TT 28: Transport - Poster Session

Time: Thursday 14:00–17:45 Location: Poster A

TT 28.1 Thu 14:00 Poster A

Conductance Measurements on Bismuth Nanobridges — •Hans-Fridtjof Pernau, Christian Schirm, and Elke Scheer — University of Konstanz, Department of Physics, 78457 Konstanz, Germany

By electron beam lithography and reactive ion etching we fabricate freestanding metallic bismuth nano-bridges which serve as starting point for arranging atomic-size and tunnel contacts with the help of the mechanically controlled breakjunction technique. Since the bridges are broken in cryogenic vacuum, the contacts are free of oxygen or other contamination. The transport measurements are performed in a ^{3}He cryostat in the temperature range from 0.25 K up to 2 K and in transverse magnetic fields up to 8 T. After determining the preferred conductance values by recording conductance histograms, we study the conductance as a function of temperature, bias voltage and magnetic field at various contact values corresponding to those preferred conductance values. We observe reproducible conductance fluctuations as a function of both bias voltage and magnetic field and a well pronounced zero-bias anomaly which is modulated periodically with the magnetic field. We interprete our data in terms of phase coherent transport and onsetting superconductivity due to the granular structure of the film.

TT 28.2 Thu 14:00 Poster A

Few-atom contacts: behavior at high electric currents — •Christian Schirm, Jochen Grebing, and Elke Scheer — Fachbereich Physik, Universität Konstanz, D-78457 Konstanz

We investigated metallic point contacts arranged with the mechanical controllable break junctions (MCB) technique of gold and aluminum at high voltages up to 1 Volt. Two mechanisms that influence the electrical resistance can be observed and studied in this regime: conductance fluctuations as function of the voltage, but also atomic rearrangements that change the conductance abruptly.

Measurements with lithographically fabricated MCB were performed in vacuum at 1.5K. Statistically atomic-size contacts adopt preferred conductance values [1]. A conductance close to these values is assumed to indicate a more stable atomic confirmation of the contact. Unexpectedly we find that when increasing the current, the conductance has the tendency to increase stepwise and eventually jump to zero. A statistical analysis of 500 such cycles will be presented. As a result the preferred conductance values just before break correspond to those found in histograms recorded for small currents [1].

Also the influence of the bias voltage on the transport properties of gold MCB has been studied at ambient conditions. First histograms taken for bias values up to 400mV seem to show a decrease in the height of the first two conductance peaks while their position stays the same. This is in accordance with work using different techniques [2].

[1] B. Ludoph, J.M. van Ruitenbeek, Phys. Rev. B 61, 2273 (2000)
[2] A. Sakai et al., Phys. Rev. B 72, 045407 (2005)

TT 28.3 Thu 14:00 Poster A

Transport measurements on nanostructured point contacts of quench-condensed Ag — •Torben Peichl, Marcel Spurny, Michael Burst, and Georg Weiss — Physikalisches Institut, Universität Karlsruhe, 76128 Karlsruhe, Germany

We report on the successful fabrication of nanostructured point contacts of disordered Ag. In the first preparation step we used electron beam lithography and SF_6 plasma etching to obtain nano-sized holes in an insulating silicon nitride membrane. Subsequent evaporation of Au onto one and Ag onto the other side of the membrane resulted in metallic point contacts. Highly disordered Ag point contacts were achieved by quench-condensing Ag films at low temperatures <10K.

Electronic transport properties of these point contacts were studied by measuring the differential resistance using lock-in methods. Our results showed distinct non-linear behavior in the region around ±1mV so-called zero bias anomalies, which are usually attributed to two-level tunneling. We also noticed spikes at higher voltages which may be related to reversible conductance transitions.

In principle, we could obtain very reproducible conductance behavior of certain sample series. However, with almost equal preparation conditions we sometimes observed huge differences between our samples. We therefore studied in more detail the geometries of our point contacts by employing focused ion beam cutting and SEM imaging.

TT 28.4 Thu 14:00 Poster A

Low Temperature Magnetoresistance Measurements on Bismuth Nanowire Arrays — •Christoph Kaiser[1,2], Georg Weiss[1], Thomas Cornelius[3], Maria Eugenia Toimil-Molares[3], and Reinhard Neumann[3] — [1]Physikalisches Institut, Universität Karlsruhe, D-76128 Karlsruhe — [2]New address: Institut für Mikro- und Nanoelektronische Systeme, Universität Karlsruhe, D-76187 Karlsruhe — [3]Gesellschaft für Schwerionenforschung, D-64291 Darmstadt

We created nanoporous templates by exposing polymeric foils to heavy ion radiation. In these templates, single-crystalline bismuth nanowires were fabricated by electrochemical deposition. The resistance and magnetoresistance of these nanowires were studied at low temperatures. We present our results and compare them with the common theories and results of other groups, respectively.

We obeserved an unexpected effect in the low temperature resistance of our nanowires when a magnetic field was present. This novel effect could be related to the temperature dependence of the magnetoresistance. Furthermore, a clear $B^{1.5}$ dependence of the transverse magnetoresistance was found. The expected T^2 dependence of the resistance at low temperatures is confirmed in the temperature range $1.5\ K < T < 10\ K$. Finally, a steplike increase in the magnetoresistance of our sample with a wire diameter of 100 nm was found, extending the results of Heremans et al. to larger diameters. This effect is attributed to a transition from one- to three-dimensional localization.

TT 28.5 Thu 14:00 Poster A

Elektrische Messungen an Kohlenstoff-Nanoröhren — •René Geithner, Holger Mühlig, Matthias Büenfeld, Matthias Grube, Frank Schmidl, Bernd Schröter, Wolfgang Richter und Paul Seidel — FSU Jena; Institut für Festkörperphysik, Helmholtzweg 5, 07743 Jena

Kohlenstoff-Nanoröhren sind nanoskopische, eindimensionale Leiter, die durch ihre Geometrie interessante elektrische Eigenschaften besitzen [1].

Bei den gezeigten Proben handelt es sich um einwandige Kohlenstoff-Nanoröhren [Single-Walled Carbon Nanotubes - SWNTs], die mit Gold elektrisch ankontaktiert sind. Mit einem Back-Gate wird so ein Feld-Effekt-Transistor realisiert.

Die Messungen zeigen, dass bei Raumtemperatur eine sowohl von der Gatespannung abhängige als auch unabhängige Leitfähigkeit der SWNTs nachgewiesen werden konnte. Diese Ergebnisse passen in das Bild der metallischen bzw. halbleitenden Nanoröhren. Bei den halbleitenden Nanoröhren können durch das Gate Leitfähigkeitsänderungen um mehrere Größenordnungen erreicht werden.

Weiterhin konnten bei tiefen Temperaturen Quanteneffekte an Nanoröhren nachgewiesen werden. Diese Effekte wurden aurf ihre Temperaturabhängigkeit untersucht.

Die dsikutierten Messungen wurden in einem Temperaturbereich von 10mK bis 300K aufgenommen.

TT 28.6 Thu 14:00 Poster A

Coherent laser control of the current through molecular junctions — Guangqi Li[1], Michael Schreiber[2], and •Ulrich Kleinekathöfer[1] — [1]International University Bremen (Jacobs University Bremen as of spring 2007), Campus Ring 1, 28759 Bremen — [2]Institut für Physik, Technische Universität Chemnitz, 09107 Chemnitz

The tunneling current through a single site molecular junction coupled to two leads is studied under the effect of an external field using a master equation approach [1]. In the case of a small bias and a high carrier frequency of the external field, the current through the molecular junction vanishes completely for certain parameters of the external field. This phenomenon is known as coherent destruction of tunneling [2]. For larger bias voltages, further tunneling channels participate in the electron conduction and therefore the current does not vanish anymore. This is known as photon-assisted tunneling and leads to steps in the current-voltage characteristics. The described phenomenon could be used for ultrafast optical switching of the current through molecular junctions.

[1] S. Welack, M. Schreiber, and U. Kleinekathöfer, J. Chem. Phys. 124, 044712 (2006).

[2] U. Kleinekathöfer, G.-Q. Li, S. Welack, and M. Schreiber, Europhys. Lett. 75, 139 (2006).

TT 28.7 Thu 14:00 Poster A

Structural Characterisation and Spin-Dependent Transport of Single Wall Carbon Nanotubes — •Dominik Preusche Preusche[1], Silvia Schmiedmaier[1], Emiliano Pallecchi[1], SungHo Jhang[1], Benoit Witkamp[2], Herre van der Zant[2], and Christoph Strunk[1] — [1]Institut für Angewandte und Experimentelle Physik, Universität Regensburg — [2]TU Delft

We investigate spin-dependent transport in and characterise the structure of individual carbon nanotubes. Low temperature magnetoconductance was found to be also gate-dependent and showed spin-valve effect, Coulomb blockade and spin-1/2 Kondo effect. Furthermore, suspended nanotubes have been investigated with a TEM. In particular, their chiral indices can be identified by means of selected area electron diffraction. The micromagnetic properties of the ferromagnetic PdFe contacts as well as their hysteretic magnetic switching have been studied by means of Lorentz microscopy and SQUID measurements. When performed on the same nanotube, structural characterisation will facilitate the interpretation of the magnetoconductance measurements and allow more direct comparison with theoretical simulations.

TT 28.8 Thu 14:00 Poster A

Hall effect and magnetoresistance of single-walled carbon nanotubes — •sung-ho jhang[1,3], seung-hyun lee[1], ursula dettlaff[2], dongsu lee[1], siegmar roth[2], and yung-woo park[1] — [1]School of Physics, Seoul National University, Seoul, Korea — [2]Max-Planck-Institute for solid state research, Stuttgart, Germany — [3]Institute of Experimental and Applied Physics, University of Regensburg, Regensburg, Germany

We report Hall coefficient and magnetoresistance measurements on films and networks of single-walled carbon nanotubes(SWNTs). Four different types of SWNTs are prepared as films; Purified SWNTs synthesized either by HiPCO (High-Pressure CO Conversion) process or by laser ablation method (laser SWNTs), plus those SWNTs chemically treated by $SOCl_2$. $SOCl_2$-modified SWNTs show higher conductivity due to doping effect. The carrier density is determined to be $\sim 10^{22} cm^{-3}$ for HiPCO or $SOCl_2$-modified SWNTs, and $\sim 10^{21} cm^{-3}$ for laser SWNTs. Considering that theoretically predicted carrier density of metallic SWNT is $\sim 10^{22} cm^{-3}$ and that of semiconducting SWNT is $\sim 10^{20} cm^{-3}$, the difference in carrier density between HiPCO and laser SWNTs can be originated from the difference in the ratio of metallic and semiconducting SWNTs in both films. While Hall coefficient is positive in the whole temperature range of 1.4-300K for HiPCO and $SOCl_2$-modified SWNTs, Hall coefficient of laser SWNTs shows a sign change around T = 15K. The magnetoresistance of SWNTs studied in high magnetic fields up to 33T, and in a temperature range of 0.4-300K will be also presented.

TT 28.9 Thu 14:00 Poster A

Electronic Transport through C_{60} — Tobias Böhler, •Achim Edtbauer, and Elke Scheer — FB Physik - Universität Konstanz

The electronic transport through a single or a few C_{60} molecules is studied experimentally with the help of the mechanically controllable break-junction (MCB) technique [1]. The tip electrodes of the MCB are fabricated of aluminum or gold. The molecule is evaporated onto an opened break-junction under UHV conditions and at low temperatures. At room and low temperature the experiment shows evidence that the conductance of a single C_{60} molecule between gold contacts is in the order of 0,1 G_0. This can be seen in opening and closing curves, by statistical analysis (conductance histograms) and by the presence of time-dependent fluctuations of the conductance. The differential conductance of individual contacts measured - for those values of conductance which in the statistical measurements have shown to be the preferred ones - reveal fluctuations on the voltage scale of several mV. We discuss the typical behavior of the different conductance regimes. Only for very few contacts the differential conductance indicates the excitation of vibrational modes. [1] T. Böhler et al. Nanotechnology 15 (2004) 465

TT 28.10 Thu 14:00 Poster A

Conductivity through single Ferrocenedithiol molecules — •Jedrzej Schmeidel[1], Gernot Gardinowski[1], Herbert Pfnür[1], Christoph Tegenkamp[1], Volodymyr Maslyuk[2], Ingrid Mertig[2], and Mads Brandbyge[3] — [1]Institut für Festkörperphysik, Leibniz-Universität Hannover, 30167 Hannover, Germany — [2]Theoretische Physik, Martin-Luther-Universität Halle-Wittenberg , 06099 Halle, Germany — [3]Mikroelektronik Centret, Technical University of Denmark, Kongens Lyngby, Denmark

We have investigated systematically the fabrication and characterization of metallic nanometer–sized(nm) gaps suitable for conductivity measurements of single molecules. Epitaxially grown Ag nanostructures with a thickness down to 10 monolayers on Si(100) were used for a controlled gap formation by electromigration (EM). The gaps obtained range from several nm down to sub–nm, as revealed by lateral conductivity measurements and by scanning tunneling microscopy done under ultra high vacuum conditions. After adsorption of a single ferrocenedithiol (FDT) molecule in between the gap by self-assembly the zero bias resistance is around 40kOhm. In addition, the dI/dV curve shows molecular contributions which can be attributed to ferrocene induced states near the Fermi edge. In particular, the zero bias resistance is calculated correctly using the TRANSIESTA code. As pre-optimized structures for transport calcuations, the adsorption parameters obtained from VASP are used, assuming a thiolate bound configuration of one molecule in between defect-free Ag contacts.

TT 28.11 Thu 14:00 Poster A

Contacting organic molecules using micro transfer printing — •Stefan Baechle, Artur Erbe, and Elke Scheer — Universität Konstanz, FB Physik, Germany

The formation of metal molecule contacts is one of the main challenges in the fabrication of electronic devices based on the functionality of single molecules. A variety of techniques has already been demonstrated. Most of these processes rely on evaporation of metals or self-organisation of molecules on metals. It has proven to be difficult to separate artifacts from the contacting technique from molecular properties. Therefore contacting techniques, which rely on completely different mechanisms for the formation of the metal molecule contact, are of great importance. Here we demonstrate the fabrication of micron sized contacts using micro transfer printing. The dependence of the conductivity on the area of the contact is studied in order to understand the quality of the contact to individual molecules.

TT 28.12 Thu 14:00 Poster A

Mechanically variable contacts to alkane molecules — •Simon Verleger, Artur Erbe, and Elke Scheer — Universität Konstanz, FB Physik, Germany

Metal-molecule contacts using the mechanically controlled break junction method are demonstrated. The contacted molecules are alkanedithiols. The thiol groups attached to each end ensure chemisorption of the molecules to the gold electrodes. Thus a mechanically stable contact is generated, which can then be tuned by varying the distance between the electrodes. All measurements are performed in a liquid cell containing the molecular solution. We observe clear features in the conductivity as a function of the electrode distance, which can be associated with the exact positioning of the molecules with respect to the electrodes. From this we conclude that we observe transport through a number of molecules. In future experiments this approach will be used to fabricate contacts to single molecules by using molecules with specific chemical properties.

TT 28.13 Thu 14:00 Poster A

Chemical binding of short, thiolated DNA molecules to gold surfaces — •Shou-Peng Liu[1], Benjamin Bornemann[2], Artur Erbe[1], Andreas Marx[2], and Elke Scheer[1] — [1]Universität Konstanz, FB Physik, Germany — [2]Universität Konstanz, FB Chemie

The electrical properties of DNA are currently investigated using various contacting techniques. The ability of the linker group to chemically anchor the DNA molecule on the metal electrodes is of great importance in these experiments. Such a link provides a mechanically and electrically stable connection, which is important for testing the current flowing through the molecules. In this work we present fluorescence microscopy characterization of the immobilization of short DNA molecules on gold. C5-thiol-modified uridine protected with a trimethylsilylethyl-group to prevent the thiol group from oxidation is used. These molecules are found to bind specifically to gold evaporated on a polyimide substrate. Test measurements with unprotected molecules ($C5\text{-}CH_2\text{-}SH$) show no specific binding of the molecules, as well as measurements with molecules without any thiol modification.

TT 28.14 Thu 14:00 Poster A

Peculiarities of non-equilibrium conductance fluctuations —

•Wanyin Cui[1,2], Peter vom Stein[1], Christoph Wallisser[1], and Roland Schäfer[1] — [1]Forschungszentrum Karlsruhe, Institut für Festkörperphysik, Germany — [2]Physikalisches Institut, Universität Karlsruhe, Germany

The quantum mechanical nature of conduction electrons leads to so-called universal conductance fluctuations in mesoscopic wires. We present new experimental results in the non-linear response regime at finite bias voltage. While earlier studies focused on the size of the fluctuation var(G) in the differential conductance, the present work takes a closer look at the critical magnetic field B_c (defined as the half width of the autocorrelation function) as well. A significant decrease of the fluctuation amplitude on a small voltage scale ($V_{\rm dc} \leq 2V_{\rm Th}$, $V_{\rm dc}$ and $V_{\rm Th}$ refer to voltage drop and Thouless energy, respectively) for all investigeted samples is observed. It is accompanied by an increase of B_c for the majority of our samples. Both facts might point to a loss of phase coherence due to self-heating. However, for $V_{\rm dc} > 2V_{\rm Th}$ an overall reduction of B_c is found indicating a further spreadout of the phase coherent region responsible for the fluctuations. The results are discussed with regard to recent theoretical work on non-equilibrium fluctuations.

TT 28.15 Thu 14:00 Poster A

Influence of defects on conductance fluctuations in metallic nanowires — •Michael Wolz, Vojko Kunej, Christian Debuschewitz, and Elke Scheer — Universität Konstanz, Fachbereich Physik, Universitätsstraße 10, D-78457 Konstanz

The goal of the project is to investigate the influence of individual artificial defects on the conductance fluctuations of metallic nanowires. Clear and reproducible conductance fluctuations have been measured.

A STM working in a conventional cryostat at 4 K and in magnetic fields up to 1 T has been developed for creating the defects. In order to position the sample with respect to the STM tip the system is equiped with a x-y-table. On nanostructures which have been fabricated by electron beam lithography and reactive ion etching [1] the succsessful positioning of the stm-tip above the wire is demonstrated. The accessibility of the samples by the STM-tip is realized by shadow evaporation of the metal (Au) onto the substrate.

First low-temperature measurements with additional defects produced with the STM will be presented.

[1] T. Hoss et al., Physica E 14 (2002) 341

TT 28.16 Thu 14:00 Poster A

Super-Poissonian current noise in coupled single-electron transistors — •Björn Kubala[1], Göran Johansson[2], and Jürgen König[1] — [1]TP III, Ruhr-Universität Bochum, Germany — [2]MC2, Chalmers University Göteborg, Sweden

Non-Poissonian noise has been explored theoretically and experimentally in a variety of systems. Here, we investigate zero-frequency noise in networks of coupled single-electron transistors (SETs) within a real-time diagrammatic theory [1]. We calculate noise including all contributions up to second order in the coupling strength, whereby incorporating sequential and standard cotunneling processes, but also renormalization processes and cotunneling involving several transistor islands. For a single SET we reproduce results of orthodox and cotunneling theories and find the familiar suppression of noise in double-barrier systems.

The capacitative coupling of two SETs in parallel, however, permits an investigation of novel correlation effects, e.g., a bunching of electrons also found in semiconductor systems [2]. We identify a number of different mechanisms causing super-Poissonian noise, which could be experimentally investigated in coupled SETs.

[1] B. Kubala, G. Johansson, and J. König, Phys. Rev. B **73**, 165316 (2006).

[2] S. S. Safonov, A. K. Savchenko, D. A. Bagrets, O. N. Jouravlev, Yu. V. Nazarov, E. H. Linfield, and D. A. Ritchie, Phys. Rev. Lett. **91**, 136801 (2003).

TT 28.17 Thu 14:00 Poster A

Conductance fluctuations in inhomogeneous mesoscopic systems — •Alexander Kohler and Wolfgang Belzig — Universität Konstanz, D-78464 Konstanz, Germany

In mesoscopic systems the conductance is influenced by quantum interference effects, such as the weak localization correction and the universal conductance fluctuations. These conductance fluctuations have been observed in magnetic fields and are in some cases independent of sample size and impurity concentration. However, the magnetic field dependence is sensitive to the geometry of the wire and other inhomogeneities. Furthermore it is observed that conductance fluctuations in experiments change only slightly upon rearrangements of the disorder [1].

We investigate systems with a spatially inhomogeneous impurity concentration using standard diagrammatic methods. We find an oscillatory contribution (depending on the layer thickness) to the weak localization correction, reflecting the symmetry of the different diffusion modes in the wire. Complementary to the analysis of [2], we also study the influence of the motion of a single scatterer on the conductance fluctuations of a mesoscopic wire. Such effects can be probed by locally depleting a sample with an AFM.

[1] Elke Scheer, PhD thesis, Universität Karlsruhe, 1995.
[2] Feng, Lee, and Stone, Phys. Rev. Lett. **56**, 1960 (1986).

TT 28.18 Thu 14:00 Poster A

Superconducting microstrip transmission line resonator for flux qubit readout — •Thomas Niemczyk, Susanne Hofmann, Achim Marx, and Rudolf Gross — Walther-Meissner-Institut für Tieftemperaturforschung, Bayerischen Akademie der Wissenschaften, Walther-Meissner Str. 8, 85748 Garching, Deutschland

Coupling superconducting quantum bits to high-quality superconducting resonators opens the fascinating field of cavity quantum electrodynamics (cQED) based on superconducting circuits. Exciting first experiments have recently been performed in Yale [1] with superconducting charge qubits. For cQED experiments using superconducting flux qubits strong coupling between the magnetic field in a suitable resonator and the flux in the qubit is required. We present the design and realization of a high-Q superconducting microstrip resonator for application in c-QED. The resonator is based on the microstrip SQUID amplifier introduced by Mück et al. [2]. We will introduce the fundamental mode of operation of the microstrip resonator and discuss the results of extended simulations of the device parameters and performance. The geometry of the device should allow for a strong qubit-cavity-coupling up to 200 MHz. A first series of superconducting microstrip resonators has been fabricated by Hypres, Inc. We will present the experimental characterization of the S-parameters of various resonators with different resonance frequency and external coupling capacitors.

[1] A. Wallraff *et al.* Nature **431**, 162 (2004).
[2] M. Mück and J. Clarke, J. Appl. Phys. **88**, 6910 (2000)
This work is supported by the DFG via SFB 631.

TT 28.19 Thu 14:00 Poster A

Dynamics of quantum coherence in a spin-1 Heisenberg chain — •Jakob Meineke and Joachim Ankerhold — Physikalisches Institut, Albert-Ludwigs-Universität Freiburg, Hermann-Herder-Straße 3, 79104 Freiburg

We study the non-equilibrium dynamics of a one-dimensional spin-1 chain (XXZ Heisenberg model) of finite length. This model can be used to describe many-body-correlations in ultra-cold Rydberg-gases in optical lattices. Our goal is to understand the dynamics of collective modes of the interacting atoms. Of special interest are Förster-like transfer processes, which involve coherent exchange of energy and ultimately lead to an entanglement state of the entire ensemble. We present results obtained by exact diagonalization and by semiclassical methods related to the non-linear sigma-model.

TT 28.20 Thu 14:00 Poster A

Limitation of entanglement due to spatial qubit separation — •Roland Doll, Martijn Wubs, Peter Hänggi, and Sigmund Kohler — Institut für Physik, Universität Augsburg, Universitätsstrasse 1, 86135 Augsburg

We consider spatially separated qubits coupled to a thermal bosonic field which acts as a heat bath and, thus, causes decoherence. By taking the spatial separation of the qubits explicitly into account, the reduced qubit dynamics becomes intrinsically non-Markovian. For pure dephasing we solve the dynamics exactly and explicitly. We first focus on the entanglement of two Bell states which for vanishing separation are known as robust and fragile entangled states. The robustness of two-qubit decoherence-free subspaces depends on temperature, qubit-field coupling strength, and qubit separation. Our exact results are then generalized to an arbitrary number of qubits. We show for weak qubit-bath coupling that a standard Bloch-Redfield approach fails to describe the reduced dynamics even at long times and predicts spurious decoherence-free subspaces. We derive a master equation that does not suffer from such deficiencies. It allows us to directly attribute

the observed non-Markovian features to spatial bath correlations.
[1] R. Doll, M. Wubs, P. Hänggi, and S. Kohler, Europhys. Lett. **76**, 547 (2006).

TT 28.21 Thu 14:00 Poster A

Gauging a quantum heat bath with dissipative Landau-Zener transitions — •Martijn Wubs[1], Keiji Saito[2], Sigmund Kohler[1], Peter Hänggi[1], and Yosuke Kayanuma[3] — [1]Institut für Physik, Universität Augsburg — [2]University of Tokyo, Japan — [3]Osaka Prefecture University, Japan

We calculate the exact Landau-Zener transition probabilities for a qubit with arbitrary linear coupling to a bath at zero temperature [1]. The final quantum state exhibits a peculiar entanglement between the qubit and the bath. In the special case of a diagonal coupling, the bath does not influence the transition probability, whatever the speed of the Landau-Zener sweep. It is proposed to use Landau-Zener transitions to determine both the reorganization energy and the integrated spectral density of the bath. Possible applications include circuit QED and molecular nanomagnets.
[1] M. Wubs *et al.*, Phys. Rev. Lett. **97**, 200404 (2006).

TT 28.22 Thu 14:00 Poster A

Design of a Flux Qubit with a nondestructive Readout System — •Christoph Kaiser, Andreas Graf, and Michael Siegel — Institut für Mikro- und Nanoelektronische Systeme, Universität Karlsruhe, D-76187 Karlsruhe

We are studying flux qubits based on $Nb/Al/Al_2O_3/Nb$ tunnel junctions. The qubit consists of three Josephson tunnel junctions connected in series in a superconducting loop and is read out by an inductively coupled SQUID. In order to obtain a nondestructive readout, the SQUID is part of an LC circuit, whose resonant frequency depends on the inductance of the SQUID and hence on the qubit state [1].

We have carried out numerical simulations in order to obtain values for the minimum energy level splitting Δ and the persistent current I_p. Suitable design parameters were found and the influence of possible parameter deviations due to fabrication tolerances was studied. Furthermore, we investigated methods to reduce the stray inductance of the readout LC circuit and hence increase the readout resolution.

[1] A. Lupasçu et al., Phys. Rev. Lett. 93, 177006 (2004).

TT 28.23 Thu 14:00 Poster A

Superconducting coplanar waveguide resonators for flux qubit readout — •Markus Rösch, Stefan Wünsch, Alexander Stassen, Hansjürgen Wermund, and Michael Siegel — Institut für Mikro- und Nanoelektronische Systeme, Universität Karlsruhe, D-76187 Karlsruhe

The usage of an transmission line resonator offers a method for flux qubit readout. For a required weak electromagnetic coupling there is a need for a high quality factor Q_L of the cavity circuit to detect small deviations in the resonance frequency.

We developed various superconducting niobium coplanar waveguide resonators for a resonance frequency of 3 GHz and a linewidth of 50 μm. Different layouts for the resonator were designed, simulated and measured on a silicon substrate at 4.2 K. We found a very good agreement between simulation and measurement results. The presented results showed a big influence of the substrate properties in respect of Q_L. To analyse the dependence of this value we implemented the resonator structure with the highest Q_L value on a sapphire substrate. In respect of the lower losses in the substrate we obtained an increasing of Q_L. Finally we discuss the results and give an outlook of future activities.

TT 28.24 Thu 14:00 Poster A

Implementation of Two-Cell Flux Qubits — •Alexey Feofanov[1], Benjamin Hinrichs[1], Abdufarrukh Abdumalikov[1,2], and Alexey Ustinov[1] — [1]Physikalisches Institut III, Universität Erlangen-Nürnberg, Erlangen, Germany — [2]Present address: Frontier Research System, RIKEN, Wako, Japan

The standard superconducting flux qubit first implemented at Delft [1] consists of a superconducting loop with three Josephson junctions, one of which is smaller than the other two, nominally identical junctions. This circuit features a double well potential at half frustration. Its limitation is that the barrier height cannot be changed without breaking the potential symmetry. An alternative device proposed by Yukon [2] is a two-cell flux qubit containing four Josephson junctions. The two-cell flux qubit can be made using identical junctions and features a double-well potential with orthogonal controls for the barrier height and the potential symmetry. We have designed and fabricated aluminum-based two-cell qubits with dc-SQUID readout and flux line controls. The useful feature of our latest two-cell qubit design is that it can be operated and read out at zero external magnetic field. Experiments to test these devices are currently on the way.
[1] I. Chiorescu, Y. Nakamura, C.J. Harmans, and J. E. Mooij, Science **299**, 1869 (2003)
[2] S.P. Yukon, Physica C **368**, 320 (2002)

TT 28.25 Thu 14:00 Poster A

Dispersive Readout Scheme for Josephson Phase Qubits — •Tobias Wirth, Jürgen Lisenfeld, Alexander Lukashenko, and Alexey V. Ustinov — Physikalisches Institut III, Universität Erlangen, Germany

Superconducting qubits require appropriate isolation from the bias leads, which can be achieved by the use of superconducting transformers. A superconducting loop with a tunnel junction can be used to prepare a double-well potential, where the discrete quantum levels in one well form the qubit states. State-dependent tunneling to the other well changes the magnetic flux in the qubit loop measured by a dc-SQUID. A standard phase qubit readout by the dc-SQUID requires switching to the non-superconducting state, which generates heat and quasiparticles in the circuitry. This results in long cool-down times after each switching event and thus limits the repetition rate of the experiment. In our ongoing experiments, we replace the standard scheme by a high-frequency readout based on a weakly-dissipative measurement of the dc-SQUID Josephson inductance, which in turn depends on the flux in the dc-SQUID. This is done by detecting a phase change of the probe signal reflected from an LC-tank circuit coupled to the dc-SQUID. The expected benefits include longer coherence times, much faster measurements, and a possibility of applying non-destructive measurement schemes to Josephson phase qubits.

TT 28.26 Thu 14:00 Poster A

On-Chip Detection of Single Microwave Photons in Superconducting Circuit QED — •Ferdinand Helmer[1], Matteo Mariantoni[2], Florian Marquardt[1], and Enrique Solano[1] — [1]Arnold Sommerfeld Center for Theoretical Physics, Department für Physik, Center for NanoScience, Ludwig-Maximilians-Universität München, Germany — [2]Walther Meissner Institut, Bayerische Akademie der Wissenschaften, Garching b. München, Germany

We propose and analyze a scheme for detecting single microwave photons traveling along a superconducting transmission line on a chip. The setup exploits a nonlinear coupling between different modes in a transmission line resonator, brought about by the interaction with a superconducting qubit (as demonstrated in recent experiments). Remarkably, the backaction produced by the measurement device may produce a fundamental limit for the fidelity of photon detection in any such scheme. This is a consequence of the Quantum Zeno effect, and we discuss both analytical estimates and quantum trajectory simulations of the measurement process.

TT 28.27 Thu 14:00 Poster A

Design, fabrication and characterization of microwave resonators for circuit Quantum Electrodynamics — •Susanne Hofmann, Thomas Niemczyk, Mattes Mariantoni, Achim Marx, and Rudolf Gross — Walther-Meissner-Institut für Tieftemperaturforschung, Bayerischen Akademie der Wissenschaften, Walther-Meissner Str. 8, 85748 Garching, Germany

A central issue in quantum information processing is the coupling of quantum bits (qubits) to a suitable readout system. In 2004 Wallraff et al. realized the strong coupling of microwave photons in a coplanar waveguide resonator to a superconducting (sc) charge qubit. To achieve strong coupling between the microwave field and the charge qubit, it is placed at the maximum of the electric field in the resonator. Furthermore, the resonator needs a high quality factor which can be achieved for sc resonators coupled weakly to the environment. With a single photon in the cavity, vacuum rabi splitting in the resonator - qubit system can be observed. We have designed and fabricated sc resonators that are designed for coupling with sc flux qubits. Flux qubits couple to the magnetic field mode of the field in the resonator. The length of the resonators is designed to be half a wavelength in order to achieve maximum coupling in the middle of the resonators. This results in short resonators without the need for a meandering geometry. Various designs with different geometries and coupling to the environment have been fabricated from niobium on silicon and sapphire substrates.

This work is supported by the DFG via SFB 631.

TT 28.28 Thu 14:00 Poster A

Relaxation of Josephson qubits due to bistable fluctuators — •Clemens Müller, Alexander Shnirman, and Gerd Schön — Institut für Theoretische Festkörperphysik, Universität Karlsruhe, 76128 Karlsruhe

Decoherence is a major problem for the use of superconducting Josephson qubits in quantum information processing. Recent measurements of the relaxation time T_1 of Josephson charge qubits reveal strongly non-monotonic behavior as a function of the energy splitting (e.g. [1] [2]), the origin of which is not understood.

As a possible model we study the relaxation time T_1 of a Josephson qubit coupled to an environment of bistable fluctuators. For two cases the behavior is well understood. These are weak coupling to a large number of fluctuators, and strong coupling to a single fluctuator. In our work we examine a Josephson qubit coupled to a finite number of fluctuators. We consider the case that the fluctuators are coherent and the energy splitting of each fluctuator is influenced by all others.

[1] G. Ithier et al., Phys. Rev. B **72**, 134519 (2005)
[2] O. Astafiev et al., Phys. Rev. Lett. **93**, 267007 (2004)

TT 28.29 Thu 14:00 Poster A

Adiabatic pumping through a quantum dot in the proximity of a superconductor — Janine Splettstoesser[1,2], •Michele Governale[2], Jürgen König[2], Fabio Taddei[1], and Rosario Fazio[1,3] — [1]NEST-CNR-INFM & Scuola Normale Superiore, I-56126 Pisa, Italy — [2]Institut für Theoretische Physik III, Ruhr-Universität Bochum, D-44780 Bochum, Germany — [3]International School for Advanced Studies (SISSA), via Beirut 2-4, I-34014 Trieste, Italy

By varying periodically in time some properties of a mesoscopic conductor, a dc current can be produced by a transport mechanism known as pumping. We study adiabatic pumping through a quantum dot tunnel-coupled to one normal and one superconducting lead. We generalize a formula which relates the pumped charge through a quantum dot with Coulomb interaction to the instantaneous local Green's function of the dot[1], to systems containing a superconducting lead. First, we apply this formula to the case of a non-interacting, single-level quantum dot in different temperature regimes and for different parameter choices, and we compare the results with the case of a system comprising only normal leads. Then we study the infinite-U Anderson model with a superconducting lead at zero temperature using the mean-field slave-boson approach, and we discuss the effect of the proximity of the superconductor on the pumped charge.

[1] J. Splettstoesser, M. Governale, J. König, and R. Fazio, Phys. Rev. Lett. **95**, 246803 (2005).

TT 28.30 Thu 14:00 Poster A

Quantum information process with nanometre precession ion implantation — •Inam Mirza — 3. Physikalisches Institut Universität Stuttgart

The spin state of a single nitrogen-vacancy centre in diamond is one of the most attractive candidate for quantum information processing because of its long spin coherence time [1]. Further more coupling (magnetic dipole) between the spins are required for scalable quantum computing (2-qbit operation) [2]. This process requires a high implantation positioning accuracy and nitrogen free clean diamond (<0.1 ppm nitrogen concentration). Here we report recent progress towards single ion implantation within nanometre scale accuracies.

[1] Nature Physics 2: 408-413 (2006).
[2] Science 314 (5797): 281-285 (2006).

TT 28.31 Thu 14:00 Poster A

Theoretical and experimental studies of circuit QED systems — •Matteo Mariantoni, Frank Deppe, and Rudolf Gross — Walther-Meissner-Institute, Garching, Germany

The interaction between superconducting quantum circuits and on-chip resonators has recently become an important research area, referred to as circuit QED. The formalism of circuit QED explains the coupling between a superconducting qubit (charge or flux) and a microwave resonator implemented by means of LC circuits or coplanar wave guide resonators fabricated on a chip. Instead of focusing on the well-known resonant and dispersive regimes, we investigate a deeply dispersive regime, where qubit and resonator are strongly detuned and the transition frequency of the resonator is almost negligible compared to the qubit one. This regime has been exploited experimentally in several different implementations, e.g., the reading-out of a superconducting qubit by means of a low frequency resonator. In this framework, we have developed a simple formalism which encompasses the many explanations given in the literature on the experiments mentioned above. Following these lines, we also introduce the main facts behind our experimental implementation of circuit QED, which will be presented in Part II. This work is supported by the DFG via SFB 631.

TT 28.32 Thu 14:00 Poster A

Measuring the many-body size of a Schrödinger cat state — Florian Marquardt, Benjamin Abel, and •Jan von Delft — Physics Department, Arnold Sommerfeld Center for Theoretical Physics, and Center for NanoScience, Ludwig-Maximilians Universität Munich

We propose a measure for the "many-body size" of a Schrödinger cat state, i.e. a quantum superposition of two many-body states with (supposedly) macroscopically distinct properties, by counting how many single-particle operations are needed to map one state onto the other. This definition gives sensible results for simple, analytically tractable cases and is consistent with a previous definition restricted to Greenberger-Horne-Zeilinger-like states. We apply our measure to the experimentally relevant, nontrivial example of a superconducting three-junction flux qubit put into a superposition of left- and right-circulating supercurrent states and find this Schrödinger cat to be surprisingly small.

Reference: quant-ph/0609007

TT 28.33 Thu 14:00 Poster A

Anomalous stability diagram in double-walled carbon nanotube quantum — •Shidong Wang, Emiliano Pallecchi, Christoph Strunk, and Milena Grifoni — Institut fuer Theoretische Physik, Universität Regensburg

We investigate a quantum dot system formed by a double-walled carbon nanotube in the Coulomb blockade regime. We show that the system can be mapped into a capacitively connected double quantum dot system. The two quantum dots are connected in parallel and have different charging energies and different energy-dependent couplings with leads. We calculate the stability diagram of this system by using the master equation approach. The diagram shows the superposition of two sets of diamond patterns with different size, as it has been recently observed in transport experiments across multi-walled carbon nanotubes.

TT 28.34 Thu 14:00 Poster A

Full Counting Statistics from quantum trajectories — •Ansgar Pernice[1] and Walter Strunz[2] — [1]Physikalisches Institut der Universität Freiburg, Herrmann-Herder-Str. 3,79104 Freiburg, Germany — [2]Physikalisches Institut der Universität Freiburg, Herrmann-Herder-Str. 3,79104 Freiburg, Germany

Motivated by a recent experiment [1], we apply a quantum trajectory approach to the determination of the full counting statistics (FCS)of single-electron transport in a quantum dot.

The FCS reveals information about the initial state of the dot [2]. In the case of the steady state, our results coincide with the formulae given by Bagrets and Nazarov [3]. However, the FCS differs in the case of an initially full/empty dot and for short times.

Last but not least, we establish the connection between our approach and those based on counting fields in providing a new deriviation of the quantum-jump-representation, here for a fermionic environment.

[1] S. Gustavsson, R. Leturcq, B. Simovic, R. Schleser, T. Ihn, P. Studerus, and K. Ensslin, Phys. Rev. 96, 076605 (2006)
[2] H. Schaefers and W. T. Strunz, Phys. Rev. B 71, 075321 (2005).
[3] D. A. Bagrets and Yu. V. Nazarov, Phys. Rev. B 67, 085316 (2003).

TT 28.35 Thu 14:00 Poster A

Full Counting Statistics from quantum trajectories — •Ansgar Pernice[1] and Walter Strunz[2] — [1]Physikalisches Institut der Universität Freiburg, Herrmann-Herder-Str. 3,79104 Freiburg, Germany — [2]Physikalisches Institut der Universität Freiburg, Herrmann-Herder-Str. 3,79104 Freiburg, Germany

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[1] S. Gustavsson, R. Leturcq, B. Simovic, R. Schleser, T. Ihn, P. Studerus, and K. Ensslin, Phys. Rev. Let. 96, 076605 (2006)

[2] H. Schaefers and W. T. Strunz, Phys. Rev. B 71, 075321 (2005).

[3] D. A. Bagrets and Yu. V. Nazarov, Phys. Rev. B 67, 085316 (2003).

TT 28.36 Thu 14:00 Poster A

Charge and spin transport in double quantum dot systems — •Georg Begemann, Ralph Peter Hornberger, Andrea Donarini, and Milena Grifoni — Universität Regensburg, Theoretische Physik

We consider spin and charge transport through two quantum dots in series, described by an extended Hubbard Hamiltonian. This model Hamiltonian describes conjugated molecules as well. Unpolarized as well as spin-polarized leads are considered. We calculate physical quantities like the conductance or the average spin using two different approaches.

On one side we start from a Liouville equation approach for the system density matrix and calculate I-V-V_g characteristics perturbatively in the tunneling.

On the other hand we evaluate the Green's functions of the interacting systems using the equation of motion technique, which allows a nonperturbative treatment of the coupling. To this extent we generalize the approximation by Meir, Wingreen and Lee [1] for the single-site to the two-site case.

[1] Y. Meir, N. S. Wingreen and P. A. Lee: Transport through a Strongly Interacting Electron System: Theory of Periodic Conductance Oscillations, Phys. Rev. Lett. 66, 3048 (1991)

TT 28.37 Thu 14:00 Poster A

Spin-dependent transport in carbon nanotube quantum dots — •Sonja Koller, Leonhard Mayrhofer, and Milena Grifoni — Universität Regensburg

We have theoretically studied spin-dependent transport across low transparently contacted interacting metallic single wall carbon nanotubes. The contacts are assumed to be magnetic with arbitrary magnetisation directions. In the low bias voltage regime, a current flow is either allowed by resonant tunnelling or Coulomb blocked. We could show how the current at the resonance peaks is influenced by the contact magnetisations and give the evolution of the tunnelling magnetoresistance with both the gate voltage and the relative polarisations. In the case of exact parallel or antiparalllel polarisations, the current follows a simple analytical law. The ratio of parallel to antiparallel current merely depends on the polarisation strength and the asymmetry of the leads.

TT 28.38 Thu 14:00 Poster A

Collective charge and spin excitations in interacting 2DEG with spin-orbit coupling — •Sergej Konschuh and Mikhail Pletyukhov — Institut für Theoretische Festkörperphysik, Universität Karlsruhe, D-76128 Karlsruhe, Germany

We present the analytic expressions for the charge and spin density response functions of the two-dimensional electron gas (2DEG) with Rashba spin-orbit (SO) coupling. Taking into account the Coulomb interaction in the random phase approximation (RPA), we study the dispersions of the collective charge and spin-polarization modes. Special attention is devoted to the role of the spin-charge mixing in the density matrix response function.

TT 28.39 Thu 14:00 Poster A

Rectification effects in quantum transport through single aromatic molecules — •Florian Pump, Bo Song, Dmitry Ryndyk, and Gianaurelio Cuniberti — Institute for Theoretical Physics, University of Regensburg, D-93040 Regensburg, Germany.

The signatures of truly molecular mediated quantum transport in single molecule experiments have to be selectively identified and often their theoretical mechanisms still need to be understood. We investigated the behavior of a donor-acceptor molecular junction in the coherent regime using a model Hamiltonian [1] as well as density functional based nonequilibrium transport calculations [2]. Additionally, we studied the system in the situation of weak coupling to the leads where charging effects do play an important role and we could show that the intrinsic energetic asymmetry of a donor-acceptor molecule remains responsible for the rectification effects even in the Coulomb blockade regime [3]. Contact to the experiments by Elbing *et al.* [4] is also provided.

[1] F. Pump and G. Cuniberti, `cond-mat/0611436`.

[2] F. Pump *et al.*, in preparation.

[3] B. Song, D. Ryndyk, and G. Cuniberti, `cond-mat/0611190`.

[4] M. Elbing *et al.*, Proc. Natl. Acad. Sci. USA **102**, 8815 (2005).

TT 28.40 Thu 14:00 Poster A

Spin-polarized tunneling currents through magnetic layer systems — •Niko Sandschneider and Wolfgang Nolting — Humboldt-Universität zu Berlin, Institut für Physik, Newtonstr. 15, 12489 Berlin, Germany

Using the Keldysh formalism we calculate the tunneling currents through a hybrid structure where a confined magnetic insulator (I) is sandwiched between two leads. They can be either normal metals (M) or superconductors(S) (M/I/M, M/I/S, S/I/S). The insulator is assumed to have localized moments which can interact with the tunneling electrons. This is described by the Kondo lattice model (KLM) and treated within an interpolating self-energy approach. For the superconductor we used the mean-field BCS theory. We also propose an effective medium approximation for the M/I/S and S/I/S systems.

By deriving a current formula it is possible to calculate the voltage-dependent tunneling current in a self-consistent way. It is shown that the current is always spin-polarized and that the degree of polarization depends on the applied voltage and the parameters of the materials. In M/I/M systems it is not possible to get a spin polarization high enough for technological applications.

The experimental results of [1] can be reproduced qualitatively. It is also possible to determine optimal parameters for high spin polarization in the systems under consideration.

[1] X. Hao, J.S. Moodera and R. Meservey, Phys. Rev. B 42, 8235 (1990)

TT 28.41 Thu 14:00 Poster A

Ballistic magnetoresistance in Ni nanocontacts — •Steven Walczak, Michael Czerner, and Ingrid Mertig — Institute of Physics, Martin Luther University Halle-Wittenberg, Germany

During the last years the ballistic magnetoresistance of nickel (Ni) single-atom contacts has been measured in various of experiments. Recently, Sullivan *et al.* [1] reported about extraordinary large magnetoresistance in Ni nanocontacts. These experimental observations are still in contradiction to other experimental [2] and theoretical results in the coherent limit of transport [3].

Ab initio calculations of the electronic structure and transport properties of magnetic nanocontacts of Ni will be presented. The electronic structure of these nanocontacts is calculated self-consistently in the framework of the density functional theory by means of the Korringa-Kohn-Rostoker method. The transport properties are described in the linear response regime based on the Landauer approach in the formulation of Baranger and Stone [4].

This contribution aims to explain the change of the conductance values in dependence on strain and compression for a single-atom contact, the influence of the symmetry for small Ni clusters, and the effect of an external magnetic field on a magnetic Ni particle in the contact region.

[1] M. R. Sullivan *et al.*, Phys. Rev. B **71**, 024412 (2005)

[2] M. Viret *et al.*, Phys. Rev. B **66**, 220401(R) (2002)

[3] A. Bagrets *et al.*, cond-mat/0510073 (2005)

[4] H. U. Baranger and A. D. Stone, Phys. Rev. B **40**, 8169 (1989)

TT 28.42 Thu 14:00 Poster A

Influence of spin waves on the transport through a quantum-dot spin valve — •Björn Sothmann[1], Jürgen König[1], and Anatoli Kadigrobov[1,2] — [1]Theoretische Physik III, Ruhr-Universität Bochum, D-44780 Bochum — [2]Department of Physics, Göteborg University, SE-412 96 Göteborg

We study transport through a quantum-dot spin valve, i.e. a single-level quantum dot with strong Coulomb interaction weakly coupled to ferromagnetic leads with non-collinear magnetizations. When a bias voltage is applied, a spin is accumulated on the dot leading to a reduction of the conductance. The Coloumb interaction leads to a spin precession which can be described in terms of an exchange field. In the linear transport regime this exchange field gives rise to a reduction of the spin-valve effect while in the non-linear regime it yields a negative differential conductance.

In Ref. [1] a real-time diagrammatic technique was developed to describe transport through quantum-dot spin valves. We extend this theory by taking into account the effect of spin waves induced in the leads. We deduce kinetic equations for the dot's occupation, its spin and the number of excited spin waves. These are used to compute the transport properties in the linear and non-linear transport regime.
[1] M. Braun, J. König, J. Martinek, Phys. Rev. B **70**, 195345 (2004)

TT 28.43 Thu 14:00 Poster A

Magnetoconductance of the Oval — Daniel Buchholz[1] and •Peter Schmelcher[1,2] — [1]Theoretische Chemie, Institut für Physikalische Chemie, Universität Heidelberg, INF 229, 69120 Heidelberg — [2]Physikalisches Institut, Universität Heidelberg, Philosophenweg 12, 69120 Heidelberg

We have calculated the ballistic quantum conductance of an open, two-dimensional, oval-shaped quantum dot with hard-wall boundary conditions using the Landauer-Büttiker formalism. The conductance depends on the deformation parameter of the oval: In the absence of magnetic fields, the temperature-averaged conductance is strongly suppressed inside an energy window covering one fourth of the first channel. A relatively weak perpendicular magnetic field raises the conductance to its maximal value.

TT 28.44 Thu 14:00 Poster A

Current induced motion of a domain wall — •Christian Wickles and Wolfgang Belzig — Fachbereich Physik, Universität Konstanz

A quantum Boltzman approach within the framework of a mean field Stoner model is employed to study the spin-current induced motion of domain walls in ferromagnetic materials. The local magnetisation of the ferromagnet is described by an exchange field with space- and time-dependent direction. The effect of magnetic impurity and spin-orbit scattering is considered. Non-adiabaticity terms are included aswell.

TT 28.45 Thu 14:00 Poster A

Spin-orbit based ratchets for spin-polarized currents — •Manuel Strehl[1], Matthias Scheid[1], Dario Bercioux[1,2], and Klaus Richter[1] — [1]Institut für Theoretische Physik, Universität Regensburg, Germany — [2]Physikalisches Institut, Albert-Ludwigs-Universität, Freiburg, Germany

Spin-quantum ratchets are a new class of ratchet devices that can give rise to spin currents. The minimal setup for the spin ratchet is given by the combination of spin-orbit interaction in a coherent quantum wire with a spatially periodic electrostatic potential.

Upon external ac-driving, and in the absence of a static bias, the system generates a directed spin current, while the total charge current is zero.

We analyze the underlying mechanism by combining symmetry properties of the scattering matrix and a Landau-Zener approach for evaluating the probability of the spin flipping, and we numerically verify the effect for different setups relevant for experiment. We further show that the spin current directions can be changed upon tuning the injection energy or the relative strength of Rashba and Dresselhaus spin-orbit coupling. In addition, also the dependences of the spin current as a function of the direction of the wire with respect to the crystallographic axes is considered.

TT 28.46 Thu 14:00 Poster A

Dissipative spin-rectifiers — •Sergey Smirnov[1], Dario Bercioux[1,2], Klaus Richter[1], and Milena Grifoni[1] — [1]Institut für Theoretische Physik, Universität Regensburg, Germany — [2]Physikalisches Institut, Albert-Ludwigs-Universität, Freiburg, Germany

In this contribution we analyze the possibility to generate, due to the presence of spin-orbit coupling, spin-currents in periodic structures subject to unbiased forcing in presence of coupling to a thermanl environment. So far the coherent regime was investigated [1]. As a model we consider a quasi-one-dimensional system where an electron is subjected to a periodic potential in the longitudinal direction, and with two modes only contributing from the confinement potential in the transverse direction. Only the lowest energy band of the longitudinal periodic potential is considered. Environmental effects are described by a bath of harmonic excitations bilinearly coupled to the particle position. Dissipation effects on the spin dynamics thus originate via the spin-orbit coupling. All the calculations are done in the framework of the real-time path integral technique. We show how the spin-current can be conveniently calculated in the generalization of the so-called discrete variable representation [2], which is the basis which diagonalizes the spin-current operator.

[1] M. Scheid, A. Pfund, D. Bercioux, and K. Richter cond-mat/0601118.

[2] M. Grifoni, M.S. Ferreira, J. Peguiron and J.B. Majer, Phys. Rev. Lett. 89, 146801 (2002).

TT 28.47 Thu 14:00 Poster A

Fingerprints of the magnetic polaron in nonequilibrium electron transport through a quantum wire coupled to a ferromagnetic spin chain — •Frank Reininghaus, Thomas Korb, and Herbert Schoeller — Institut für Theoretische Physik A, RWTH Aachen, 52056 Aachen, Germany

We study nonequilibrium quantum transport through a mesoscopic wire coupled via local exchange to a ferromagnetic spin chain [1]. Using the Keldysh formalism in self-consistent Born approximation, we identify fingerprints of the magnetic polaron state formed by hybridization of electronic and magnon states. Due to its low decoherence rate, we find coherent transport signals. Both elastic and inelastic peaks of the differential conductance are discussed as function of external magnetic fields, the polarization of the leads and the electronic level spacing of the wire.
[1] F. Reininghaus, T. Korb, and H. Schoeller, Phys. Rev. Lett. **97**, 026803 (2006)

TT 28.48 Thu 14:00 Poster A

Transport in Nanomechanical Nonlinear Oscillators — •Hannes Huebener[1] and Tobias Brandes[2] — [1]I. Institut für Theoretische Physik, Universität Hamburg — [2]Institut für Theoretische Physik, TU Berlin

We solve the model of a nanomechanical oscillator in the nonlinear potential created by the image charges of an additional transport electron. This system shows level anticrossing in the eigenvalue spectrum as a function of its frequency. We use the Franck-Condon principle to calculate the transition rates from leads to the oscillator. Under damping conditions we find rich behaviour even in a two-level approximation. We present results for transport properties of the system based on Master equations and Wigner function representations.

TT 28.49 Thu 14:00 Poster A

Charge Transfer along molecular chains: Quantum Monte Carlo simulations, rate equations and steady state currents — •Charlotte Escher[1], Lothar Mühlbacher[2], and Joachim Ankerhold[1] — [1]Physikalisches Institut, Albert-Ludwigs-Universität Freiburg — [2]School of Chemistry, Tel Aviv University, Israel

Based on a path integral Monte Carlo approach we investigate the real-time dynamics of single and correlated charge transfer along molecular chains interacting with vibronic and/or solvent environments. We identify regions in parameter space, where sequential hopping influenced by tunneling of collective vibronic modes allows for an accurate rate description of the full dynamics. In case of correlated transfer symmetries in the charge-vibron coupling lead to invariant subspaces in which entangled states do not equilibrate. Results for isolated molecular chains are extended to calculate the voltage dependence of the steady state currents through molecular wires between two conducting leads.

TT 28.50 Thu 14:00 Poster A

Spin-boson dynamics in a structured environment: A path integral approach — •Johannes Hausinger, Francesco Nesi, and Milena Grifoni — Universität Regensburg

In our work we examine the dynamics of a spin-boson Hamiltonian coupled to a reservoir featuring a peaked spectral density.This system has become relevant to investigate e. g. relaxation and dephasing in flux qubits coupled to a dc-SQUID detector [1].

We investigate that system using the real-time path integral approach of Feynman and Vernon.

We consider the case of a symmetric as well as of a biased two-level system (TLS). In the symmetric case the so-called noninteracting-blip approximation (NIBA), being perturbative in the tunneling coupling Δ, well describes the TLS dynamics. In particular the related power spectrum exhibits Rabi-vacuum splitting in the proper parameter regime. In the biased case however, the NIBA fails [2] in the low temperature and damping regime.

We present a novel approximation scheme capable to deal with bath-

induced correlations in such a low temperature regime.
[1] M. Thorwart, E. Paladino, M. Grifoni, Chem. Phys. 296, 333 (2004)
[2] U. Weiss, *Quantum Dissipative Systems*, 2nd ed. (World Scientific, Singapore, 1999)

TT 28.51 Thu 14:00 Poster A

Break junction tunnel spectroscopy in the hopping regime — •Barbara Sandow[1], Dirk Brossell[1], Olaf Bleibaum[2], and Walter Schirmacher[3] — [1]Institut für Experimentalphysik, Freie Universität Berlin — [2]Institut für Theoretische Physik, Otto-von-Gericke Universität Magdeburg — [3]Physic Department E13, Technische Universität München

Break junction tunnel spectroscopy is a tradtional method for investigating the electronic structure of solids. In weakly doped semiconductors in the hopping regime the spectra cannot be interpreted by means of Bardeen's [1] theory, because it is based on a metallic conduction mechanism. We have formulated a new ansatz [2] for the tunnel current in the hopping regime. Using our new theory we are able to interpret data which exhibit the Coulomb gap in a satisfactory way. The dependence of the gap width on temperature and carrier concentration is discussed in terms of current theories of the Coulomb gap.

1 J. Bardeen, Phys. Rev. Lett. 6, 75 (1961) 2 O. Bleibaum, B. Sandow, W. Schirmacher, Phys. Rev. B 70, 045308-1 (2004)

TT 28.52 Thu 14:00 Poster A

Probing Spin Precession by Noise Spectroscopy — •Matthias Braun[1], Jürgen König[1], and Jan Martinek[2] — [1]TPIII, Ruhr-Universität Bochum, 44780 Bochum, Germany — [2]IMP, Polish Academy of Science, 60-179 Poznań, Poland

We theoretically discuss the possibility to observe electron-spin precession by its imprint on the noise spectrum of a reference quantity. A finite-frequency noise measurement of this reference quantity can therefore be used as unorthodox electron-spin resonance experiment. We review two different systems illustrating this idea.
1.) In a single-level quantum dot with ferromagnetic leads, the spin noise is mapped on the current noise by tunnel magnetoresistance [1]. The current-noise frequency spectrum then reveals Larmor frequency and spin life time of the conduction electrons. This transport experiment is therefore equivalent to a single spin cw-ESR experiment.
2.) By sending laser light through selected semiconductor [2] or gas [3] samples, one can observe a Faraday rotation of the polarization plane. In addition, the spin fluctuations in the sample also lead to fluctuations of the Faraday rotation. These fluctuations can again be measured, and used as ESR experiment. It is even possible to realize Faraday-rotation fluctuation experiments, which avoid some sources of inhomogeneous line broadening [4].
[1] M. Braun *et al.*, Phys. Rev. B **74**, 075328 (2006).
[2] M. Oestreich *et al.*, Phys. Rev. Lett. **95**, 216603 (2005).
[3] S. A. Crooker *et al.*, Nature **431**, 49 (2004).
[4] M. Braun *et al.*, cond-mat/0601607.

TT 28.53 Thu 14:00 Poster A

Functional renormalization group for nonequilibrium quantum many-body problems — •Riccardo Gezzi, Thomas Pruschke, and Volker Meden — Institut für theoretische Physik Friedrich-Hund-Platz 1 37077 Göttingen

We extend the concept of the functional renormalization for quantum many-body problems to non-equilibrium situations. Using a suitable generating functional based on the Keldysh approach, we derive a system of coupled differential equations for the m-particle vertex functions. The approach is completely general and allows calculations for both stationary and time-dependent situations. As a specific example we study the stationary state transport through a quantum dot with local Coulomb correlations at finite bias voltage employing two different truncation schemes for the infinite hierarchy of equations arising in the functional renormalization group scheme.

TT 28.54 Thu 14:00 Poster A

Mesoscopic to universal crossover of transmission phase of multi-level quantum dots — •Christoph Karrasch[1], Theresa Hecht[2], Yuval Oreg[3], Jan von Delft[2], and Volker Meden[1] — [1]Institut für Theoretische Physik, Göttingen, Germany — [2]Physics Department, Ludwig-Maximilians-Universität, Munich, Germany — [3]Department of Condensed Matter Physics, The Weizmann Institute of Science, Rehovot, Israel

Transmission phase α measurements [1] of many-electron quantum dots (small mean level spacing δ) revealed universal phase lapses by π between consecutive resonances. In contrast, for dots with only a few electrons (large δ), the appearance or not of a phase lapse depends on the dot parameters. We introduce a model of a multi-level quantum dot with local Coulomb correlations and arbitrary level-lead couplings [2]. Using the functional RG to tackle the two-particle interaction we reproduce the generic features of the experimentally observed behavior. The fRG results are backed up by NRG calculations.

[1] M. Avinun-Kalish, M. Heiblum, O. Zarchin, D. Mahalu, and V. Umansky, Nature **436**, 529 (2005).
[2] C. Karrasch, T. Hecht, Y. Oreg, J. von Delft, and V. Meden (2006), cond-mat/0609191

TT 28.55 Thu 14:00 Poster A

Temperature induced phase averaging in one-dimensional mesoscopic systems — •Severin Jakobs[1], Volker Meden[2], Herbert Schoeller[1], and Tilman Enss[3] — [1]Institut für Theoretische Physik A, RWTH Aachen, Germany — [2]Institut für Theoretische Physik, Universität Göttingen, Germany — [3]Dipartimento di Fisica, Università di Roma "La Sapienza", Italy

We analyse phase averaging in one-dimensional interacting mesoscopic systems with several barriers and show that for incommensurate positions an independent average over several phases can be induced by finite temperature [1]. For three strong barriers with conductances G_i and mutual distances larger than the thermal length, we obtain $G \sim \sqrt{G_1 G_2 G_3}$ for the total conductance G. For an interacting wire, this implies power laws in $G(T)$ with novel exponents, which we propose as an experimental fingerprint to distinguish temperature induced phase averaging from dephasing.

[1] S. Jakobs, V. Meden, H. Schoeller, T. Enss, cond-mat/0606486