TT 35: Postersession Transport: Nanoelectronics, Quantum Coherence and Quantum Information, Fluctuations and Noise

Time: Wednesday 14:00–18:00 Location: P1A

TT 35.1 Wed 14:00 P1A

Interference and interaction effects in adiabatic pumping through quantum dots — •Bastian Hiltscher, Michele Governale, and Jürgen König — Theoretische Physik, Universität Duisburg-Essen, 47048 Duisburg, Germany

In order to investigate the effects of interference and interaction in adiabatic pumping, we consider an Aharonov-Bohm (AB) interferometer with a quantum dot embedded either in one or in both arms[1]. We employ a real-time formalism and we perform an expansion both in the tunnel-coupling strengths between dot and leads and in the pumping frequency[2], taking into account the Coulomb interaction non perturbatively.

We find that pumping in the AB interferometer with only one dot has a peristaltic but at the same time phase-coherent character. The flux dependence of the pumped current clearly indicates the presence of coherent processes in this transport mechanism. In an AB interferometer with one dot in each arm, it is possible to pump with the gate voltages of the two different dots. In this case, pumping relies purely on quantum-mechanical interference and has no classical counterpart.

[1] J. König und Y. Gefen, Phys. Rev. B **65**, 045316 (2002).

[2] J. Splettstoesser, M. Governale, J. König, and R. Fazio, Phys. Rev. B **74**, 085305 (2006).

TT 35.2 Wed 14:00 P1A

Non-local Andreev transport through an interacting quantum dot — •David Futterer[1], Michele Governale[1], Marco G. Pala[2], and Jürgen König[1] — [1]Theoretische Physik, Universität Duisburg-Essen, D-47048 Duisburg, Germany — [2]IMEP-LAHC-MINATEC (UMR CNRS/INPG/UJF 5130), 38016 Grenoble, France

We investigate sub-gap transport through an interacting quantum dot tunnel coupled to one superconducting lead and two normal conducting leads which can be either ferromagnetic or non-magnetic[1]. Despite the tendency of a large charging energy to suppress the equilibrium proximity effect on the dot, a finite Andreev current can be achieved in non-equilibrium situations. We propose two schemes to identify non-local Andreev transport. In one of them, we identify crossed Andreev reflection by the dependence of the Andreev current on the relative orientation and polarization of the ferromagnetic leads. In the second scheme, the presence of strong Coulomb interaction leads to negative values of the non-local conductance as a clear signal of non-local Andreev transport. For our calculation we apply a real-time transport theory[2,3] in the limit of a large pair potential Δ.

[1] D. Futterer, M. Governale, M. G. Pala, and J. König, arXiv:0806.0237(2008).

[2] M. G. Pala, M. Governale, and J. König, New J. Phys. **9**, 278 (2007).

[3] M. Governale, M. G. Pala, and J. König, Phys. Rev. B **77**, 134513 (2008).

TT 35.3 Wed 14:00 P1A

Influence of spin waves on transport through a quantum-dot spin valve — •Björn Sothmann[1,2], Jürgen König[1,2], and Anatoli Kadigrobov[3,2] — [1]Theoretische Physik, Universität Duisburg-Essen, Germany — [2]Theoretische Physik III, Ruhr-Universität Bochum, Germany — [3]Departement of Physics, Göteborg University, Sweden

A quantum-dot spin valve, i.e. a single-level quantum coupled to ferromagnetic leads with arbitrarily oriented magnetizations, reveals interesting transport properties as e.g. negative differential conductance due to an interplay between non-equilibrium spin accumulation on the quantum dot and spin precession due to an exchange field which is created by virtual tunneling to the leads.

In order to describe the influence of spin waves on transport through a quantum-dot spin valve, we generalize the real-time diagrammatic transport theory developed in Ref. [1] to include magnonic degrees of freedom in the leads. In the regime of large spin-wave energies, we find that the formation of a trapping state leads to a negative differential conductance. Moreover, we find that magnons will be pumped from the source to the drain lead. In addition, we observe that the magnons can pump a completely spin-polarized current at zero bias voltage. We also report on the zero- and finite-frequency current noise. We find the latter to be sensitive to the magnonic contributions to the exchange field.

[1] M. Braun, J. König, J. Martinek, Phys. Rev. B **70**, 195345 (2004).

[2] B. Sothmann, J. König, A. Kadigrobov, in preparation.

TT 35.4 Wed 14:00 P1A

Time-resolved Electron Transport through Quantum Dot Systems — •Alexander Croy and Ulf Saalmann — Max-Planck-Institut für Physik komplexer Systeme, Nöthnitzer Str. 38, 01187 Dresden, Germany

The investigation of *time-resolved* currents in mesoscopic devices has gained a lot of interest over the past few years. There has been a lot of experimental and theoretical progress in realizing, modeling and understanding time-dependent electron transport.

In this context we study theoretically the time-resolved electric currents flowing through single and double quantum dots that are subject to a voltage pulse. An established tool in this regard is the non-Markovian quantum master equation (QME) for the many-body density matrix describing the state of the quantum dot system. Usually the QME is taken up to second order in the dot-reservoir coupling. For QMEs of higher order in the coupling not as many results are available.

In the present work we numerically solve a QME including terms up to fourth order and give results of the time-resolved occupation and the currents flowing through the system. Complementary to that we present a new method for treating time-dependent non-equilibrium Green function calculations in the wide-band limit. We show a comparison of the results obtained from both methods for the non-interacting resonant level model, indicating that the additional terms are important to describe the electric current.

TT 35.5 Wed 14:00 P1A

Towards quantum dots on GaAs nanowires — •Johannes Mösl[1], Anna Fontcuberta i Morral[2,3], and Stefan Ludwig[1] — [1]Fakultät für Physik and Center for NanoScience, LMU Munich, Geschwister-Scholl- Platz 1, D-80539 München, Germany — [2]TU Munich, Walter Schottky Institut, Am Coulombwall 3, 85748 Garching, Germany — [3]EPF Lausanne, Switzerland

Semiconductor nanowires is an emergent research topic in the field of nanoelectronics, as they form an excellent building block for 0D and 1D applications and allow novel architectures and material combinations. We study electronic transport properties of catalyst-free MBE grown GaAs nanowires, p-doped at a number of different doping levels. Detailed characterization of the wires including electronic contacts fabricated by e-beam lithography and based on palladium or annealed zinc-silver alloys are discussed. Contact properties and a pronounced hysteresis of the current through the nanowires, as a backgate-voltage is swept, are explained within tentative models. In addition we present first transport measurements on quantum dots, which are defined electrostatically as well as by etched constrictions.

TT 35.6 Wed 14:00 P1A

Nonequilibrium transport through a correlated quantum dot with magnetic impurity — •Daniel Becker[1], Stephan Weiss[2], Michael Thorwart[3], and Daniela Pfannkuche[1] — [1]I. Institute for Theoretical Physics, University of Hamburg, D-20355 Hamburg, Germany — [2]Niels Bohr Instituttet, Nano-Science Centret, Universitetsparken 5, DK-2100 Copenhagen, Denmark — [3]FRIAS, Albert-Ludwigs-Universität Freiburg, Albertstr.19, 79104 Freiburg, Germany

The deterministic, non-perturbative scheme of iterative summation of path integrals (ISPI)[1] is adopted to a single-level quantum dot with one quantum spin-1/2 magnetic impurity interacting with the dot-electron spins. For two electrons on the dot, Coulomb interaction is taken into account. A generating function is obtained to calculate the dc tunneling current at finite bias voltages and the orientation of the impurity spin. This real-time path integral extends over all paths of (i) the magnetic impurity spin and of (ii) Ising-like fluctuating spin fields, which are introduced to decouple the interacting dot-electrons. With the use of the ISPI scheme, the sum over all these paths can be carried out numerically, while exactly accounting for all lead-induced self-energies within a sufficiently long, but finite coherence time. This

allows to study real-time nonequilibrium transport through the considered system in the case of strong electron-impurity interaction as well as strong coupling to the leads, even at low temperatures and for a wide range of bias voltages. In particular, the mutual influence between tunneling current and the impurity spin dynamics is of interest.

[1] S. Weiss et al., Phys. Rev. B 77, 195316 (2008)

TT 35.7 Wed 14:00 P1A

Transport properties of smooth and rough interfaces — •Mohamed Fadlallah[1], Cosima Schuster[1], and Udo Schwingenschlögl[2] — [1]Institut für Physik, Universität Augsburg, D-86135 Augsburg, Germany — [2]ICCMP, Universidade de Brasilia, 70904-970 Brasila-DF, Brazil

The functionality of nanoscale devices depends crucially on the transport properties across the interfaces. As devices are reduced in size, interfaces dominate the transport. Nanocontacts hence were studied intensively over the last years and many approaches to calculate the transport were developed. Most are based on electronic structure calculations to obtain the material specific aspects. Nevertheless the properties of simple distorted interfaces are not well understood. Distortions may occur due to orientation mismatch, vacancy sites, buckling of the interface layer, or impurities. We discuss the equilibrium and non-equilibrium properties of distorted interfaces between simple metals (Au, Al) using the SMEAGOL code which combines density functional theory (DFT) and non-equilibrium Green's functions (NEGF) by using Landauer formula. The transmission coefficient is proportional to the density of states (DOS). Only in the case of a vacancy, we see a substantial reduction of the transmission coefficient near the Fermi level. Other kinds of distortion influence only the transmission at lower energies. With increasing voltage the transmission coefficient of the d-band decreases linearly, but stays constant near the Fermi level in the gold system. For Aluminum it is reduced over the whole energy range. This work was done in the collaboration with Dublin group of SMEAGOL.

TT 35.8 Wed 14:00 P1A

Current without external bias and diode effect in shuttling transport of nanoshafts — •Klaus Morawetz[1,2], Sibylle Gemming[1], Regina Luschtinetz[3], Lukas Eng[4], Gotthard Seifert[3], and Anatole Kenfack[5] — [1]Forschungszentrum Dresden-Rossendorf, PF 51 01 19, 01314 Dresden, Germany — [2]International Center for Condensed Matter Physics, 70904-910, Brasília-DF, Brazil — [3]Institute of Physical Chemistry and Electrochemistry, TU Dresden, 01062 Dresden, Germany — [4]Institute of Applied Photophysics, TU Dresden, 01062 Dresden, Germany — [5]Max-Planck-Institute for the Physics of Complex Systems, Nöthnitzer Str. 38, 01187 Dresden, Germany

A row of parallel ordered and coupled molecular nanoshafts is shown to develop a shuttling transport of charges at finite temperature. The appearance of a current without applying an external bias voltage is reported as well as a natural diode effect allowing unidirectional charge transport along one field direction while blocking the opposite direction[1]. The zero-bias voltage current appears above a threshold of initial thermal and/or dislocation energy.

[1] New J. Phys. 10 (2008) 103014-1-8

TT 35.9 Wed 14:00 P1A

A Microscopic Model of Current-Induced Switching of Magnetization — •Niko Sandschneider and Wolfgang Nolting — AG Festkörpertheorie, Institut für Physik, Humboldt-Universität zu Berlin, Newtonstr. 15, 12489 Berlin

We study the behaviour of the magnetization in a ferromagnetic metal/nonmagnetic insulator/ferromagnetic metal/paramagnetic metal (FM1/NI/FM2/PM) tunnel junction. It is calculated self-consistently within the nonequilibrium Keldysh formalism. The magnetic regions are treated as band ferromagnets, such as Co, and are described by the single-band Hubbard model. The left (FM1) and right (PM) lead are assumed to remain in equilibrium. We developed a nonequilibrium spectral density approach to solve the Hubbard model approximately in the switching magnet FM2. By applying a voltage to the junction it is possible to switch between antiparallel (AP) and parallel (P) alignment of the magnetizations of the two ferromagnets. The transition from AP to P occurs for positive voltages while the inverse transition from P to AP can be induced by negative voltages only. This behaviour is in agreement with the Slonczewski model[1] of current-induced switching and appears self-consistently within the model, i.e. without using half-classical methods like the Landau-Lifshitz-Gilbert equation.

[1] J. Slonczewski, J. Magn. Magn. Mater. **159**, L1 (1996)

TT 35.10 Wed 14:00 P1A

Electrical-physical characteristics of $Si/SiO_2/Ni$ nanoelectronic systems with ion tracks in strong magnetic fields — •Alexander Petrov[1], Egor Kaniukov[1], Sergey Demyanov[1], Ivan Svito[2], Alexander Fedotov[2], and Eugene Belonogov[3] — [1]Scientific-Practical Materials Research Centre NAS of Belarus, Minsk, Belarus — [2]Belarusian State University, Minsk, Belarus — [3]Voronezh State Technical University, Voronezh, Russia

The present research deals with the swift heavy ion track technology, which includes irradiation of a material by Au ions (energy 350 MeV, fluence 10^8 cm^{-2}), chemical etching of resulting swift heavy ion tracks and precision electrochemical deposition of magnetic metals in the resulting nanopores.

In this way structures on the base of SiO_2/n-Si with nanopores in silicon dioxide layers, filled with Ni nanoclusters, have been prepared and studied. Investigations of current-voltage dependences and magnetic characteristics of the obtained structures with Ni nanoclusters at strong magnetic fields up to 8 T and at low temperatures in the range of 1.8 K - 150 K have shown a possibility of control of these nanostructures properties by the effect of magnetic fields.

The obtained results confirm a feasibility of the use of the $Si/SiO_2/Ni$ nanoelectronic systems with swift heavy ion tracks in low-temperature spintronic sensor devices.

TT 35.11 Wed 14:00 P1A

Conductance oscillations of polyacetylene at finite temperature — •Davoud Pouladsaz[1,2], Thomas Gessner[2,3], Michael Schreiber[1], and Reinhard Streiter[2,3] — [1]Institut für Physik, Technische Universität Chemnitz — [2]Zentrum für Mikrotechnologien (ZfM), Technische Universität Chemnitz — [3]Fraunhofer-Einrichtung für Elektronische Nanosysteme (ENAS), Chemnitz

The length-dependence of the differential conductance oscillations in *trans*-polyacetylenes, suspended between gold contacts, is investigated by employing the non-equilibrium Green's function technique within the density-functional-based tight-binding method (gDFTB) to study the electronic transport properties of the proposed system under the applied bias voltages at finite temperature. The results reveal the efficient influence of the sulfur atoms, as the strong bonding clips to gold atoms, in the quantum transport.

TT 35.12 Wed 14:00 P1A

Charge transport properties of highly conducting tetrathiafulvalene (TTF) based nano-wires — •Marius Bürkle[1], Fabian Pauly[1], Janne Viljas[1,2], Juan Carlos Cuevas[3], and Gerd Schön[1,2] — [1]Institut für Theoretische Festkörperphysik and DFG-Center for Functional Nanostructures — [2]Forschungszentrum Karlsruhe, Institut für Nanotechnologie, 76021 Karlsruhe, Germany Condensada, Universidad Autònoma de Madrid, 28049 Madrid — [3]Departamento de Física Teórica de la Materia

In a recent experiment [1], an unexpectedly high conductance was observed for tetrathiafulvalene based nanowires, when contacted by gold electrodes. Using density functional calculations [2], we demonstrate that this is due to the highest occupied molecular orbital, which aligns such that it is located only slightly below the Fermi energy of gold. We study the robustness of our findings by an analysis of different types of tetrathiafulvalene based nanowires and contact geometries.

[1] F. Giacalon et. al., Chem. Commun., 2007, 4854 - 4856, DOI: 10.1039/b710739k

[2] F. Pauly et. al., arXiv:0806.4173 and New J. Phys. (in press)

TT 35.13 Wed 14:00 P1A

Fermi-edge singularities: Bulk vs. mesoscopic systems — •Martina Hentschel and Georg Röder — MPI für Physik komplexer Systeme, Dresden

Fermi-edge singularities are among the simplest many-body effects and have been a key interest in condensed matter physics for many years. They have been extensively studied, and are understood, for bulk systems such as metals. In contrast, our focus here is on small (mesoscopic) systems like quantum dots and graphene. We mainly address the Fermi-edge singularities in the photoabsorption cross section that are known as the x-ray edge problem. They comprise the phenomena of Anderson orthogonality catastrophe and Mahan's exciton (Mahan-Nozieres-DeDominicis response) and result from the system's many-

body response to the sudden, localized perturbation given by the core hole that is left behind when the x-ray excites an electron. We show that the mesoscopic regime holds surprises in form of many-body responses that strongly deviate from the macroscopic (bulk, or metallic) case. The differences originate in the finite system size, the intrinsic mesoscopic fluctuations, and most importantly, the modifications of the electron dynamics in confined ballistic systems that are typically studied in the field of quantum chaos. A particularly interesting behavior is seen in graphene where the vanishing density of states at the Dirac point significantly modifies the system's many-body response.

TT 35.14 Wed 14:00 P1A

Density functional theory on a lattice: Transport through a small interacting region — Michael Dzierzawa, Ulrich Eckern, •Stefan Schenk, and Peter Schwab — Universität Augsburg

Density functional theory is the method of choice for calculations of the electronic structure of complex materials. In recent years the method has been applied to study charge transport through systems of molecular size. However it is clearly necessary to determine the limits of the approach to assess the obtained results. To this end we suggest to study simple lattice systems, where the comparison with exact calculations is possible.

Hence we investigate a one-dimensional system with spinless fermions consisting of a small interacting region between two noninteracting leads. In particular we study the linear conductance through the interacting region. We find that for this specific system a naive calculation of the conductance, i. e. by ignoring the exchange-correlation kernel, is often sufficient. The local density approximation performs rather badly even for weak interaction, whereas the so-called exact-exchange approximation gives sensible results. We also propose an exact diagonalization procedure to obtain a non-local exchange-correlation potential for strongly interacting systems.

TT 35.15 Wed 14:00 P1A

Geometry-Dependence of 0.7 Anomaly in Quantum Point Contacts: A Study Using the Functional Renormalization Group — •Jan Heyder, Florian Bauer, and Jan von Delft — Arnold Sommerfeld Center for Physics, Ludwig-Maximilians-Universitaet, Muenchen

We study the geometry-dependence of the 0.7 anomaly of the conductance through a quantum point contact at zero temperature as a function of magnetic field, using the functional renormalization group (fRG). We model a 1-D quantum wire using a tight-binding chain with short-ranged Coulomb interactions and a prescribed onsite potential to mimick the potential barrier caused by the 2-D constriction. We study the influence of various shapes of this potential barrier on the magnetic-field dependence of the conductance, finding that it indeed does show a significant geometry-dependence.

TT 35.16 Wed 14:00 P1A

Using wave packet propagation to calculate conductivities — •Christoph Kreisbeck[1], Viktor Krückl[1], and Tobias Kramer[1,2] — [1]Institute for Theoretical Physics, University of Regensburg, 93040 Regensburg, Germany — [2]Department of Physics, Harvard University, Cambridge, MA 02138, USA

The solution of the time dependent Schrödinger equation contains a lot of information about the stationary properties of the system under consideration. To reveal these information we consider the time evolution of a single wave packet and perform the Fourier transform of the autocorrelation function leading to the local density of states (LDOS), which is a key ingredient for the calculation of currents through semiconductor devices. Another way to calculate transport properties is to use flux lines - kind of charge sensors - detecting the energy dependent flux. Using these lines we obtain transmission propabilities, which are closely connected to the conductance, for a whole range of energies from a single wave packet run. In this contribution we illustrate the described technique for a multi-terminal device.

TT 35.17 Wed 14:00 P1A

Multiple electron transfer and transport through a DNA dimer — •Sabine Tornow[1], Gertrud Zwicknagl[1], Ralf Bulla[2], and Frithjof Anders[3] — [1]Inst. math. Physik, TU Braunschweig — [2]Inst. th. Physik, U Köln — [3]Inst. th. Physik, U Dortmund

We investigate multiple electron transfer in a donor-bridge-acceptor system where the molecular bridge comprises a DNA dimer (AT-AT or GC-GC) strongly coupled to a bosonic bath. The time dependent population probabilities and transfer characteristics of multiple electrons is calculated with the time-dependent renormalization group method at low temperatures and kinetic equations at large temperatures. The related transport properties for a system where donor and acceptor are replaced by left and right leads is discussed in different temperature and coupling regimes.

TT 35.18 Wed 14:00 P1A

Laser excitation of atomic point contacts on silicon membranes — •Reimar Waitz[1], Olivier Schecker[1,2], and Elke Scheer[1] — [1]University of Konstanz, D-78457 Konstanz, Germany — [2]IMEP-LAHC, MINATEC-INPG, F-38016 Grenoble, France

Light-induced conductance changes in metallic atomic-sized contacts in the tunneling and in the contact regime are studied. For this purpose, a new type of mechanically controlled break-junction (MCBJ) has been used [1].

MCBJs are made of a metallic wire with a suspended constriction. This constriction, forming a 100 nm wide bridge, can be elongated until having - just before breaking - a diameter of one atom. The elongation is achieved by stretching the substrate, consisting of a 340 nm thin crystalline silicon membrane, in contrast to MCBJs on bulk substrates, which use the bending of the substrate.

Compared to MCBJs on bulk substrates, this new type is advantageous for measuring the conductance of atomic point contacts under laser irradiation. Both the very low absorption and the low reflectivity of the membranes for visible light, make it possible to separate effects caused by the metal from effects caused by the substrate.

On our Poster we present results on light-induced reversible conductance changes of gold contacts. The dependence on intensity, wavelength and polarisation of the incident light has been investigated.

[1] R. Waitz, O. Schecker, and E. Scheer, Rev. Sci. Instrum. 79, 093901 (2008)

TT 35.19 Wed 14:00 P1A

Magneto-resistance of atomic-sized contacts of magnetic metals — •Stefan Egle[1], Hans-Fridtjof Pernau[1], Cécile Bacca[1], Magdalena Hüfner[2], and Elke Scheer[1] — [1]University of Konstanz, Germany — [2]ETH Zürich, Switzerland

We report electronic transport measurements carried out on atomic-size contacts made of ferromagnetic metals or noble metals with ferromagnetic electrodes. The magneto-resistance (MR) curves show very rich behavior with strong magneto-resistance ratios (MRR) up to 1,000 %. We study the possible influence due to the micro-magnetic order of the domains in the vicinity of the contact, giant MR, tunnel MR, ballistic MR and magneto-striction by analyzing MR curves in different orientations of the applied magnetic field with respect to the film plane and current direction. In order to separate the influence of the large electrodes from the influence of the contacts themselves, we used different sample geometries. We used cobalt samples within a symmetric and an asymmetric layout as well as combinations of nonmagnetic electrodes with magnetic bridges and vice versa. In all geometries the MRR is of comparable size and the MR traces show a rich behavior. The main conclusion which we draw from our results is that the micromagnetism of the electrodes as well as the precise atomic arrangement of the contact account for the large MR values.

TT 35.20 Wed 14:00 P1A

Formation of low conductive constrictions in nanostructures by electromigration — •Birgit Kiessig[1,2], Wanyin Cui[1,2], Kai Grube[1], Regina Hoffmann[2], and Roland Schäfer[1] — [1]Forschungszentrum Karlsruhe, IFP, Postfach 3640, 76021 Karlsruhe — [2]Physikalisches Institut, Universität Karlsruhe, 76128 Karlsruhe

Exposure of metallic nanostructures to high currents leads to deterioration by melting or electromigration. Ref. 1 describes a method how to use the latter in a controlled way to form constrictions with conductances down to the conductance quantum $G_0 = 2e^2/h$. Below several G_0 conductance prefers to stabilize at material dependent values well known from conductance quantization experiments.

We apply the method described in Ref. 1 to different materials and extend it to nanostructures containing rings. The rings are connected to two leads at opposite sides and the electromigration-controlled constriction formation acts in a balanced way in both ring arms.

[1] R. Hoffmann, D. Weissenberger, J. Hawecker, and D. Stöffler, Appl. Phys. Lett. **93**, 0431118 (2008).

TT 35.21 Wed 14:00 P1A

Electron induced heating and molecular phonon cooling in

single C_{60} junctions — Gunnar Schulze, Katharina J. Franke, and •Jose Ignacio Pascual — Fachbereich Physik, Freie Universität Berlin, Arnimallee 14, 14195 Berlin, Germany

The functionality of single molecules as electronic devices relies on its stability against large current densities. Electronic current generates heat in the molecular junction due to coupling of electrons with molecular vibrations. Using a scanning tunnelling microscope operated at 5 K, we thermally decompose single C_{60} molecules on a metal surface by passing current through them, and investigate the response of the degrading current (and power) to changes in electron energy. The power for decomposition results from the balance between heating and cooling efficiencies [1]. We find that heating varies with electron energy and reflects the molecular resonance structure participating in the transport. Through inelastic electron spectroscopy measurements, we identify those vibrations which are mostly excited when tunneling through the LUMO state, confirming that symmetry selection rules apply here. Cooling, on the other hand, is a non-resonant process, dominated by the decay of molecular vibrations into electron-hole pair excitations. We find that the partial occupation of molecular states enhance the molecular cooling due to an enhancement of density of states at the molecule-metal interface [2].

[1] G. Schulze, et al., Phys. Rev. Lett. 100, 136801 (2008)
[2] G. Schulze, et al., N. J. Phys. 10, 065005 (2008)

TT 35.22 Wed 14:00 P1A

Quantum Transport Through Gold Wires: Ab Initio Studies Using Plane Waves and Supercells — •Björn Oetzel[1,2], Martin Preuss[1,2], Frank Ortmann[1,2], Karsten Hannewald[1,2], and Friedhelm Bechstedt[1,2] — [1]Institut für Festkörperphysik und -optik, Friedrich-Schiller-Universität Jena, Max-Wien-Platz 1, 07743 Jena, Germany — [2]European Theoretical Spectroscopy Facility, Friedrich-Schiller-Universität Jena, Max-Wien-Platz 1, 07743 Jena, Germany

We present a numerical scheme for an *ab initio* implementation of the Landauer-Büttiker theory for quantum transport by means of supercells and plane-wave basis sets. The suggested method works entirely in **k** space which allows to circumvent the complicated projections onto tight-binding Hamiltonians necessary in the more common real-space approaches to quantum transport. Here we apply this method to DFT calculations of transmission functions for quasi-1D Au nanowires of various lengths and widths. The results are discussed with respect to the possible replacement of semi-infinite electrodes by short Au nanowires in future calculations of metal-molecule-metal junctions.

TT 35.23 Wed 14:00 P1A

Molecular Switches in Break Junction Metal-Molecule-Metal Contacts — •Bernd Briechle[1], Thomas Kirchner[1], Uta Eberlein[1], Simon Verleger[1], Marcel Mayor[2], Alfred Blaszczyk[2], Thomas Huhn[3], Jannic Wolf[3], Dima Sysoiev[3], Elke Scheer[1], and Artur Erbe[1] — [1]FB Physik, Universität Konstanz, Germany — [2]Forschungszentrum Karlsruhe, Institut für Nanotechnologie, 76021 Karlsruhe — [3]FB Chemie, Universität Konstanz, Germany

Metal-molecule-metal contacts are established using the Mechanically Controllable Break Junction (MCBJ) technique at room temperature in a toluene solution. We investigate short oligo phenylene ethynylenes (OPE) with various nitrogen-based end groups as well as different thiol-terminated molecular switches. Analysis is based on statistics of conductance traces recorded during opening and closing the junction, and on current-voltage characteristics taken at a constant electrode distance. We show that the latter can be described by a simple transport model involving a single broadened molecular orbital. The molecular switches exhibit a pronounced hysteretic switching behavior when the bias voltage exceeds a certain value ($\approx 0.4V$).

TT 35.24 Wed 14:00 P1A

Optical Spectroscopy on Tuneable Nano Gaps — •Daniel Gerster[1], Joachim Reichert[1], Stefan Klein[2], Harald Fuchs[2], and Johannes V. Barth[1] — [1]Physik Department, TU München, Germany — [2]Physikalisches Institut, Universität Münster, Germany

Novel techniques to establish tuneable nano gaps designed to act as electrodes for single molecule charge transport measurements are required both for fundamental research and device oriented applications. Hereby, the implementation of additional control parameters to influence the properties of the functional molecule within the gap is of special interest. We present a method to fabricate tuneable nanoscale electrodes where an apertureless scanning nearfield tip (SNOM-tip) is employed to serve as a counter electrode in a molecular junction and simultaneously as a light source. The apertureless SNOM-tip acts as plasmonic waveguide to focus surface plasmon polaritons to the apex of the tip, where a strongly enhanced evanescent field is confined to only a few nanometers. First spectroscopic measurements of light absorption at the empty gap reveal distinct standing wave patterns of optical waves between the electrodes, indicating high field intensities in the gap region.

TT 35.25 Wed 14:00 P1A

Phase-dynamics in superconducting atomic and molecular point contacts — •Benjamin Obert — Institut für theoretische Physik, Universität Ulm, Germany

In the conventional theory for current biased superconducting atomic point contacts the dynamics of the phase difference across the contact is described on single adiabatic surfaces for the Andreev bound states. Here we consider

(i) non-adiabatic transitions between these surfaces relevant for highly transmitting channels and

(ii) energy dependent transmission channels which may occur in molecular junctions.

TT 35.26 Wed 14:00 P1A

Charge transport through an interference SET — •Georg Begemann, Dana Darau, Andrea Donarini, and Milena Grifoni — University of Regensburg, Germany

We study the charge transport through a benzene interference single electron transistor. The interplay between Coulomb interaction and orbital symmetry produces specific transport characteristics that can be considered as the fingerprints of the contacted molecule. Specifically we predict selective conductance suppression and the appearance of negative differential conductance and current blocking when changing the contacts from para to meta configuration[1,2]. All effects originate from destructive interference in transport involving states with orbital degeneracy.

The studied transport phenomena are also robust under the perturbation exerted by the anchor groups binding the contact atoms to the leads or by an external electrostatic field.

[1] G.Begemann, D.Darau, A.Donarini, and M.Grifoni, Phys. Rev. B 77, 201406(R) (2008).
[2] D.Darau, G.Begemann, A.Donarini, M.Grifoni, arXiv:0810.2461

TT 35.27 Wed 14:00 P1A

Electron Dynamics in Molecular Wires Studied by a Density Matrix Approach — •Lisa Mövius and Ulrich Kleinekathöfer — School of Engineering and Science, Jacobs University Bremen, Campus Ring 1, 28759 Bremen, Germany

Recent investigations in the field of molecular electronics [1-3] are targeted on controlling the current through single molecules by laser fields. In the present work, as in [1], the metal-molecule-metal junction is described using a quantum master equation within second-order perturbation theory, since the wire-lead coupling is assumed to be weak. The dynamics of the system can be influenced by applying a laser field, leading to novel effects like coherent destruction of tunneling to effectively suppress the current through the molecular wire. Using a projection operator approach [3] an efficient reduction of dimensionality can be achieved to render effective calculations of longer wires possible.

[1] S. Welack, M. Schreiber, and U. Kleinekathöfer, J. Chem. Phys. 124, 044712 (2006).
[2] I. Franco, M. Shapiro, and P. Brumer, Phys. Rev. Lett. 99, 126802 (2007).
[3] U. Harbola, M. Esposito, and S. Mukamel. Phys. Rev. B 74, 235309 (2006).

TT 35.28 Wed 14:00 P1A

Noise Measurements of Cryogenic Amplifiers for Qubit Experiments — •Christian Schwemmer[1], Tobias Wirth[1], Alexander Lukashenko[1], Jürgen Lisenfeld[1], Michael Mück[2], and Alexey Ustinov[1] — [1]Physikalisches Institut, Universität Karlsruhe (TH), Germany — [2]Institut für Angewandte Physik der Justus-Liebig Universität Giessen, Germany

Ultra-low noise cryogenic amplifiers are a prerequisite for a variety of readout schemes of qubits based on Josephson junctions. Evaluation of the noise temperature of cryogenic amplifiers is an essential task for achieving high sensitivity and lowest back action. We developed

a cryogenic noise source based on a 50 Ohm load located in vacuum with variable temperature between 8 K and 60 K. By measuring the output power of a cryogenic low noise HEMT-amplifier at different temperatures of the load using a standard spectrum analyzer we determine the amplification and the noise temperature of the amplifier. The advantage of our method compared to the conventional noise diode switching technique is that in our approach the noise source is heated up continuously providing many data points and thus offering better resolution. In our ongoing measurements we are using this approach to measure the noise temperature and amplification of microstrip SQUID amplifiers operated at 4.2 K.

TT 35.29 Wed 14:00 P1A

Microwave Spectroscopy on Superconducting Flux Qubits — •Thomas Niemczyk[1], Lars Eggenstein[1,2], Frank Deppe[1,2], Elisabeth Hoffmann[1,2], Edwin Menzel[1], Matteo Mariantoni[1,2], Achim Marx[1], and Rudolf Gross[1,2] — [1]Walther-Meißner-Institut, Bayerische Akademie der Wissenschaften, Garching, Germany — [2]Physik-Department E23, Technische Universität München, Garching, Germany

There is promising progress in the realization of solid-state based quantum information processing (QIP) systems. Up to now, there is a number of different realizations of qubits, the building blocks for future quantum computers. Among these, superconducting (SC) qubits are very promising candidates. Furthermore, coupling SC qubits to high quality factor SC cavities opens the fascinating field of circuit quantum electrodynamics (cQED) where matter-light interaction can be studied on a fundamental level. We have fabricated SC flux-qubits which consist of an Al loop interrupted by 3 nm-sized $Al/AlO_x/Al$ Josephson junctions. For readout, the qubit is inductively coupled to a dc-SQUID which detects the small flux signal ($10^{-3}\Phi_0$) induced by the circulating currents in the qubit loop. The energy gap Δ between the ground state and the first excited state of the flux-qubits has been determined by μ-wave spectroscopy at 30 mK. We reproducibly could fabricate flux qubits with Δ values ranging between 3 and 5 GHz.
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TT 35.30 Wed 14:00 P1A

The dissipative quantum Duffing oscillator — •Carmen Frammelsberger and Milena Grifoni — Institute for Theoretical Physics, University of Regensburg

The knowledge about relaxation and dephasing properties of solid state qubits is essential for quantum computation. In this contribution we consider a qubit interacting with an intermediate driven quantum Duffing oscillator which is itself coupled to an Ohmic bath. This resembles the case of a flux qubit read out by a DC-SQUID acting as a nonlinear oscillator. We consider the oscillator to be part of the environment seen by the qubit. We generalize the concept of an effective spectral density introduced by [1] to the case, that the intermediate oscillator is nonlinear. This is done by mapping the whole system onto a spin-boson problem with an effective spectral density using linear response theory. Within this approach we relate the effective spectral density with the imaginary part of the susceptibility of the quantum Duffing oscillator.

We derive the nonlinear effective spectral density in the rotating wave approximation (RWA) and observe both Ohmic low frequency behaviour and for high damping the response of a linear oscillator with shifted eigenfrequency. Within the RWA the possible parameters are restricted to finite nonlinearity and weak driving amplitudes. We elaborate a time-dependent perturbation theory to consider both the exact Floquet states of the linear oscillator as well as the result for the undriven quantum Duffing oscillator.

[1] A. Garg et al., J. Chem. Phys. 83, 9 (1985).

TT 35.31 Wed 14:00 P1A

Josephson Phase Qubits with Submicron Nb Junctions — Ralf Dolata[1], •Jürgen Lisenfeld[2], Brigitte Mackrodt[1], Alexander Lukashenko[2], Alexander Zorin[1], and Alexey Ustinov[2] — [1]Physikalisch-Technische Bundesanstalt, Braunschweig, Germany — [2]Physikalisches Institut, Universität Karlsruhe (TH), Karlsruhe, Germany

The microscopic properties of materials including insulating dielectrics and tunnel barriers play a significant role in engineering of Josephson qubits. The use of ultra-small Josephson tunnel junctions should reduce the probability that the macroscopic variable (Josephson phase) couples to parasitic microscopic quantum systems located inside the junction barrier of smaller volume and, therefore, improve the coherence of the qubit. We have fabricated phase qubits applying multilayer Nb technology with lateral dimensions of the junctions of 0.5 μm by 0.5 μm and external on-chip capacitors with either SiO_2 or Si_3N_4 dielectric material. Preliminary measurements of the Rabi oscillations show for the latter samples an increase of the qubit coherence by about a factor of two, whereas generally short coherence times of order 10 ns indicate further decoherence sources being active.

TT 35.32 Wed 14:00 P1A

Engineering Quantum States of Light in Coplanar Cavities — •Michael Wulf, Ralf Dolata, and Alexander B. Zorin — Physikalisch Technische Bundesanstalt

Recently it has become possible to detect single photons in the microwave-regime using tools developed by the Quantum Information community. We propose here an experiment to directly study the coherence times of confined photons. For this purpose we use Single-Cooper-Pair boxes as photon detectors for two coupled superconducting coplanar cavities, and show how a photon-coherence time much longer than the rather limited coherence-times of charge boxes operating in the qubit regime can be observed.

TT 35.33 Wed 14:00 P1A

Full Counting Statistics of Interacting Quantum Dots with Ferromagnetic Leads — •Stephan Lindebaum, Daniel Urban, and Jürgen König — Theoretische Physik, Universität Duisburg-Essen, 47048 Duisburg, Germany

We investigate the full counting statistics of electronic transport through a single-level quantum dot weakly coupled to two leads. In the systems under consideration either one or both leads are ferromagnetic. For both situations we study the influence of the two spin channels on the transport properties to identify several underlying transport processes.

Starting from a generalized master equation we use a diagrammatic real-time theory to calculate the cumulant generating functions to first order in the tunnel coupling strength [1]. In the case of two ferromagnetic leads and strong Coulomb interaction an exchange field between dot and leads exists, which leads to a precession of the accumulated dot spin [2].

The interaction of dot electrons crucially affects the cumulants. If both leads are ferromagnetic the cumulants show a non-trivial dependence on the angle between the magnetization directions of the leads. They become strongly super Poissonian and may even diverge for high polarizations. Furthermore, they exhibit sign changes in dependence of the polarization angle. With only a single ferromagnetic lead it turns out that the majority electrons govern the statistics of the system.

[1] A. Braggio *et al.*, Phys Rev. Lett. **96**, 026805 (2006).
[2] M. Braun *et al.*, Phys. Rev. B **70**, 195345 (2004).