92**, 195107 (2015)

TT 76.23 Thu 15:00 P2-OG1

Topological Quantum Wires with Balanced Gain and Loss — •Henri Menke and Moritz Hirschmann — Max-Planck-Institut für Festkörperforschung, Heisenbergstraße 1, D-70569 Stuttgart, Germany

We study a one-dimensional topological superconductor, the Kitaev chain, under the influence of a non-Hermitian but $\mathcal{PT}$-symmetric potential. This potential introduces gain and loss in the system in equal parts. We show that the stability of the topological phase is influenced by the gain/loss strength and explicitly derive the bulk topological invariant in a bipartite lattice and compute the corresponding phase diagram using analytical and numerical methods. Furthermore we find that the edge state is exponentially localized near the ends of the wire despite the presence of gain and loss of probability amplitude in that region.

TT 76.24 Thu 15:00 P2-OG1

Transport Properties of Superconducting $In_xSn_{1-x}Te$ nano-plates and nano-ribbons — •Fan Yang, Zhiwei Wang, and Yoichi Ando — Institute of Physics II, University of Cologne, Zülpicher Straße 77, 50937 Cologne, Germany

$In_xSn_{1-x}Te$ nano-plates and nano-ribbons were grown on Si wafers coated with 300 nm SiO_2 via vapor-transport method. After the growth, the nano-plates and nano-ribbons were fabricated into devices. A sharp superconducting transition was observed at low temperatures. We also tried to fabricate tunneling junctions on the nano-plates and nano-ribbons, and the preliminary results are presented.

TT 76.25 Thu 15:00 P2-OG1

Low-temperature heat transport of the topological superconductor $Cu_xBi_2Se_3$ — •Lionel Andersen, Zhiwei Wang, Thomas Lorenz, and Yoichi Ando — II. Physikalisches Institut - Universität zu Köln, Germany

The topological insulator Bi_2Se_3 becomes superconducting when intercalated with copper. Recently the interest in this material was heightened by the confirmation of the topological superconductivity through observations of a rotational symmetry braking [1,2].

A manifestation of Majorana fermions is predicted to be a ballistic surface heat transport [3]. This could provide a possibility of a direct macroscopic observation of these exotic surface states by standard heat transport measurements. For these measurements, a disentanglement of the contributions from phonons, surface Majorana fermions and bulk quasiparticles is required. In this poster, measurements of the heat transport of $Cu_xBi_2Se_3$ performed in a dilution refrigerator will be presented.

[1] K. Matano et al., Nat. Phys. **12**, 852 (2016)
[2] S. Yonezawa et al., Nat. Phys. DOI: 10.1038/NPHYS3907 (2016)
[3] L. Kouvenhoven and C. Beenakker, Nat. Phys. **12**, 618 (2016)

TT 76.26 Thu 15:00 P2-OG1

Zero-Temperature Bell Test in a Driven Mesoscopic Contact — •hongxin zhan[1], mihajlo vanevic[2], and wolfgang belzig[1] — [1]Fachbereich Physik, Universität Konstanz, D-78457 Konstanz, Germany — [2]Department of Physics, University of Belgrade, 11158 Belgrade, Serbia

The standard Clauser-Horne-Shimony-Holt (CHSH) inequality [1] is known to fail in mesoscopic junctions at finite temperature [2]. Since this is due to the bidirectional particle flow, a similar failure is expected for an ac-driven junction. We develop a generalized Bell test which is suitable for ac driven system. Similar to the standard CHSH inequality, our Bell inequality cannot be violated when the detection time or the conductance are sufficiently large. Differently, our inequality cannot be violated for ac-driven system when the probability [3] of creating one or more electron-hole pairs is large. To determine the optimal ac bias for Bell test, we develop a quantitative criterion - similar to the Fano factor - for the probability of the creation of electron-hole pairs.

[1] N. M. Chtchelkatchev, G. Blatter, G. B. Lesovik, T. Martin, Phys. Rev. B **66**, 161320(2002).
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Full counting statistics analyzed by generalized factorial cumulants — •Philipp Stegmann, Stephan Weiss, and Jürgen König — Theoretische Physik, Universität Duisburg-Essen and CENIDE, 47048 Duisburg, Germany

We discuss the advantages of generalized factorial cumulants $C_{s,m}$ [1] yielding informations that are not accessible via ordinary cumulants commonly used in literature. Generalized factorial cumulants indicate the presence of correlations between transferred electrons [1,2]. Especially for short measuring-time intervals, higher-order tunneling events can be identified [2]. Moreover, generalized factorial cumulants can be utilized to obtain a lower bound of the system dimension and the full spectrum of relaxation rates. The generalized factorial cumulants give access to additional dimensions and relaxation rates hidden for ordinary cumulants [3]. Furthermore, coherent oscillations can be detected, although the oscillations do not influence commonly studied quantities as the charge current, zero- and finite-frequency noise, ordinary cumulants, and waiting times. We illustrate our findings for several Coulomb-blockade systems.

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