TT 58: Poster Session Transport & Matter at Low Temperature

Time: Thursday 15:00–19:00 Location: Poster D

TT 58.1 Thu 15:00 Poster D

Weak localization and magnetoresistance in a two-leg ladder model — •Michael P. Schneider[1,2], Sam T. Carr[2], Igor V. Gornyi[2], and Alexander D. Mirlin[2] — [1]Max-Born-Institut, 12489 Berlin, Germany — [2]Institut für Theorie der Kondensierten Materie and DFG Center for Functional Nanostructures, Karlsruher Institut für Technologie, 76128 Karlsruhe, Germany

We analyze the weak-localization correction to the conductivity of a spinless two-leg ladder model in the limit of strong dephasing $\tau_\phi \ll \tau_{tr}$, paying particular attention to the presence of a magnetic field, which leads to an unconventional magnetoresistance behavior. We find that the magnetic field leads to three different effects: (i) negative magnetoresistance due to the regular weak-localization correction, (ii) effective decoupling of the two chains, leading to positive magnetoresistance, and (iii) oscillations in the magnetoresistance originating from the nature of the low-energy collective excitations. All three effects can be observed depending on the parameter range, but it turns out that large magnetic fields always decouple the chains and thus lead to the curious effect of magnetic-field-enhanced localization [1].

[1] M. P. Schneider, S. T. Carr, I. V. Gornyi and A. D. Mirlin, Phys. Rev. B **86**, 155141 (2012)

TT 58.2 Thu 15:00 Poster D

Majorana fermions in systems with coexisting density waves and superconductivity — •Daniel Mendler, Panagiotis Kotetes, and Gerd Schön — Institut für Theoretische Festkörperphysik, Karlsruhe Institute of Technology, 76128 Karlsruhe, Germany

The recent discovery of topological materials such as HgTe/CdTe quantum wells and Bi-based compounds has motivated the systematic study of topological phases. Among the ten possible topological classes, we find cases in which topological systems admit Majorana bound state solutions which could be used as building blocks for topological quantum computing. In this work, we focus on strongly correlated systems that can exhibit conventional or unconventional density waves and superconductivity. We perform an exhaustive study of the possible phases by inferring their point group symmetry and topological class, in order to identify which of them can support Majorana fermions. Our results can be applied to the hexagonally warped Dirac modes living on a surface of the 3D topological insulator Bi_2Te_3, that demonstrates enhanced tendency towards spin density wave instabilities. Superconductivity can also emerge in this system due to correlations or proximity effects. We focus on heterostructures consisting of a superconducting wire on top of a Bi_2Te_3 surface and investigate the conditions under which Majorana bound states are accessible.

TT 58.3 Thu 15:00 Poster D

Majorana modes and localization in a disorderd Kitaev model — •Hanno Schmiedt, Lars Fritz, and Alexander Altland — Institut für theoretische Physik, Universität zu Köln, Deutschland

The periodic table of topological insulators and superconductors makes predictions about the localization properties as well as the absence or presence of gapless edge modes of systems having a certain type of symmetry. In one dimension it has been established that systems in class D exhibit protected Majorana edge modes. A microscopic realization of this system was introduced by Kitaev in terms of a simple one dimensional tight binding model. Using this lattice model we study (i) the robustness of the Majorana edge modes upon including disorder and increasing the number of parallel channels by computing the topological invariant as well as (ii) the existence or absence of extended zero energy states from the inverse participation ratio.

TT 58.4 Thu 15:00 Poster D

Spectral properties of disordered multi-channel Majorana wires — •Patrick Neven, Dmitry Bagrets, and Alexander Altland — Institut für Theoretische Physik, Universität zu Köln, Köln, Germany

Proximity coupled multi-channel spin-orbit quantum wires may support midgap Majorana states at the ends. We study the fate of these Majorana fermions in the presence of disorder in such wires. Inspired by the widely established theoretical methods of mesoscopic superconductivity, we develop a quasiclassical approach which is valid in the limit of strong spin-orbit coupling. A numerical solution of the Eilenberger equation reveals that disordered topological wires are prone to the formation of a zero-energy anomaly (class D impurity spectral peak) in the local density of states which shares the key features of a Majorana peak. We also find that the $\mathbb{Z}_2$ topological invariant distinguishing between the state with and without Majorana fermions (symmetry class B and D, resp.) is related to the Pfaffians of quasiclassical Green's functions.

TT 58.5 Thu 15:00 Poster D

Energy-charge separation in an electronic interferometer with two-particle collision — •Guillem Rosselló[1], Mikhail Moskalets[2], and Janine Splettstoesser[1] — [1]Institut für Theorie der Statistischen Physik, RWTH Aachen, Germany — [2]Department of Metal and Semic. Physics, NTU "Kharkiv Polytechnical Institute", Ukraine

Quantum wave experiments with electrons were recently reported in mesoscopic devices in the quantum Hall regime, with quantum point contacts as beam splitters and unidirectional edge states as waveguides. They resemble quantum optics experiments but are based on fermions instead of bosons. An important further ingredient is a recently developed single-particle source [1], which permits to inject single particles in a controllable manner into an electronic circuit. This allows to address single-particle coherence properties as well as controlled two-particle exchange effects occurring as "collisions" between particles. On this poster a setup consisting of a Mach-Zehnder interferometer and two synchronized sources is presented, in which collisions of particles strongly influence - and in certain cases even suppress - the single-particle interference pattern [2]. In particular, the signatures occurring in the heat current and the noise are theoretically investigated, complementing the features occurring in the charge current. This study yields further insight into the particle-emission process and the impact of collisions on which-path information.

[1] G. Fève, et al., Science 316, 1169 (2007)
[2] S. Juergens, J. Splettstoesser, and M. Moskalets, EPL 96, 37011 (2011)

TT 58.6 Thu 15:00 Poster D

Measurement back-action on the dynamics of an interacting quantum dot — •Jens Schulenborg[1], L.Debora Contreras-Pulido[2], Janine Splettstoesser[1], and Michele Governale[3] — [1]Institut für Theorie der Statistischen Physik, RWTH Aachen University, Germany — [2]Institute of Theoretical Physics, Ulm University, Germany — [3]School of Physical and Chemical Sciences, Victoria University of Wellington, New Zealand

Due to potential applications in nanoelectronics, metrology and quantum information, the study of the *dynamics* of quantum dots has attracted great interest over the past years. Recently, the relaxation rates in the dynamical response of an interacting single-level quantum dot, weakly tunnel coupled to an electronic reservoir and initially brought out of equilibrium, have been investigated [1]. The theoretical study presented on this poster focuses on the readout of the dynamic response of the quantum dot, capacitively coupled to a measuring device. In particular, the influence of measurement back-action effects on the dot's time-evolution is addressed. Starting from a master equation approach for the quantum dot coupled to the measuring device, the relaxation behavior of the dot (influenced by the measurement) is extracted. The result shows that the back-action of the measurement leads to a significant modification of the dot's relaxation rate for gate voltages close to the electron-hole symmetric point. On top of that, an additional rate governs the time-evolution of the quantum dot, which is closely related to the characteristics of the measuring device.

[1] L. D. Contreras-Pulido et al., Phys. Rev. B **85**, 075301 (2012).

TT 58.7 Thu 15:00 Poster D

Mechanical characterization of single electron charging in a quantum dot in the Kondo regime — •Daniel Schmid, Alois Dirnaichner, Peter Stiller, Christoph Strunk, and Andreas K. Hüttel — Institute for Experimental and Applied Physics, University of Regensburg, 93040 Regensburg, Germany

Detection of the transversal mechanical resonance frequency of a suspended, doubly clamped carbon nanotube resonator can be used to infer changes in the time-averaged charge on the embedded quantum

dot at cryogenic temperatures. This method is applied to the case of strong Kondo correlations between the quantum dot and its leads; we observe and model single electron charging as function of the applied gate voltage in a highly regular transport spectrum. Good agreement with theoretical predictions and previous observations in literature in GaAs is observed.

TT 58.8 Thu 15:00 Poster D

Lab::Measurement — Measurement control and automation with Perl — Alois Dirnaichner[1], Hermann Kraus[1], Stefan Geissler[1], Christian Butschkow[1], David Kalok[2], Florian Olbrich[1], and •Andreas K. Hüttel[1] — [1]Institute for Experimental and Applied Physics, University of Regensburg, 93040 Regensburg, Germany — [2]Department of Condensed Matter Physics, Weizmann Institute of Science, 76100 Rehovot, Israel

For quickly setting up varying and evolving complex measurement tasks involving diverse hardware, graphical logic programming quickly reaches practical limits. We present *Lab::Measurement*, a collection of Perl modules designed to control instruments connected by as various means as GPIB, USB, serial cable, Oxford Instruments IsoBus, or ethernet. Internally, backends as e.g. Linux-GPIB or National Instruments' NI-VISA library are used as well as direct operating system calls. Dedicated instrument driver classes relieve the user from taking care of internal details. Recording a measurement trace, say $I(V_{sd})$, becomes as easy as programming a single for-loop, and much more complex setups can be implemented. At the same time, the modules provide (live) plotting and metadata handling. For simple applications, a graphical control front end is being developed. *Lab::Measurement* has already been successfully used in several low temperature transport spectroscopy setups. It is free software and available at `http://www.labmeasurement.de/`

TT 58.9 Thu 15:00 Poster D

kwant - A computer program for quantum transport — Anton Akhmerov[1], Christoph Groth[2], Xavier Waintal[2], and •Michael Wimmer[3] — [1]Harvard University, USA — [2]CEA Grenoble, France — [3]Instituut-Lorentz, Universiteit Leiden, The Netherlands

We discuss methods for computing various quantum transport properties in tight-binding systems. We discuss both Green's function and wave function based methods, and how to implement them in a numerically stable way. In addition, we also discuss practical issues such as convenient data structures for defining the transport problem in a computer program. These algorithms and data structures are implemented in an easy to use, open source python package - kwant.

TT 58.10 Thu 15:00 Poster D

Fabrication of Au atomic sized contacts and conductivity measurements — •Karthiga Kanthasamy, Christoph Tegenkamp, and Herbert Pfnür — Institut für Festkörperphysik, Leibniz Universität Hannover, Appelstrasse 2, 30167 Hannover, Germany

Mechanically controllable break junctions offers an inherent stability and repeatability to contact a single atom and measure its electrical properties. We describe the fabrication of Au contacts on thin silicon substrate. Shadow mask technique, Electron Beam lithography and Thermal evaporation are used to fabricate Au contacts. The undercut is done by Reactive Ion Etching and Chemical Etching. The comparison of electrical conductance on Silicon substrate with different etching methods are discussed. Stepwise changes in the conductance measurements are observed for both room and low temperature and conductance histogram graph is studied.

TT 58.11 Thu 15:00 Poster D

Quantum-point contact based charge read-out for the InAs nanowire tip of a scanning tunneling microscope — •Sebastian Wüsten[1], Kilian Flöhr[1], Eugen Kaganovitch[1], Nils Freitag[1], Kamil Sladek[2], Mihail Lepsa[2], Hilde Hardtdegen[2], Marcus Liebmann[1], Thomas Schäpers[2], and Markus Morgenstern[1] — [1]II. Physikalisches Institut, RWTH Aachen and JARA-FIT, 52074 Aachen, Germany — [2]Peter Grünberg Institut, Forschungszentrum Jülich and JARA-FIT, 52425 Jülich, Germany

Proximal on-chip read-out of the current of a scanning tunneling microscope (STM) could improve low-current operation of the STM dramatically down to the detection of single tunneling electrons. Recently, we have demonstrated that InAs nanowires work as semiconducting tips for STM providing atomic resolution [1]. The wires grown by metal-organic vapor phase epitaxy (MOVPE) without catalysts are picked up individually with a sharp indium tip exploiting adhesion forces and subsequently, placed on the edge of a GaAs wafer [2]. Further on, this process creates the possibility of circuitry on the wafer, i.e. within $1\mu m$ from the tip apex. As a first step in that direction, we used a quantum point contact (QPC) processed into an AlGaAs/GaAs heterostructure [3]. Different QPC shapes are characterized by low-temperature (>0.3 K) transport measurements with respect to the nanowire read-out.

[1] K. Flöhr, K. Sladek, H. Y. Günel, M. I. Lepsa, H. Hardtdegen, M. Liebmann, Th. Schäpers, M. Morgenstern, Apl. Phys. Lett., accepted (2012)
[2] K. Flöhr et al., Rev. Sci. Instrum. 82, 113705 (2011)
[3] I. Shorubalko et al., Nano Lett. 8, 382 - 385 (2008)

TT 58.12 Thu 15:00 Poster D

Non-equilibrium quantum dynamics of the magnetic Anderson model — •Daniel Becker[1,2], Stephan Weiss[3], Michael Thorwart[1], and Daniela Pfannkuche[1] — [1]I. Institut für Theoretische Physik, Universität Hamburg, 20355 Hamburg — [2]Department Physik, Universität Basel, 4056 Basel, Schweiz — [3]Theoretische Physik, Universität Duisburg-Essen and CENIDE, 47048 Duisburg, Germany

For a Coulomb-interacting single-level quantum dot in contact with two metallic leads and a spin-1/2 magnetic impurity, which is exchange-coupled to the electron spin, a systematical investigation of the mutual dependencies between charge current and impurity relaxation dynamics is provided. To this end, the numerically exact, non-perturbative scheme of iterative summation of path integrals (ISPI)[1] is employed in a regime, where all appearing energy scales are of the same order of magnitude. We observe a significant influence of the non-equilibrium decay of the impurity spin polarization both in the presence and absence of Coulomb interaction. The exponential relaxation is faster for larger bias voltages, electron-impurity interactions and temperatures. Conversely, we find a reduction of the stationary current for increasing coupling to the impurity. Moreover, our approach allows us to systematically distinguish mean-field Coulomb and impurity effects from the influence of quantum fluctuations and flip-flop scattering, respectively. In fact, we find a local maximum of the current for a finite Coulomb interaction due to the presence of the impurity.

[1] D. Becker et al., NJP **14**, 073049 (2012)

TT 58.13 Thu 15:00 Poster D

Joule heating and current-density profiles during electromigration controled gap formation in nanostructures — •Birgit Kiessig[1,2], Roland Schäfer[1], and Hilbert v. Löhneysen[1,2] — [1]Karlsruher Institut für Technologie, Institut für Festkörperphysik, 76021 Karlsruhe — [2]Karlsruher Institut für Technologie, Physikalisches Institut, 76131 Karlsruhe

For molecular electronics gaps between metallic electrodes not larger than a few nm are needed. However, the structuring of such gaps is still a challenging task. One route towards reliable nanogaps utilizes electromigration which is reported to yield extremely small gaps if current and resistance is carefully monitored during the process. Electromigation leads to a continuous thinning out of metallic nanowires at sufficiently large current densities. The main driving force is the so called electron wind, e.g. the momentum transfer from the directional flow of conduction electrons to the atomic cores and the resulting displacement of the latter. However, electromigation depends on elevation of temperature due to Joules heating as well. We present our own experience with so called feedback controlled electromigration and discuss the influence of sample geometry and substrate texture on current-density and temperature profiles.

TT 58.14 Thu 15:00 Poster D

Transport through capacitively coupled carbon nanotube bundles. — Birgit Kiessig[1,2], •Roland Schäfer[1], Cornelius Thiele[1,3], Ralph Krupke[1,3], and Hilbert v. Löhneysen[1,2] — [1]Karlsruher Institut für Technologie, Institut für Festkörperphysik, 76021 Karlsruhe — [2]Karlsruher Institut für Technologie, Physikalisches Institut, 76131 Karlsruhe — [3]Karlsruher Institut für Technologie, Institut für Nanotechnologie, 76021 Karlsruhe

We have investigated transport through single walled carbon nanotubes deposited by AC electrophoresis at low temperatures. The samples comprise source and drain electrodes as well as two indepen-

dent gates. Measurements of current as function of the gate voltages give evidence that transport is due to a bundle of a few tubes which open up several parallel conductance channels. We present a sequential tunneling model in which three quantum dots are connected in parallel to source and drain. Including capacitive coupling between the dots leads to transport characteristics which are in qualitative accord with our measurements.

TT 58.15 Thu 15:00 Poster D

Anomalous Hall effect in Mn_5Si_3 and $Mn_5Si_3C_{0.8}$ films — Patrick Winkel[1], •Christoph Sürgers[1], Gerda Fischer[1], Inga A. Fischer[2], and Hilbert v. Löhneysen[1,3] — [1]Physikalisches Institut, KIT, Karlsruhe — [2]Institut für Halbleitertechnik, Universität Stuttgart — [3]Institut für Festkörperphysik, KIT, Karlsruhe

Antiferromagnetic Mn_5Si_3 (T_N = 100 K) can be tuned ferromagnetically by incorporation of carbon [1]. The highest Curie temperature is observed for $Mn_5Si_3C_{0.8}$ with T_C = 350 K. We investigate the magnetoresistance and Hall effect of 45-nm thick films for temperatures $T = 2 - 400$ K and magnetic fields up to 8 T. For each temperature, the different contributions to the Hall conductivity, σ_{xy}^0 and σ_{xy}^{AH}, arising from the ordinary and anomalous Hall effect, respectively, are separated by taking into account the temperature dependence of the magnetoresistance and magnetization M.

For ferromagnetic $Mn_5Si_3C_{0.8}$, we find a positive ordinary Hall coefficient and a linear behaviour $\sigma_{xy}^{AH} \propto M$ similar to the isotructural ferromagnet Mn_5Ge_3 [2]. In contrast, a negative ordinary Hall coefficient and a nonlinear behaviour of $\sigma_{xy}^{AH}(M)$ is observed for antiferromagnetic Mn_5Si_3. While the negative σ_{xy}^0 is attributed to the change of the electronic structure induced by carbon [3] the nonlinear $\sigma_{xy}^{AH}(M)$ awaits theoretical calculations of the anomalous Hall effect in antiferromagnetic compounds.

[1] C. Sürgers et al., Appl. Phys. Lett. **93**, 062503 (2008)
[2] C. Zeng et al., Phys. Rev. Lett. **96**, 037204 (2006)
[3] I. Slipukhina et al., Appl. Phys. Lett. **94**, 192505 (2009)

TT 58.16 Thu 15:00 Poster D

Electronic and magnetic properties of NiMnSb/MgO and NiMnSi/MgO interfaces — •Rui-Jing Zhang[1], Ulrich Eckern[1], and Udo Schwingenschlögl[2] — [1]Institute of Physics, University of Augsburg, 86135 Augsburg, Germany — [2]KAUST, PSE Division, Thuwal 23955-6900, Kingdom of Saudi Arabia

The electronic and magnetic properties of the interfaces between the half-metallic Heusler alloys NiMnSb and NiMnSi, and MgO have been investigated using first-principles density-functional calculations with projector augmented wave (PAW) potentials generated with Generalized Gradient Approximation. In all the cases of NiMnSb/MgO(100) and NiMnSb(Si)/MgO(111), the half-metallicity is lost. However, the MnSb/MgO-terminated interface in the NiMnSb/MgO(100) contact keeps a high degree of spin polarization at the Fermi level, which can be up to 77%. The (111) interfaces show a spin polarization at the Fermi level of around 52% at most for NiMnSb/MgO with Sb/O termination, which has more potential in real applications than NiMnSi/MgO(111) with Si/O termination (36% spin polarization).

TT 58.17 Thu 15:00 Poster D

Rashba spin-orbit interaction in graphene armchair nanoribbons — Lucia Lenz[1], Daniel F. Urban[2,3], and •Dario Bercioux[1,4] — [1]Freiburg Institute for Advanced Studies, Albert-Ludwigs-Universität, 79104 Freiburg, Germany — [2]Physikalisches Institut, Albert-Ludwigs-Universität, 79104 Freiburg, Germany — [3]Fraunhofer Institute for Mechanics of Materials IWM, Wöhlerstraße 11, 79108 Freiburg, Germany — [4]Department of Physics, Stanford University, Stanford, California 94305, USA

We study graphene nanoribbons (GNRs) with armchair edges in the presence of Rashba spin-orbit interaction (RSOI). We impose the boundary conditions on the tight binding Hamiltonian for bulk graphene with RSOI by means of a sine transform and use the results to derive different approximations and to investigate their ranges of validity. In addition, we derive an approximation for the lowest two energy bands, which is valid for experimentally available sizes of RSOI. Finally, we address the effect of RSOI on the spin polarization in GNRs. We show that the spin polarization perpendicular to the nanoribbon axis changes sign when reversing the momentum along the GNR. This effect arises from the coupling of the modes induced by RSOI.

[1] L. Lenz, D.F. Urban, D. Bercioux, arXiv:1210.2865.

TT 58.18 Thu 15:00 Poster D

Spin-resolved scattering in bilayer graphene — •Linnéa Schätzle and Dario Bercioux — Freiburg Institute for Advanced Studies, Albert-Ludwigs-Universität, D-79104 Freiburg, Germany

Bilayer graphene in contrast to single layer graphene has a tunable bandgap. This makes it a promising material for a novel kind of field effect transistors. Electrons in bilayer graphene have high mobilities and long spin-relaxtion-lengths that makes it interesting for electronic applications [1].

We are interested in spin-resolved scattering through regions of inhomogeneous spin-orbit interactions. The spin-resolved scattering properties, for the case of single layer graphene with these spin-orbit barriers, are a function of the incident angle [2]. We show that the more complex band structure of bilayer graphene leads to similar results. These can be useful for the implementation of carbon-based spintronics devices.

[1] T.- Y. Yang *et al.*, PRL **107**, 047206 (2011)
[2] D. Bercioux and A. de Martino, Phys. Rev. B **81**, 165410 (2010)

TT 58.19 Thu 15:00 Poster D

Electronic structure and transport properties of crossed carbon nanotubes — •Fabian Teichert[1], Andreas Zienert[1], and Jörg Schuster[2] — [1]Center for Microtechnologies, Chemnitz University of Technology, Chemnitz, Germany — [2]Fraunhofer Institute for Electronic Nano Systems, Chemnitz, Germany

According to their geometric structure carbon nanotubes (CNT) have different electronic properties. The metallic ones could be used for interconnects in future microelectronic devices. During experimental preparation CNTs can not be placed isolated. They get curved and form bundles. Therefore it is necessary to study the interaction of closely neighboring CNTs and its influence on the electronic and transport properties.

In the present work the attention is focused on a special geometry, where two (4,1)-CNTs (one curved and one linear) are aligned at a minimum distance of 3 Å. For this system electron densities, densities of states and transmission spectra are obtained from ab initio simulations. To get the current-voltage characteristic $I(U)$, transmission spectra are calculated for non-zero voltages by the use of non-equilibrium Green's function theory and integrated within the Landauer-Büttiker formalism. All calculations are performed for various angles α between the periodic axes of the two CNTs so that the influences of the crossing and curving effects could be extracted separately. The simulations show that the behavior of $I(U)$ changes with increasing α. Furthermore, the reduction of the current with respect to a linear CNT is dominated by the crossing effect for small α and by the curving effect for large α.

TT 58.20 Thu 15:00 Poster D

Model study of vibrationally dependent electron-electron interactions in single-molecule junctions — •André Erpenbeck[1], Rainer Härtle[1,2], Michel Bockstedte[1], and Michael Thoss[1] — [1]Institut für Theoretische Physik, Friedrich-Alexander-Universität Erlangen- Nürnberg, Staudtstr. 7/B2, D-91058 Erlangen, Germany — [2]Department of Physics, Columbia University, 538 W. 120th St., New York, NY 10027, USA

In a single molecule junction, the interaction of the electrons with the vibrational degrees of freedom gives rise to direct electronic-vibrational coupling, but results also in vibrationally dependent electron-electron interactions. We derive a general, reduced model that incorporates vibrationally dependent electron-electron interactions and show that it leads to an effective electronic-vibrational coupling, which depends on the population of the electronic states of the molecular bridge. Employing a Born-Markov master equation approach, the influence of the interactions on the transport characteristics is analyzed. In particular, we show that vibrationally dependent electron-electron interactions may result in regimes of purely electronic transport, negative differential resistance, a significant decrease of the vibrational excitation as well as characteristic asymmetries in the gate-voltage dependence of the conductance properties of a molecular contact.

TT 58.21 Thu 15:00 Poster D

Electrical characterization of single organic molecules via mechanically controllable break junctions — •Torsten Sendler[1], Matthias Wieser[1], Shou-Peng Liu[2], Samuel Weisbrod[2], Zhou Tang[2], Andreas Marx[2], Jannic Wolf[2], Thomas Kuhn[2], Elke Scheer[2], Francesca Morecso[3], Jochen Grebing[1], and Ar-

tur Erbe[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Germany — [2]Universität Konstanz, Germany — [3]Max Bergmann Center of Biomaterials, Germany

Molecular electronics has been of big interest for the last years. To allow an electrical characterization of single molecules a reliable contact to gold atoms is required. We ensure this by using single organic molecules with a plain structure, in particular 1,4-Diethoxy-2,5-bis (4-sulfanyl-phenylethynyl)-benzene and single stranded DNA fragments, dissolved in an organic non-polar solvent. For measurements we use the technique of mechanically controllable break junctions. IV-curves taken from single molecules connected to single gold atom contacts show the expected tunneling behavior, from which we gain the energy of the molecular level and the coupling between electrode and molecule.

TT 58.22 Thu 15:00 Poster D

Combining master-equation and DFT for simulating STM images of single molecules: An ab-initio approach for the coupling-strength — •Tim Ludwig[1], Carsten Timm[1], Torsten Hahn[2], and Jens Kortus[2] — [1]U Dresden, Dresden, Germany — [2]TU Freiberg, Freiberg, Germany

The power of STM imaging of single molecules lies in the spatial resolution and a well-defined contact with highly controllable contact strength. Traditional methods for simulating STM images, e.g., DFT + Tersoff-Hamann, combine a static single-particle density-of-states description of the scanned object with more or less artificial models for the tunneling amplitude between the object and the contacts. This can be inappropriate for the investigation of single molecules, as for example Coulomb blockade may occur. We propose a new *ab-initio* algorithm for the calculation of the tunneling amplitudes. Together with a master-equation approach, which models the full many-body dynamics of the scanned object, both limitations can be overcome.

TT 58.23 Thu 15:00 Poster D

Insertable ^{4}He sample probe for combined microwave and dc electrical transport measurements — •Oleksandr V. Dobrovolskiy[1,2], Jörg Franke[1], and Michael Huth[1] — [1]Physikalisches Institut Goethe-Universität, Frankfurt am Main, Germany — [2]Department of Physics, Kharkiv National University, Ukraine

Combined microwave and dc electrical transport measurements at low temperatures represent a valuable experimental method in many research areas. In particular, when samples are conventional superconductors, a typical experiment requires a combination of helium temperatures, a wide range of magnetic fields, and the utilization of coaxial lines along with the usual dc wiring. We report on the general design features and the microwave performance of a home-made low-temperature sample probe, with a measurement bandwidth tested from dc to 20 GHz. Equipped with 6 coaxial cables, a heater, Hall and temperature sensors, the probe fits into a ⌀32 mm shaft. We present our setup, describe the calibration procedures, and give examples of experiments enabled by this system. The proposed setup will be essential for a systematic study of the dc- and ac-response of the vortex dynamics in nanopatterned superconductors subjected to combined dc and microwave stimuli. Besides, it will be valuable for the investigation of a broad class of nonlinear stochastic systems where a combination of dc and high-frequency ac driving in a wide temperature range is necessary.

TT 58.24 Thu 15:00 Poster D

Negative frequency tuning of a carbon nanotube nanomechanical resonator — Sabine Kugler, Daniel Schmid, •Peter Stiller, Christoph Strunk, and Andreas K. Hüttel — Institute for Experimental and Applied Physics, University of Regensburg, 93040 Regensburg, Germany

The transversal mechanical resonance frequency of a suspended carbon nanotube doubly clamped at its contact points can be tuned with an externally applied gate voltage. In a simple picture, the electrostatic force between the gate and the resonator applies mechanical tension, increasing the resonance frequency at finite voltage. We present data on an unusual resonator where application of a back gate voltage leads to a strong detuning of the mechanical resonance towards *lower* frequencies; we observe a decrease of approximately 30%. Tentative models for this effect are discussed.

TT 58.25 Thu 15:00 Poster D

Stabilizing Superconducting Qubits by Coupling To A Cavity — •Christos Bokas and Joachim Ankerhold — Institut für Theoretische Physik, Universität Ulm

We consider a superconducting qubit capacitively coupled with a one-dimensional cavity. This system can be mapped to a model consisting of a quantum mechanical harmonic oscillator interacting with a two level system.The unavoidable influence of the environment causes the qubit to loose its coherence. Here, we focus on whether and under which conditions, the stability of qubit's states can benefit from being entangled with resonator states. We identify parameters relevant for the experimental realisation, in order to determine the optimal range in which stabilizing takes place. The total system is analyzed in the context of the Jaynes-Cummings-Model, both by applying a RWA and without any approximation.

TT 58.26 Thu 15:00 Poster D

High cooperativity in a microwave resonator coupled to YIG — H. Huebl[1], •J. Lotze[1], C. Zollitsch[1,2], F. Hocke[1], S. T. B. Goennenwein[1], and R. Gross[1,2] — [1]Walther-Meißner-Institut, Bayerische Akademie der Wissenschaften, Garching, Germany — [2]Physik-Department, Technische Universität München, Garching, Germany

Understanding the coupling of magnetic moments (spins) to light fields (photons) on a quantum level is of fundamental interest. Recent work [1,2] on paramagnetic samples coupled to superconducting resonators has shown coherent coupling between microwave photons and electron spins. This coupling is enhanced compared to a single spin by a factor of $\sqrt{N}$, where N is the number of spins in the ensemble. Here [3], we study a bulk ferrimagnetic Ga-doped yttrium iron garnet (YIG) crystal coupled to a superconducting niobium coplanar waveguide resonator operating at 5.9 GHz. Measuring the transmission through the resonator in a magnetic field H, we observe an anticrossing of the spin and photon dispersions with a splitting of 900 MHz. From the H dependence of the resonance linewidths in the interaction regime, we find that the coupling clearly dominates the intrinsic loss rates of the exchange-locked spins and the resonator, with a cooperativity $C = 1350$. This system is therefore well suited for studying the magnon-photon interaction in the strong coupling regime. This work is supported by DFG via SFB 631 and the German Excellence Initiative via NIM.

[1] D. I. Schuster *et al.*, Phys. Rev. Lett. **105**, 140501 (2010)
[2] Y. Kubo *et al.*, Phys. Rev. Lett. **105**, 140502 (2010)
[3] H. Huebl *et al.*, arXiv:1207.6039 (2012)

TT 58.27 Thu 15:00 Poster D

Scalable chains of coupled superconducting transmission line resonators — •Ling Zhong[1,2], Lisa Janker[2], Friedrich Wulschner[1,2], Frank Deppe[1,2], Edwin Menzel[1,2], Max Haeberlein[1,2], Alexander Baust[1,2], Elisabeth Hoffmann[1,2], Jan Goetz[1,2], Manuel Schwarz[1,2], Achim Marx[1,2], and Rudolf Gross[1,2] — [1]Walther-Meißner-Institut, D-85748 Garching, Germany — [2]Technische Universität München, D-85748 Garching, Germany

The investigation of many-body Hamitonians is relevant to understand collective quantum behavior in solid state physics. However, solving these many-body Hamitonians can be challenging on a classical computer. For this reason, quantum simulations are an attractive approach to simulate such complex Hamitonians with experimentally easily accessible and well-controlled systems. In our experiment, we use superconducting circuits to take the first steps towards this direction. More precisely, we characterize chains of up to four coupled transmission line resonators in a scalable layout. After introducing nonlinearities in the form of Josephson junctions and scaling to longer chains, our system can become a quantum simulator for Bose-Hubbard-type Hamitonians.

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TT 58.28 Thu 15:00 Poster D

From strong to ultrastrong coupling in Circuit QED — •A. Baust[1,2], T. Losinger[2], M. Haeberlein[1,2], E. Hoffmann[1,2], P. Eder[1,2], J. Goetz[1,2], F. Loacker[2], E.P. Menzel[1,2], M.J. Schwarz[1,2], F. Wulschner[1,2], L. Zhong[1,2], F. Deppe[1,2], H. Huebl[1,2], A. Marx[1,2], and R. Gross[1,2] — [1]Walther-Meißner-Institut, Germany — [2]TU München, Garching

In circuit quantum electrodynamics, the light-matter coupling strength can be tuned over several orders of magnitude and can even be increased to a significant fraction of the system energy. For a flux qubit coupled to a transmission line resonator, we have reached the regime of ultrastrong light-matter interaction and show experimental

evidence for the breakdown of the Jaynes-Cummings-model [1]. We present spectroscopic measurements for different coupling schemes of flux qubits and transmission line resonators and discuss the possibility to further increase the coupling strength and reach the regime of deep-ultrastrong coupling. For a complete characterization of our qubits we also perform time-domain spectroscopy measurements in order to determine the coherence times of our qubits.

This work is supported by DFG via SFB 631, the German Excellence Initiative via NIM, as well as EU projects CCQED and PROMISCE.

[1] T. Niemczyk et al., Nature Phys. 6, 772-776 (2010)

TT 58.29 Thu 15:00 Poster D

Hysteresis effects in superconducting resonators — •Philipp Mayer[1], Fengbin Song[1], Martin Weides[1], Hannes Rotzinger[1], Michael Stüber[2], Harald Leiste[2], and Alexey V. Ustinov[1] — [1]Physikalisches Institut, Karlsruher Institut für Technologie, Center for Functional Nanostructures — [2]Angewandte Werkstoffphysik, Karlsruher Institut für Technologie

Superconducting microwave resonators are of considerable interest for quantum circuits. They can be used for many applications in circuit quantum electrodynamics, for example as a readout tool for qubits, a quantum bus or a coupling to spins in crystals. For these purposes, it is important to understand the behavior of superconducting resonators in magnetic fields. Previous studies on resonators made of Nb have shown a hysteretic dependence of quality factor and resonance frequency on applied magnetic field. High quality microwave resonators are made of TiN and can have high internal quality factors in the order of 10^7 at high and 10^6 at low photon numbers. Furthermore they were shown to have a large kinetic inductance. In this work, 40 nm thin films of TiN were sputtered on intrinsic Si wafers. The films were patterned by reactive ion etching into resonators of $\frac{\lambda}{2}$, $\frac{\lambda}{4}$ and lumped LC geometry. We investigated their hysteretic behavior in out-of-plane magnetic fields at temperatures ranging from 275 mK up to 1K in both the many photon and single photon limit. We will present and discuss results of our on-going experiments.

TT 58.30 Thu 15:00 Poster D

Probing the TLS Density of States in Thin a-SiO Films using Superconducting Lumped Element Resonators — •Sebastian T. Skacel[1,2], Christoph Kaiser[2], Stefan Wünsch[2,3], Hannes Rotzinger[1], Oleksandr Lukashenko[1], Markus Jerger[1], Georg Weiss[1,3], Michael Siegel[2,3], and Alexey V. Ustinov[1,3] — [1]Physikalisches Institut, Karlsruher Institut für Technologie, Wolfgang-Gaede-Straße 1, D-76131 Karlsruhe, Germany — [2]Institut für Mikro- und Nanoelektronische Systeme, Karlsruher Institut für Technologie, Hertzstraße 16, D-76187 Karlsruhe, Germany — [3]Center for Functional Nanostructures, Karlsruher Institut für Technologie, Wolfgang-Gaede-Straße 1a, D-76128 Karlsruhe, Germany

In the context of low-loss materials needed for superconducting qubits, we investigated the dielectric loss in the volume of a-SiO thin films at mK temperatures and single photon power levels. Our broadband measurement setup employs multiplexed lumped element resonators as well as suitable power combiner and low noise amplifier. This enables measurements on all resonators to be carried out in one cool down cycle. The results are in good agreement with the temperature and power dependence of the dielectric losses predicted for atomic two-level tunneling systems (TLSs). We find indication that the TLS density of states increases with frequency, which had not been seen in previous loss measurements.

TT 58.31 Thu 15:00 Poster D

Decoherence of the Majorana fermions — •François Konschelle and Fabian Hassler — Institute for Quantum Information, RWTH Aachen University, 52056 Aachen, Germany

Majorana fermion is one of the possible candidates for future quantum computation implementations. Of interest are their topological properties which protect them from decoherence. More precisely, the delocalization of the Majorana wave function at the two ends of a semi-conducting wire in the proximity with a superconductor allows the parity (i.e. the number of fermions) to be conserved up to some exponential corrections. We want to discuss the decoherence aspects of the Majorana fermion in general terms. To do that, we first establish a toy-model for the calculation of the wave function associated with a delocalized Majorana fermion. Then, we discuss the possibilities for exciting a proximity-induced superconductor. Finally, we discuss the decoherence characteristic times associated with several quantities, the most important of them being the parity of a given part of the wire.

TT 58.32 Thu 15:00 Poster D

Decoherence due to quasi particle tunneling in superconducting resonators — •Sebastian Zanker, Michael Marthaler, and Gerd Schön — Institut für Theoretische Festkörperphysik, Karlsruher Institut für Technologie, D-76128 Karlsruhe

We investigate decoherence in superconducting resonators due to quasi particle tunneling. In particular resonators shunted by single Josephson junctions and SQUIDs as well as transmission line embedded Josephson junctions are studied. Quasi particle tunneling is assumed to occur because of the presence non-equilibrium quasi particles and decay times may be used to calculate quasi particle densities.

TT 58.33 Thu 15:00 Poster D

Solving non-Markovian master equations for N-Qubit-systems — •Christian Karlewski[1], Michael Marthaler[2], and Gerd Schön[2] — [1]Fakultät für Physik, Universität Bielefeld, Postfach 100131, D-33501 Bielefeld, Germany — [2]Institut für theoretische Festkörperphysik, Karlsruher Institute for Technology, D-76128 Karlsruhe, Germany

We solve non-Markovian master-equations of N-Qubit systems with Born-approximation using Fourier-transformation. With the full solution of the reduced density matrix of the Qubit-system we analyze different noise-spectra and the resulting dynamics. Decoherence and the appearance of dark states can be seen. One special system we have a closer look at is the one-excitation model with one of the N-Qubits in an excited state. By the use of the observable that measures the population of all other qubits and some constraints to the system it is possible to reduce the dynamics of this observable to three ODE.

TT 58.34 Thu 15:00 Poster D

Current noise in disordered Josephson junctions — •Pierre-Luc Dallaire-Demers[1], Mohammad Ansari[2], and Frank Wilhelm-Mauch[1] — [1]Universität des Saarlandes, Saarbrücken, Deutschland — [2]Institute for Quantum Computing, Waterloo, Canada

Josephson junctions are one of the fundamental building blocks of mesoscopic superconducting circuits. Despite being dissipationless, spurious low-energy Andreev bound states inside those junctions could provide an intrinsic microscopic mechanism for fluctuations of the current, therefore limiting the coherent operation time of superconducting quantum circuits. Models of bound states arising from pinholes in different models of disorder were investigated and their current noise signatures were characterized with respect to temperature, phase difference and sample-to-sample fluctuations of the conductance. In this theoretical work, it is shown that the low-frequency noise signature of Josephson junctions is a property specific to each individual sample independent of the fabrication process. Furthermore, the comparison of sample-specific noise spectra and characteristic current-voltage relations reveals under which conditions the presence of those disorder-induced bound states may elude detection in a 4-probe measurement but still reveal themselves as dephasing of coherent observables in circuits dominated by inductive energy.

TT 58.35 Thu 15:00 Poster D

Non-perturbative stochastic method for driven quantum impurity systems — •Peter Orth[1] and Karyn Le Hur[2] — [1]Institute for Theory of Condensed Matter, Karlsruhe Institute of Technology (KIT), 76131 Karlsruhe — [2]Center for Theoretical Physics, Ecole Polytechnique, CNRS, 91128 Palaiseau Cedex, France

We discuss a numerically exact method for investigating the real-time dissipative dynamics of quantum impurities embedded in a macroscopic environment beyond the weak-coupling limit. We focus on the spin-boson Hamiltonian that describes a two-level system interacting with a bosonic bath of harmonic oscillators. Starting from the real-time Feynman-Vernon path integral, we derive an exact stochastic Schrödinger equation that allows to compute the full spin density matrix and spin-spin correlation functions beyond weak coupling. We present an analogy between the dissipative dynamics of a quantum spin and that of a classical spin in a random magnetic field. This analogy is used to recover the well-known Non- Interacting-Blip-Approximation (NIBA) in the weak-coupling limit. As interesting applications of our method, we explore the non-Markovian effects of the initial spin-bath preparation on the dynamics of the coherence $\sigma^x(t)$ and of $\sigma^z(t)$ under a Landau-Zener sweep of the bias field. We also compute to a high precision the asymptotic long-time dynamics of $\sigma^z(t)$ without bias and

demonstrate the wide applicability of our approach by calculating the spin dynamics at non-zero bias and different temperatures.

TT 58.36 Thu 15:00 Poster D

Absorption and transfer properties of quantum aggregates under the influence of Lévy-stable disorder — Sebastian Möbius[1], •Sebastiaan M. Vlaming[1,2,3], Victor A. Malyshev[2], Jasper Knoester[2], and Alexander Eisfeld[1] — [1]Max Planck Institute for Physics of Complex Systems, Dresden, Germany — [2]Centre for Theoretical Physics and Zernike Institute for Advanced Materials, University of Groningen, Groningen, The Netherlands — [3]Department of Chemistry and Center for Excitonics, Massachusetts Institute of Technology, Cambridge, USA

Molecular aggregates exhibit extraordinary absorption properties, depending on their geometrical conformation and inter-monomeric coupling. The narrowing of the absorption band for J-aggregates can be well described by diagonal Gaussian static disorder for individual site energies. Aggregates consisting of large molecules are usually embedded in complex environments, making it impossible to separate individual contributions to the energy fluctuations.

Recent developments in generating and trapping highly excited Rydberg atoms allow for quantum simulations of molecular aggregates. By controlling the environment, e.g. a polar background gas, static disorder besides Gaussian can be studied. We analyze how the environment generates disorder distributions with heavy tails, so called Lévy-stable distributions. These distributions can lead to broadening of the absorption bandwidth [1] as well as subdiffusive exciton transfer.

[1] A. Eisfeld, S.M. Vlaming, V.A. Malyshev, J. Knoester, PRL **105**, 137402 (2010)

TT 58.37 Thu 15:00 Poster D

Real Time Dynamics in the Central Spin Model: a Chebyshev Polynomial Approach — •Johannes Hackmann and Frithjof B. Anders — Technische Universität Dortmund, Lehrstuhl für Theoretische Physik II, 44221 Dortmund, Germany

The central spin model describes the dephasing of a single electron spin in a negatively doped semiconductor quantum dot. The real time dynamics of the system are studied using the Chebyshev polynomial expansion for arbitrary initial conditions. Typically, we include a representation of 20 nuclear spins in our simulations. We discuss the influence of different couplings between the central spin and the bath and compare our data to a mean field result. We extend our simulations and include a finite transverse magnetic field. We study the interplay of the Larmor precession and the spin dephasing as function of magnetic field strength. We gauge a simplified mean-field approach for a large number of spins with our numerical data for a small cluster.

TT 58.38 Thu 15:00 Poster D

Interacting electrons on trilayer honeycomb lattices — Michael M. Scherer[3], Stefan Uebelacker[1,2], •Daniel D. Scherer[4], and Carsten Honerkamp[1,2] — [1]Institute for Theoretical Solid State Physics, RWTH Aachen University, D-52056 Aachen, Germany — [2]JARA-FIT Fundamentals of Future Information Technology — [3]Institute for Theoretical Physics, Heidelberg University, D-69120 Heidelberg, Germany — [4]Institute for Theoretical Physics, Leipzig University, D-04103, Leipzig, Germany

Few-layer graphene systems come in various stacking orders. Considering tight-binding models for electrons on stacked honeycomb layers, this gives rise to a variety of low-energy band structures near the charge neutrality point. Depending on the stacking order, these band structures enhance or reduce the role of electron-electron interactions. Here, we investigate the instabilities of interacting electrons on honeycomb multilayers with a focus on trilayers with ABA and ABC stackings theoretically by means of the functional renormalization group. We find different types of competing instabilities and identify the leading ordering tendencies in the different regions of the phase diagram for a range of local and non-local short-ranged interactions. The dominant instabilities turn out to be toward an antiferromagnetic spin-density wave (SDW), a charge density wave, and quantum spin Hall (QSH) order. Ab initio values for the interaction parameters put the systems at the border between SDW and QSH regimes. We thus obtain a comprehensive picture of the possible interaction-induced ground states of few-layer graphene.

TT 58.39 Thu 15:00 Poster D

Zero-Gap State in Organic Conductors — •Rebecca Beyer[1], Armin Dengl[1], Mohamed Assili[2], Tomislav Ivek[1,3], and Martin Dressel[1] — [1]1. Physikalisches Institut, Universität Stuttgart, Germany — [2]University of Tunis, Tunisia — [3]Institut za fiziku, Zagreb, Croatia

The quasi-two-dimensional molecular crystal α-(BEDT-TTF)$_2$I$_3$ exhibits a metallic behavior down to $T_{MI} = 135$ K, at which it undergoes a metal-insulator transition into a charge-ordered state. This transition is very sensitive to hydrostatic pressure: it not only decreases the transition temperature by about 9 K/kbar but also the charge disproportionation gets reduced with increasing pressure. Above a certain pressure of about 15 kbar, the metal-insulator transition is completely suppressed and the material goes into a zero-gap semiconducting (ZGS) state with close similarities to the Dirac-Cone in Graphene. The ZGS-state has been predicted by theory and been supported by dc- and Hall-measurements while the NMR-response shows very exotic features which also have been assigned to ZGS fingerprints.

For further investigation of the ZGS state in α-(BEDT-TTF)$_2$I$_3$ we performed infrared optical measurements in the frequency range of 100 cm^{-1} to 8000 cm^{-1} at temperatures as low as 10 K under hydrostatic pressure up to 15 kbar. We were able to follow the decrease of the transition temperature and the closure of the insulating gap with increasing pressure. Calculations were performed predicting the optical conductivity of free charge carriers in a tilted Dirac-Cone, in order to compare experimental results with theory.

TT 58.40 Thu 15:00 Poster D

Non-perturbative laser effects on the electrical properties of graphene nanoribbons — •Hernán L. Calvo[1], Pablo M. Pérez Piskunow[2], Horacio M. Pastawski[2], Stephan Roche[3,4], and Luis E. F. Foa Torres[2] — [1]Institut für Theorie der Statistischen Physik, RWTH Aachen University, Germany — [2]Instituto de Física Enrique Gaviola (CONICET) and FaMAF, Universidad Nacional de Córdoba, Argentina — [3]CIN2 (ICN-CSIC), Catalan Institute of Nanotechnology, Universidad Autónoma de Barcelona, Spain — [4]Institució Catalana de Recerca i Estudis Avançats (ICREA), Barcelona, Spain

We study the interplay between lateral confinement and photon-induced non-adiabatic processes on the electronic properties of laser-illuminated graphene nanoribbons. By using Floquet theory applied to realistic models of these nanostructures, we predict a strong dependence on the polarization direction which is averaged out in the bulk limit. Depending on the device setup (edges geometries, ribbon width, polarization direction and metallic/semiconducting character of the sample), a laser with frequency Ω may either not affect the electronic structure, or induce bandgaps or depletions at $\pm\hbar\Omega/2$, and/or at other energies not commensurate with half the photon energy. Similar features are also observed in the dc conductance, suggesting the use of the polarization direction to switch on and off the graphene device. Our results could guide the design of novel types of optoelectronic nano-devices.

TT 58.41 Thu 15:00 Poster D

Kondo effect in graphene with isolated vacancies — •Lars Fritz[1] and Andrew Mitchell[1,2] — [1]Universität zu Köln, Institut für Theoretische Physik — [2]Department of Chemistry, Physical and Theoretical Chemistry, Oxford University,UK

The physics of a reconstructed vacancy in graphene is investigated by a combination of numer- ical renormalization group and analytical techniques. The effective model introduced recently by [1] describes a localized σ level hybridized with the π-band, whose local density of states is enhanced due to potential scattering. Rich quantum impurity physics is shown to result, with both doublet and triplet powerlaw Kondo phases accessible, depending on microscopic parameters. Thermodynamic quantities and the scattering t matrix are calculated exactly in each phase. The quantum phase transition separating Kondo phases is examined, and the unusual role of particle-hole symmetry breaking is also considered. We show that the asymmetric lo- cal moment phases of simplified Kondo models are not in practice accessible in the full Andersonian model describing the vacancy, and that Kondo screening is always important at low energies.

[1] Cazalilla et al., arXiv:1207.3135 (2012)

TT 58.42 Thu 15:00 Poster D

De Haas - van Alphen oscillations in graphene — •Carolin Küppersbusch and Lars Fritz — Institut für Theoretische Physik, Universität zu Köln

De Haas van Alphen oscillations are customarily analyzed using the

Lifshitz-Kosevich (LK) formula. This is a phenomenological formula which relates the amplitude of the harmonics to system parameters such as the temperature, disorder strength and the effective mass of the electrons. For systems which can be described within Fermi liquid theory the LK formula holds without modifications when electron-electron interactions are included. The introduction of a renormalized mass is fully effectual. Since graphene cannot be described within Fermi liquid theory for all doping levels, modifications of the LK formula should be expected for this system with electron-electron interactions included. These modifications are investigated.

TT 58.43 Thu 15:00 Poster D

Kondo effect in a graphene sheet with a vacancy — •Martin Sprengel and Fakher F. Assaad — Institut für theoretische Physik und Astrophysik, Universtität Würzburg, Am Hubland, D-97074 Würzburg, Germany

We study the influence of a single-atom vacancy in a Graphene lattice using a tight-binding model with nearest neighbour hopping and a Hubbard U term. The vacancy generates a *localised* state, which extends into the bulk with a power law. The question we wish to address is if under correlation effects a local moment is created and if it is ultimately screened by the bulk. To do so, we use continuous-time Quantum Monte Carlo (CT-QMC) simulations to calculate the dependence of the spin susceptibility on temperature, chemical potential and the Hubbard U. For small deviation from half-filling no sign problem occurs which allows us to benefit from the fact that CT-QMC is a numerically exact method. At half filling and down to our lowest temperatures we observe a Curie behaviour of the local spin susceptibility. Away from half filling, the very signature of the local moment is absent within the considered parameter range.

TT 58.44 Thu 15:00 Poster D

Probing the transport properties of graphene nanostructures produced by local anodic oxidation — •Nils Freitag[1], Aviral Vaid[2], Marco Pratzer[1], Marcus Liebmann[1], Theresa Hecking[1], Alexander Nent[1], and Markus Morgenstern[1] — [1]II. Physikalisches Institut, RWTH Aachen and JARA-FIT, Otto-Blumethal-Straße, 52074 Aachen — [2]Dept. of Materials Science and Engineering, Indian Institute of Technology Kanpur, India 208016

Graphene flakes exfoliated on 300 nm SiO_2/Si and contacted by Indium soldering are modified by local anodic oxidation in an atomic force microscope (AFM). By varying voltage, tip velocity and contact pressure, we produced either cuts or areas appearing as elevations in AFM. The width of the cuts and elevations ranged down to 15 nm and 35 nm respectively. However, the cuts are mostly surrounded by additional elevations. The elevations are insulating at room temperature with an areal resistance of several TΩ and exhibit a D and a 2D peak in Raman spectroscopy.

Transport studies on an Aharanov-Bohm ring with a diameter of 600 nm showed magnetooscillations with a visibility of 0.2 % at 300 mK and a strong peak around 0 T attributed to weak localization within the ring. Transport measurements on a Quantum Dot structure with a diameter of 60 nm and several side gates showed several Coulomb diamonds, however, with addition energies not compatible with the structured dot area. Nevertheless, the plunger gate was six times more effective than the back gate and charge rearrangements were seldom observed.

TT 58.45 Thu 15:00 Poster D

Back-action of charge detectors on graphene quantum dots — •Marvin Junk[1], Christian Volk[1,2], Christoph Neumann[1,2], Stephan Engels[1,2], and Christoph Stampfer[1,2] — [1]JARA-FIT and II. Institute of Physics B, RWTH Aachen, 52074 Aachen, Germany — [2]Peter-Grünberg-Institut (PGI-9), Forschungszentrum Jülich, 52425 Jülich, Germany

Graphene quantum devices, such as single electron transistors and quantum dots have received increasing attention over the last years. Quantum dots (QDs) made from graphene have been suggested to be an interesting system for implementing spin qubits. Compared to the well-established GaAs-based quantum dots their advantages are the smaller hyperfine interaction and reduced spin-orbit coupling, which promises more favorable spin coherence times.

Our devices consist of etched graphene QDs surrounded by electrostatic gates and two nearby graphene nanoribbons. Local resonances in these nanoribbons can be successfully used to detect individual charging events in the quantum dot even in regimes where the direct current through the QD is below the detection limit. The current through the QD and the charge detectors (CD) are measured simultaneously. In finite-bias spectroscopy measurements - so-called Coulomb diamonds - the CD is an important tool providing information on the asymmetry of the quantum dot device tunneling barriers. In the presented work we focus on the back-action of graphene CDs on the transport through the graphene quantum dot.

TT 58.46 Thu 15:00 Poster D

Driven Topological Insulator Quantum Dot: A single-electron spin-source — •Andreas Inhofer and Dario Bercioux — Freiburg Institute for Advanced Studies, Albert-Ludwigs-Universität, 79104 Freiburg, Germany

We use the concepts of scattering matrix theory and recent progress in theory and experiment on topological insulators in order to investigate the feasibility of a single-particle spin-source. The basic concept of such a device has been realized by Fève and coworkers as a single electron source (SES) in Ref. [1]. They used a driven quantum dot in a quantum Hall device to allow for the controlled emission of quantized charges into the edge-states of a quantum well. The conducting edge-states exhibit interesting features such as insensitivity to (strong) disorder, providing mainly dissipationless transport. However, these SES require high magnetic fields. Recently, spin-polarized edge-states were theoretically predicted and experimentally observed in two- and three-dimensional topological insulators in the absence of magnetic fields [2]. Such a source could provide quantized spin-currents and become one of the key components for spintronic devices. Further investigations involve the characterisation of the emitted spin-currents with respect to current-noise and entanglement of the counter-propagating electrons.

[1] G. Fève *et al.*, Science **316**, 1169 (2007)
[2] M. Z. Hasan and C. L. Kane, Rev. Mod. Phys. **82**, 3045 (2010)

TT 58.47 Thu 15:00 Poster D

Majorana single-charge transistor — •Roland Hützen[1], Alex Zazunov[1], Bernd Braunecker[2], Alfredo Levy Yeyati[2], and Reinhold Egger[1] — [1]Institut für Theoretische Physik, Heinrich-Heine-Universität, D-40225 Düsseldorf, Germany — [2]Departamento de Física Teórica de la Materia Condensada C-V and Instituto Nicolás Cabrera, Universidad Autónoma de Madrid, E-28049 Madrid, Spain

We study transport through a Coulomb blockaded topologically nontrivial superconducting wire (with Majorana end states) contacted by metallic leads. An exact formula for the current through this interacting Majorana single-charge transistor is derived in terms of wire spectral functions. A comprehensive picture follows from three different approaches. We find Coulomb oscillations with universal halving of the finite-temperature peak conductance under strong blockade conditions, where the valley conductance mainly comes from elastic cotunneling. The nonlinear conductance exhibits finite-voltage sidebands due to anomalous tunneling involving Cooper pair splitting.

TT 58.48 Thu 15:00 Poster D

Topological edge states in a HgTe quantum well in proximity to an s-wave superconductor — •Luzie Weithofer and Patrik Recher — Institute for Mathematical Physics, TU Braunschweig, 38106 Braunschweig, Germany

Topological insulators represent a new class of condensed matter systems which are characterized by topologically protected edge states. Two-dimensional topological insulators have been experimentally realized in HgTe quantum wells [1]. In a HgTe quantum well in the topologically non-trivial phase, two edge states of different spin propagate in opposite directions at the same boundary.

Here, we consider the proximity-induced superconductivity in the bulk of a HgTe quantum well in terms of a four-band model [2]. In addition, we include various symmetry-breaking terms and discuss their consequences on the topological properties of the system, focusing on the existence of edge states.

[1] M. König *et al.*, Science **318**, 766 (2007)
[2] B. Bernevig *et al.*, Science **314**, 1757 (2006)

TT 58.49 Thu 15:00 Poster D

Quantum dot coupled to a quantum spin Hall edge — •Benedikt Probst and Patrik Recher — Institute for Mathematical Physics, TU Braunschweig, 38106 Braunschweig, Germany

In topological insulators new interesting states of matter are realised. In two dimensional topological insulators the quantum spin Hall effect was predicted and observed [1-3]. In this effect the different spin polarisations propagate in opposite directions, which gives new perspectives

for spintronic devices.

We couple a quantum dot in the Coulomb blockade regime to an helical edge, where the quantum dot can be treated as a spin impurity. We discuss the behaviour of the impurity in an open quantum system approach. The helical edge is used as a bath and to manipulate the dot spin. We also discuss the transport signature of this system.

[1] B. A. Bernevig, T. L. Hughes and S.-C. Zhang, *Science* **314**, 1757 (2006)
[2] M. König, S. Wiedemann, C. Brüne, A. Roth, H. Buhmann, L. W. Molenkamp, X.-L. Qi and S.-C. Zhang, *Science* **318**, 766 (2007)
[3] A. Roth, C. Brüne, H. Buhmann, L. W. Molenkamp, J. Maciejko, X.-L. Qi and S.-C. Zhang, *Science* **325**, 294 (2009)

TT 58.50 Thu 15:00 Poster D

Electrically tunable charge transport in CVD-grown nanostructures of Bi_2Se_3 — •Louis Veyrat — IFW-Dresden, Dresden, Germany

Electrical transport in nanostructures of the 3D topological insulator Bi_2Se_3 is studied as a function of a back-gate voltage. Shubnikov de Haas oscillations indicate the presence of Dirac fermions, reproducing the results of previous studies based on exfoliated crystals [1], but here with a 4-probe geometry. Besides, the simultaneous measure of both the longitudinal and transverse magneto-resistance allows us to compare the different carrier densities infered from Shubnikov-de-Haas oscillations and the Hall resistance. The strong back gate effect on the longitudinal and Hall resistances shows that we can efficiently tune the total carrier density in a nanostructure. Moreover, we can separate the contributions to the conduction from bulk carriers and surfaces states, and evaluate their different mobilities and densities.

[1] Sacépé et al., Nature Comm. 2, 575, (2011)

TT 58.51 Thu 15:00 Poster D

Modulation of Majorana induced current cross-correlations by quantum dots — •Björn Zocher[1,2] and Bernd Rosenow[1] — [1]Institut für Theoretische Physik, Universität Leipzig, D-04103 Leipzig, Germany — [2]Max Planck Institut für Mathematik in den Naturwissenschaften, D-04103 Leipzig, Germany

We study charge transport through a topological superconductor with a pair of Majorana end states, coupled to leads via quantum dots with resonant levels [1]. The non-locality of the Majorana bound states opens the possibility of crossed Andreev reflection with nonlocal shot noise, due to the injection of an electron into one end of the superconductor followed by the emission of a hole at the other end. In the space of energies of the two resonant quantum dot levels, we find a four peaked clover-like pattern for the strength of noise due to crossed Andreev reflection, distinct from the single ellipsoidal peak found in the absence of Majorana bound states. For finite temperatures, we observe a characteristic sign change of the crossed noise for two leafs of the clover-like pattern. We apply our findings to disordered multichannel semiconductor-superconductor heterostructures with Rashba spin-orbit coupling which are predicted to host Majorana bound states [2] and show that the clover-like crossed noise pattern is a robust feature of quasi one-dimensional Majorana wires.

[1] B. Zocher and B. Rosenow, arXiv:1208.4092
[2] J. D. Sau, R. M. Lutchyn, S. Tewari, and S. Das Sarma, Phys. Rev. Lett. **104**, 040502 (2010)