TT 22: Transport: Poster Session

Time: Wednesday 14:00–18:00 Location: Poster B

TT 22.1 Wed 14:00 Poster B

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. This is not only because of the potential application to quantum-computing but also due to the advent of new experiments specifically looking into 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. To this end we numerically solve a quantum master equation (QME) for the many-body density matrix describing the state of the quantum dot system. This allows us to access the time-resolved occupation and the currents flowing through the system. As a first application we show for the non-interacting resonant level model a comparison of our results with non-equilibrium Green function calculations [1]. Furthermore, we revisit a recent experiment [2] with double quantum dots and analyse it by means of the QME. For this purpose we focus on the number of pulse-induced tunneling electrons as a function of pulse length. In addition to numerical results we propose a simple analytical model which allows for the interpretation of the characteristic features observed.

[1] N. S. Wingreen et al., Phys. Rev. **B48**, 8487 (1993)
[2] T. Hayashi et al., Phys. Rev. Lett. **91**, 226804 (2003)

TT 22.2 Wed 14:00 Poster B

Transport through an interacting quantum dot tunnel coupled to a ferromagnet with time-dependent magnetisation — •Nina Winkler, Michele Governale, and Jürgen König — Institut für Theoretische Physik III · Ruhr-Universität Bochum

We study spin and charge transport through a system composed of a quantum dot with Coulomb interaction, weakly tunnel coupled to a normal and a ferromagnetic lead with time-dependent magnetisation. We also allow the level position of the dot and the tunnel coupling to the normal lead to vary in time. In general, this setup works as a quantum pump and we focus on the adiabatic-pumping regime. To calculate the pumped charge and spin we extend a diagrammatic real-time approach to pumping through interacting quantum dots [1] to include ferromagnetic leads with time-dependent magnetisations.

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

TT 22.3 Wed 14:00 Poster B

Influence of spin waves on 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 tunnel coupled to ferromagnetic leads with non-collinear magnetizations. By applying a bias voltage, a spin on the dot is created, reducing the conductance. Furthermore, there is an exchange field due to the Coloumb interaction. In the case of linear transport this leads to a decrease of the spin valve effect, while in the case of nonlinear transport it gives rise to a negative differential conductance.

In Ref. [1] a real-time diagrammatic technique was developed to describe transport through quantum dot spin valves. We generalize this theory to include the excitation of spin waves in the leads. Thereby we distinguish the regimes of the spin wave energy being comparable or being much larger than the tunnel coupling. By solving a generalized master equation for the system's reduced density matrix, we derive the transport properties of the system in the different regimes in linear and non-linear response.

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

TT 22.4 Wed 14:00 Poster B

Non-equilibrium proximity effect in quantum dots — •Michele Governale[1], Marco G. Pala[2], and Jürgen König[1] — [1]Institut für Theoretische Physik III, Ruhr-Universität Bochum, D-44780 Bochum, Germany — [2]IMEP-LAHC-MINATEC (UMR CNRS/INPG/UJF 5130), BP 257, F-38016 Grenoble, France

We present a real-time diagrammatic theory for transport through interacting quantum dots tunnel coupled to normal and superconducting leads [1]. We apply it to a system made up of a single-level quantum dot with Coulomb interaction, coupled to one normal and two superconducting leads. A finite bias voltage can be applied to the normal lead to drive the dot out of equilibrium. We compute both the Andreev current in the normal lead and the Josephson current between the two superconductors. In the large-superconducting-gap limit, we are able to calculate the non-equilibrium Andreev and Josephson currents to all orders in the tunnel coupling with the superconducting leads. In particular, we show that a spectroscopy of the Andreev bound states in the dot can be performed by measuring the current in the normal lead as a function of the dot level position and of the bias voltage. Furthermore, we identify the regions of bias and gate voltage where the system behaves as a π-junction.

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

TT 22.5 Wed 14:00 Poster B

Super-Poissonian current noise in coupled single-electron transistors — •Björn Kubala[1,2], Göran Johansson[3], and Jürgen König[1] — [1]TP III, Ruhr-Universität Bochum, Germany — [2]Physics Department, ASC, and CeNS, Ludwig-Maximilians-Universität, 80333 Munich, Germany — [3]MC2, Chalmers University Göteborg, Sweden

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

A setup, where two SETs are capacitatively coupled, provides an inside into novel correlation effects, e.g., bunching of electrons as similarly 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] A. Cottet, W. Belzig, and C. Bruder, Phys. Rev. B **70**, 115315 (2004); S. S. Safonov *et al.*, Phys. Rev. Lett. **91**, 136801 (2003).

TT 22.6 Wed 14:00 Poster B

An iterative real-time path integral method for an Anderson dot with metallic leads — •Jens Eckel, Stephan Weiss, Michael Thorwart, and Reinhold Egger — Institut für Theoretische Physik IV, Heinrich-Heine-Universität Düsseldorf

We present a newly developed method based on an iterative non-equilibrium real-time path integral approach, which is numerically exact since no perturbative approximations are involved [1]. The convergence procedure [2] allowing to eliminate the discretization errors within the method (e.g., (i) a finite memory length of the lead correlator and the interaction self-energy, and (ii) a discretization error due to a Trotter breakup) is illustrated in detail and physically motivated to show the universal validity of the method. The method is applied to a single level Anderson dot attached to metallic leads, where we take into account a finite bias voltage as well as an external magnetic field. The full dI/dV characteristics is computed numerical exact without any perturbative limitation for various experimentally relevant parameters, e.g., the gate voltage and the temperature of the system.

[1] S. Weiss, J. Eckel, M. Thorwart, and R. Egger, submitted.
[2] J. Eckel, S. Weiss, and M. Thorwart, Eur. Phys. J. B **53**, 91-98 (2006).

TT 22.7 Wed 14:00 Poster B

Signatures of Aharonov-Bohm effect in the charge transfer statistics of the interacting quantum dot — •Stefan Maier[1]

and Andrei Komnik[1,2] — [1]Physikalisches Institut, Albert-Ludwigs-Universität Freiburg, Hermann-Herder-Str. 3, 79104 Freiburg, Germany — [2]Institut für Theoretische Physik, Universität Heidelberg, Philosophenweg 19, 69120 Heidelberg, Germany

We study the electron transport statistics of an Aharonov-Bohm interferometer with an embedded single level quantum dot under non-equilibrium conditions. Special emphasis is placed on the interplay of Aharonov-Bohm interferences and Coulomb on-site interaction. To this end we model the system by an Anderson impurity coupled to two metallic electrodes, between which a direct tunnelling is possible. By means of perturbative expansion in interaction amplitude we are able to identify the relevant effects in the generating function of the charge transfer statistics. We see a pronounced magnetic field dependence of the latter and investigate the evolution of the emerging Fano resonances as the electrode-dot as well as electrode-electrode couplings are changed.

TT 22.8 Wed 14:00 Poster B

State Dependent Full Counting Statistics and Statistics of State Changes in a Quantum Dot — •Ansgar Pernice and Walter T. Strunz — Physikalisches Institut der Universität Freiburg, Herrmann-Herder-Str. 3, 79104 Freiburg, Germany

We consider a quantum dot in the Coulomb blockade regime, coupled to source and drain. Making use of the quantum jump representation of the density operator, we derive a state dependent formula for the full counting statistics (FCS) of electrons entering the quantum dot. In the steady state our result reduces to the one obtained by Bagrets and Nazarov [1] as well as de Jong [2]. Furthermore, we investigate the "Full Statistics of State Changes" on the dot. Remarkably, for this novel quantity an analytical expression can be found in the time domain which turns out to be highly sensitive to the coupling symmetry of the quantum dot to the leads.

[1] D.A. Bagrets and Yu.V. Nazarov. Full Counting Statistics of Charge Transfer in Coulomb Blockade Systems. Phys. Rev. B, 67(8):085316, 2003.

[2] M.J.M. de Jong. Distribution of transmitted charge through a double-barrier junction. Phys. Rev. B, 54(11):8144-8149,1996.

TT 22.9 Wed 14:00 Poster B

Excited states in the conductance of a double dot — Georg Begemann, •Andrea Donarini, and Milena Grifoni — University of Regensburg, Germany

We study the linear transport through two coupled interacting quantum dots in series at temperatures smaller than the tunneling rate, though still larger than the Kondo temperature.

In this regime the sequential tunnelling picture breaks down and the conductance is not uniquely determined by ground states transitions. Coulomb blockade is partially lifted due to transitions to excited states and also the resonances acquire a dependance on the tunnelling coupling to the leads.

We adopt in our calculation the equation of motion technique and systematically compare different truncation schemes unified under a general formalism.

TT 22.10 Wed 14:00 Poster B

Effects of the intershell tunneling in the spectrum of incommensurate DWNTs — •Magdalena Marganska, Shidong Wang, and Milena Grifoni — Institut of Theoretical Physics, University of Regensburg, 93047 Regensburg

In calculations involving multi-wall nanotubes and taking into account the inter-wall coupling, some form of that coupling must be adopted. We study the effects which the choice of a particular expression for the inter-shell electron tunneling has on the calculated electronic spectrum of an incommensurate double-wall carbon nanotube (DWNT). We examine the level statistics and the fractal dimensions of the spectra obtained using different forms of the coupling. The former quantity can determine whether the system is chaotic or regular, the latter may be an indicator of the nature of the transport in the system. We find that the more localized is the tunneling, the more pronounced are the fractal features of the spectrum and the chaotic nature of the system. Therefore when investigating e.g. the transport characteristics in incommensurate DWNTs, different results may be obtained depending on the choice of the inter-shell tunneling.

TT 22.11 Wed 14:00 Poster B

Dynamics of a qubit in a linear/nonlinear structured environment — •Carmen Frammelsberger, Johannes Hausinger, and Milena Grifoni — Institute for Theoretical Physics, University of Regensburg

The understanding of the main dephasing and relaxation mechanisms is crucial for the realization of efficient solid state qubits. In this contribution we focus on the case in which the qubit is coupled to a driven linear or non-linear oscillator which in turn interacts with a dissipative environment. This situation mimicks the case of flux qubits read-out by a DC-SQUID, the latter being a linear or non-linear oscillator, or a Cooper-pair box in a resonant electromagnetic cavity.

In our work we adopt the point of view that the oscillator is part of the environment itself. In the linear oscillator case, this amounts to consider a spin-boson problem with a structured spectral density. Generalizing [1] to the case of a finite bias, we show that analytic solutions for the dynamics can be obtained, at arbitrary detuning and finite temperatures, in the case of large Q-factors of the oscillator. One, two or more dominating oscillation frequencies of the qubit can be observed as a consequence of the entanglement with the oscillator. In the nonlinear case we show, using a mapping procedure which is exact in the linear case, that the problem can be approximated to a spin-boson model whose spectral density is proportional to the imaginary part of the nonlinear susceptibility of a quantum Duffing oscillator.

[1] F Nesi, M Grifoni and E Paladino, New J. Phys. 9, 316 (2007).

TT 22.12 Wed 14:00 Poster B

Spin-dependent tunneling current in magnetic tunnel junctions — •Niko Sandschneider and Wolfgang Nolting — Humboldt-Universität zu Berlin, Institut für Physik, Newtonstr. 15, 12489 Berlin, Germany

The tunneling current through a hybrid structure where a confined nonmagnetic insulator is sandwiched between two ferromagnetic metals is calculated within the non-equilibrium Keldysh formalism. The metals are assumed to be band ferromagnets, such as Co, and are described by the single-band Hubbard model. Special emphasis is made to explain the tunneling current features in terms of the quasiparticle density of states of the materials. Also the relationship between the current and the inter-layer exchange coupling is discussed.

Furthermore we show how a generalization of the model presented here can be used to model current-induced switching of magnetization in a self-consistent way.

TT 22.13 Wed 14:00 Poster B

Tunable transmission via quantum state evolution in oval quantum dots — •Daniel Buchholz[1], Panagiotis Drouvelis[3], and Peter Schmelcher[1,2] — [1]Theoretische Chemie, Universität Heidelberg, INF 229, 69120 Heidelberg, Deutschland — [2]Tyndall National Institute, Lee Maltings, Prospect Row, Cork, Ireland — [3]Physikalisches Institut, Universität Heidelberg, Philosophenweg 12, 69120 Heidelberg, Deutschland

We explore the quantum transmission through open oval shaped quantum dots. The transmission spectra show periodic resonances and, depending on the geometry parameter, a strong suppression of the transmission for low energies. Applying a weak perpendicular magnetic field changes this situation drastically and introduces a large conductance. We identify the underlying mechanisms being partially due to the specific shape of the oval that causes a systematic decoupling of a substantial number of states from the leads. Importantly a pairwise destructive interference of the transmitting states is encountered thereby leading to the complete conductance suppression. Coupling properties and interferences can be tuned via a weak magnetic field. These properties are robust with respect to the presence of disorder in the quantum dot.

TT 22.14 Wed 14:00 Poster B

Theoretical and experimental investigations of Coulomb blockade in coupled quantum dot systems — •Franz J. Kaiser[1], Sigmund Kohler[1], Peter Hänggi[1], Marcin Malecha[1], Jens Ebbecke[1,2], and Achim Wixforth[1] — [1]Institut für Physik, Universität Augsburg, D-86135 Augsburg — [2]School of Engineering and Physical Sciences, Heriot-Watt University, Edinburgh, EH14 4AS, UK

We investigate the electron transport through coupled quantum dots in a ratchet like geometry. Our experimental observations of the 'Coulomb diamonds' at low temperatures are supported by a theoretical description, where we compare the results from scattering theory with those of a master equation approach for strong interaction [1].

Moreover, we characterize in each case the shot noise by the Fano factor and identify our experimental findings of sub structures in the Coulomb diamonds as being related to the orbital degrees of freedom. We find very good agreement for the strongly interacting case.
[1] F.J. Kaiser, M. Strass, S. Kohler, and P. Hänggi, Chem. Phys. **322**, 193 (2006)

TT 22.15 Wed 14:00 Poster B

Effective capacitance of charge qubits undergoing Landau-Zener transitions — •Georg Reuther, Peter Hänggi, and Sigmund Kohler — Institut für Physik, Universität Augsburg, 86135 Augsburg

A Cooper pair box in the charging regime has been used for the implementation of solid-state qubits in various experiments. The state of such a qubit can be probed by a weak rf signal. At the charge degeneracy point, the phase of the reflected signal depends sensitively on the effective capacitance of the qubit which, in turn, depends on the energy of the qubit state. For an ac-driven qubit undergoing multiple Landau-Zener transitions, the tunnelling dynamics has been monitored in this way [1]. Relating the measured data to the qubit state, however, was based on the assumption that the qubit relaxation is either very slow or very fast. We work beyond this limit and study the effective capacitance in the crossover regime of intermediate relaxation times. Our results allow for relating the measured phase shift to the actual state of the qubit and to estimate the measurement fidelity.
[1] M. Sillanpää et al, Phys. Rev. Lett. 96, 187002 (2006)

TT 22.16 Wed 14:00 Poster B

Landau-Zener tunneling in circuit QED at finite temperatures — •David Zueco, Sigmund Kohler, and Peter Hänggi — Institut für Physik, Universität Augsburg, Augsburg, Germany

A possibility to generate single photons in a transmission line coupled to a superconducting charge qubit relies on Landau-Zener transitions between different dressed states [1,2]. Photon losses in the transmission line influence the transition probability and, moreover, limit the photon lifetime.

We study these limitations by taking the coupling of the circuit QED to its electromagnetic environment into account. The environment is integrated out within Born-Markov approximation which yields a master equation for the reduced density operator of the qubit and the transmission line. Its numerical solution provides the final occupation of both the oscillator and the spin-flip probability, as well as the conditions on the loss rate and the temperature which still allow a reliable single-photon generation.

[1] K. Saito, M. Wubs, S. Kohler, P. Hänggi and Y. Kayanuma Europhys. Lett v 76 pp. 22-28 (2006)

[2] M. Wubs, S. Kohler and P. Hänggi Physica E 40, 187Ž013197 (2007)

TT 22.17 Wed 14:00 Poster B

Relaxation of Josephson qubits due to bistable fluctuators — •Clemens Müller[1], Alexander Shnirman[1], and Gerd Schön[2] — [1]Institute for Theoretical Physics, University of Innsbruck, 6020 Innsbruck, Austria — [2]Institut für Theoretische Festkörperphysik, Universität Karlsruhe, 76128 Karlsruhe, Germany

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 nonmonotomic 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 (TLF) in the case that the TLFs are coupled between each other. We show new features of T_1 due to the interaction between TLFs. Two methods were used for calculation, succesive use of Golden Rule and Bloch-Redfield equations for the density matrix. The validity of the widely used Golden Rule method was studied.
[1] G. Ithier et al., Phys. Rev. B **72**, 134519 (2005)
[2] O. Astafiev et al., Phys. Rev. Lett. **93**, 267007 (2004)

TT 22.18 Wed 14:00 Poster B

Fabrication of sub-μm Nb/Al-AlO$_x$/Nb Josephson Junctions with Electron Beam Lithography for Qubit Applications — •Christoph Kaiser, Konstantin Il'in, and Michael Siegel — Institut für Mikro- und Nanoelektronische Systeme, Universität Karlsruhe (TH), D-76187 Karlsruhe

We fabricated sub-μm Josephson Junctions in Nb/Al-AlO$_x$/Nb trilayer technology. The shape of the junctions was defined by electron beam lithography and reactive ion etching. The junctions were electrically insulated by a layer of anodically oxidized Niobium as well as a SiO layer. The SiO film was deposited in a lift off process via thermal evaporation and its contact windows were also defined by electron beam lithography. Samples with different critical current densities were characterized at low temperatures in order to examine their suitability for qubit experiments.

TT 22.19 Wed 14:00 Poster B

Superconducting Quantum Circuits: Building Blocks for cQED experiments — •Thomas Niemczyk, Elisabeth Hoffman, Achim Marx, and Rudolf Gross — Walther-Meissner-Institut, Bayerische Akademie der Wissenschaftem, Garching

There have been numerous promising advancements in the field of quantum information processing (QIP) since its conception. Coupling *superconducting (SC) qubits* to high-Q SC resonators opens the fascinating field of circuit quantum electrodynamics (cQED). Recent experiments with SC *charge qubits* have demonstrated the fundamental interaction of these 'artificial atoms' with a single microwave photon. In our work we are concentrating on the development of SC *flux-qubits* and the required building blocks for cQED. We present designs and realizations of different SC coplanar waveguide resonators for cQED experiments with quality factors up to $2.3 \cdot 10^5$. Furthermore, we present measurements on high-transparency Al/AlO$_x$/Al Josephson-Junctions (JJ). The JJs were characterized at 500 mK and exhibit E_J/E_C ratios of 30 - 70 with critical current densities J_c larger than 1000 A/cm^2. Finally, we present measurements on different realizations of microstrip hybrid rings, which act as a beam splitter in the microwave regime. The hybrid rings were characterized at 4.2 K and 1.5 K and exhibit isolation (S_{31}) and coupling (S_{23}) spectra suitable for a quantum homodyne measurement scheme for the detection of single microwave photons.
Financial support by the DFG via SFB 631 and the Excellence Initiative via NIM is gratefully acknowledged.

TT 22.20 Wed 14:00 Poster B

Observation of coherent oscillations in a superconducting qubit with π-junction — •Jürgen Lisenfeld[1], Stefano Poletto[1], Alexey Feofanov[1], Anna N. Rossolenko[2], Vladimir A. Oboznov[2], Vitaly V. Bolginov[2], Alexander Lukashenko[1], Valery V. Ryazanov[2], and Alexey V. Ustinov[1] — [1]Physikalisches Institut III, Universität Erlangen-Nürnberg, D-91058 Erlangen, Germany — [2]Institute of Solid State Physics, Russian Academy of Sciences, Chernogolovka, 142432 Russia

Flux qubits consist of superconducting loops interrupted by Josephson junctions. It has been theoretically proposed that embedding a π-junction into the loop allows to realize a 'quiet' qubit, which does not require applying any external magnetic field for biasing at the optimum operation point. When the phase drop across the π-junction with high critical current is set to π, a circulating current spontaneously emerges and stabilizes the qubit at the working point.
We incorporated a superconductor-ferromagnet-superconductor π-junction in the loop of a phase qubit made by conventional Nb technology. We observed Rabi oscillations and measured the qubit decay from the excited state. We found no difference between the decoherence times of otherwise identical qubits with and without π-junctions. The short decay of the order of several nanoseconds is limited in both cases by the decoherence sources in the on-chip dielectrics rather than by dissipation induced by the ferromagnetic π-junction phase shifter. This promising first result supports the feasibility of designing self-biased 'quiet' flux qubits.

TT 22.21 Wed 14:00 Poster B

Dispersive Readout of Josephson Phase Qubits — •Tobias Wirth[1], Jürgen Lisenfeld[1], Alexander Lukashenko[1], Alexander Zhuravel[2], and Alexey V. Ustinov[1] — [1]Physikalisches Institut III, Universität Erlangen-Nürnberg, Erlangen, Germany — [2]B. Verkin Institute for Low Temperature Physics & Engineering, National Academy of Sciences of Ukraine, Kharkov, Ukraine

Solid-state quantum bits based on current-biased Josephson junctions require appropriate isolation from the bias leads which can be achieved by using superconducting transformers. A superconducting loop with a tunnel junction allows to prepare an asymmetric double-well potential, where the discrete quantum levels in the shallow well form the qubit states. State-dependent tunneling to the deeper well changes

the magnetic flux in the qubit, which is measured by a dc-SQUID. In our ongoing experiments, we use a high-frequency readout based on a non-dissipative measurement of the dc-SQUID Josephson inductance, which in turn depends on the qubit flux. The measurement is done by detecting either the resonance shift of the LC-circuit, which consists of the dc-SQUID with a shunt capacitor, or the phase change of the reflected probe signal. We observed the periodic dependence of the reflected microwave amplitude and phase on externally applied magnetic flux. By using a low temperature scanning laser microscope, we map the microwave current distribution in our circuit. Current experiments are focused on a pulsed rf-readout and the use of an IQ-mixer to detect the phase change of the reflected signal.

TT 22.22 Wed 14:00 Poster B

Experiments with two-cell flux qubits — •Alexey K. Feofanov and Alexey V. Ustinov — Physikalisches Institut III, Universität Erlangen-Nürnberg, Erlangen, Germany

A two-cell flux qubit with four Josephson junctions has an advantage over conventional single-cell three-junction flux qubits that it features orthogonal controls of both the potential barrier height and its symmetry.This aspect facilitates reliable initialization of the qubit and offers additional fast gate control. Changing the potential barrier height allows for moving the qubit operation point away from parasitic resonances and makes it possible to realize tuneable coupling to common bus. Our two-cell qubits feature asymmetric dc-SQUID readout and on-chip flux controls. To bias the qubit at the optimal working point we use a passive pi-shifter in the superconducting bar separating two cells. The readout is performed by standard pulse sequence consisting of short switching and long latching pulses. Experimental results on testing these devices will be reported.

TT 22.23 Wed 14:00 Poster B

Modeling of quasiparticle transitions in Josephson charge-phase qubits — •Jens Könemann, Hermann Zangerle, Brigitte Mackrodt, Ralf Dolata, and Alexander B. Zorin — Physikalisch-Technische Bundesanstalt, Bundesallee 100, 38116 Braunschweig, Germany

Superconducting circuits, based on the tunneling of single Cooper pairs, enable remarkable charge-phase qubits. The qubit operation relies on the coherent superposition of the macroscopic quantum states, but the unwanted tunneling of unpaired electrons (quasiparticles) changes instantly the charge state and thus, the working point of the qubit.

Recently we have investigated quasiparticle transitions in an Al charge-phase qubit [1] inducing a dynamic change of the qubit states. Non-equilibrium quasiparticles tunnel stochastically on and off the island and may excite the qubit. The relaxation of the qubit by releasing a single quasiparticle to the leads becomes the dominating relaxation mechanism. In this work, we present a numerical modeling of these transitions. Moreover, we discuss the effect of microwave irradiation on the quasiparticle-induced transitions.

[1] J. Könemann *et al.*, Phys. Rev. B **76**, 134507 (2007).

TT 22.24 Wed 14:00 Poster B

Finite-temperature Bell test for quasiparticle entanglement in the Fermi sea — •Wolf-Rüdiger Hannes[1], Mikhail Titov[1,2], and Wolfgang Belzig[1] — [1]Universität Konstanz, Fachbereich Physik, D-78457 Konstanz — [2]School of Engineering & Physical Sciences, Heriot-Watt University, Edinburgh EH14 4AS, UK

Theoretical predictions of the presence of quantum entanglement in solid-state devices commonly make use of Bell-type inequalities formulated in terms of currents and current-current cross correlators. We demonstrate [1] that no such Bell-test can be performed at finite temperatures in the vast majority of setups proposed previously for entanglement generation. This fundamental difficulty originates in a finite probability of quasiparticle emission from Fermi sea detectors. The feedback problem can be overcome by a resonant coupling of the detectors and an additional detector cooling. Application of this simple improvement to a generic beam splitter setup constitutes a device that can be used to determine the critical temperature for the entanglement produced in the absence of fermionic interactions.

In the future we will try to access the temperature dependent entanglement generation of an electronic beam splitter by investigating its full counting statistics.

[1] W.-R. Hannes and M. Titov, Preprint arXiv:0710.0348v1

TT 22.25 Wed 14:00 Poster B

Numerical analysis of shaped coherent pulses — •Peter Karbach, Stefano Pasini, Götz S. Uhrig, and Joachim Stolze — TU Dortmund - Theoretische Physik I

Recently we presented analytical results on the optimization of coherent pulse shapes based on the Magnus-expansion (arXiv:0709.0588, submitted to PRA). The expansion parameter is the pulse duration τ_p. The coefficients for the linear and the quadratic order have been obtained. Depending on the pulse shapes certain coefficients vanish and the resulting pulses are better suited than the plain pulses (i.e. with constant amplitude) for the coherent control of small quantum systems in general and for single quantum bits in particular.

These analytical results are tested numerically for the proposed piecewise-constant pulses in different coupling geometries. It is confirmed that the analytical calculations are valid for a large parameter range (coupling constants, number of spins in the bath).

The numerical results are presented and the limitations of the analytical findings are discussed.

TT 22.26 Wed 14:00 Poster B

Non-equilibrium states in graphene rings driven by ultrashort light pulses — •Andrey Moskalenko and Jamal Berakdar — Institut für Physik, Martin-Luther-Universität Halle-Wittenberg, Germany

Graphene became a hot topic since the demonstration of its fabrication because of the quasi-relativistic properties of its band structure. Mesoscopic effects are of a particular interest as they exhibit features unusual for metallic or semiconductor mesoscopic structures. Recently, mesoscopic graphene rings were fabricated. The properties of the Aharonov-Bohm effect were investigated theoretically and experimentally. We investigate non-equilibrium mesoscopic effects in graphene rings excited by picosecond asymmetric electromagnetic pulses. Ultrafast generation of charge-polarized and current-carrying states is demonstrated and illustrated for the experimentally relevant parameters of the graphene ring.

TT 22.27 Wed 14:00 Poster B

Conductance through a strongly interacting region – LDA versus exact results — •Stefan Schenk, Michael Dzierzawa, Ulrich Eckern, and Peter Schwab — Universität Augsburg

Density functional theory within the local density approximation is the method of choice for calculations of the electronic structure of complex materials. In recent years the method has been adapted to transport problems, in particular to transport through systems of molecular size.

Here we study a one-dimensional model of spinless fermions. This has the advantage that the density matrix renormalization group provides numerically exact results for the conductance. We find that although for weak electron-electron interaction the local density approximation gives reasonable estimates for the location of conductance resonances, the method strongly overestimates the conductance in the non-resonant case. The discrepancies arise from the insufficient accuracy of the ground state density obtained within the local density approximation. Dynamic effects that can be captured within the time-dependent density functional theory are only of minor importance.

TT 22.28 Wed 14:00 Poster B

Resistance measurements on Bismuth nanowire arrays at low temperatures — •Thomas Kaupp[1], Christoph Kaiser[2], Georg Weiss[1], Thomas Cornelius[3], and Reinhard Neumann[3] — [1]Physikalisches Institut, Universität Karlsruhe, 76128 Karlsruhe, Germany — [2]Institut für Mikro- und Nanoelektronische Systeme, Universität Karlsruhe, 76187 Karlsruhe, Germany — [3]Gesellschaft für Schwerionenforschung, 64291 Darmstadt, Germany

Our sample fabrication started with creating nanoporous templates by exposing polymeric foils to heavy ion radiation. Into these templates, single- and poly-crystalline bismuth nanowires were electrochemically deposited. Resistance and magnetoresistance of arrays of these nanowires were studied at temperatures down to 50 mK. Additionally, aged samples of single-crystalline nanowires could be studied.

We observed a reduction of the resistance below 0.5 K of about 3 to 20 percent depending on the type of sample. The magnetoresistance of single-crystalline samples in this temperature range showed a linear behaviour up to 50 mT and then follows a power law with an exponent of 3/2 as previously reported. A linear magnetoresistance was observed for the poly-crystalline sample. The size of the linear increase up to 50 mT corresponds to the temperature dependent resistance reduction below 0.5 K.

Presently the interpretation of our observations is unclear. We discuss both the role of localization effects as well as the possibility that parts of the nanowires become superconducting.

TT 22.29 Wed 14:00 Poster B

Switching Dy break junctions by a magnetic field — •Marc Müller[1], Richard Montbrun[1], Christoph Sürgers[1,2], and Hilbert v. Löhneysen[1,2,3] — [1]Physikalisches Institut, Universität Karlsruhe, D-76128 Karlsruhe — [2]Center for Functional Nanostructures, Universität Karlsruhe, D-76128 Karlsruhe — [3]Forschungszentrum Karlsruhe, Institut für Festkörperphysik, D-76021 Karlsruhe

In search for conductance steps in rare-earth-metal atomic contacts, we study the low-temperature electronic transport properties of mechanically controlled Dy break junctions. The junctions are prepared from Dy wires cut from a dentritic polycrystal which are broken in-situ by means of a three-point bending mechanism. Magnetic fields are applied along the wire axis. In a mechanically pre-adjusted and fixed position of the two electrodes, the contact can be reproducibly opened and closed by variation of the applied magnetic field. The switching, i.e. the change in resistance vs. contact distance, shows a hysteretic behavior and presumably arises from the large magnetostriction of ferromagnetic Dy. Preliminary measurements show steps in the conductance-distance characteristics which are, however, much larger than one conductance quantum $G_0 = 2e^2/h$.

TT 22.30 Wed 14:00 Poster B

Point contact spectroscopy of quench-condensed Ag films — •Torben Peichl, Marcel Spurny, Michael Burst, and Georg Weiss — Physikalisches Institut, Universität Karlsruhe, 76128 Karlsruhe, Germany

We report on the progress in fabricating nanostructured point contacts as a result of our structural characterization studies. The point contacts are defined by electron beam lithography on top of silicon nitride membranes. Then the bottom side is covered with a layer of Au before a SF_6 plasma etching from the top side is used to obtain nano-sized holes in the membrane. Finally, a highly disordered Ag layer is prepared by quench-condensing Ag films at low temperatures <10 K on the top side. This results in metallic point contacts with diameters <50 nm and resistances between 1 and 10 Ω.

Electronic transport properties of these point contacts were studied at temperatures from 1.5 to 8 K by measuring the differential resistance using lock-in methods. Within sample series we find reproducible results, in particular a distinct minimum of the differential resistance which we identify as a zero-bias minimum shifted by a DC offset of yet unknown origin. This minimum becomes narrower at increasing temperatures and vanishes at 8 K. Similarly, the minimum diminishes continuously with magnetic field until it vanishes completely at about 2 T. Low energy excitations as well as coulomb blockade effects might be responsible for the observed behavior. Additionally, slight oscillations of the differential resistance curves are reminiscent of weak localisation effects.

TT 22.31 Wed 14:00 Poster B

Charge transport properties of biphenyl molecules and tetrathiafulvalene — •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, Universität Karlsruhe, 76128 Karlsruhe, Germany — [2]Forschungszentrum Karlsruhe, Institut für Nanotechnologie, 76021 Karlsruhe, Germany — [3]Departamento de Física Teórica de la Materia Condensada, Universidad Autónoma de Madrid, 28049 Madrid, Spain

We study theoretically the charge transport properties of single molecule junctions. For this, we use a combination of density functional theory and Green's-function techniques [1]. In our analysis, we consider different types of molecules, namely biphenyl molecules and tetrathiafulvalene. For the biphenyl molecules, the tilt angle of the phenyl rings is changed continuously by means of alkyl chains of varied lengths. We investigate the dependence of both the tilt angle and the conductance on this chain length. In addition, we examine the conductance of tetrathiafulvalene.

[1] F. Pauly, Ph.D. Thesis, Universität Karlsruhe (2007).

TT 22.32 Wed 14:00 Poster B

In-situ fabrication of nanobridges under ultra-high vacuum conditions — •Dominik Stöffler[1], Hilbert v. Löhneysen[1,2], and Regina Hoffmann[1] — [1]Physikalisches Institut and DFG Center for Functional Nanostructures (CFN), Universität Karlsruhe, D-76128 Karlsruhe, Germany — [2]Forschungszentrum Karlsruhe, Institut für Festkörperphysik, D-76021 Karlsruhe, Germany

Contacting single molecules with nanostructured metallic leads remain a challenge, in spite of numerous attempts. We investigate nanocontact formation by thermally assisted electromigration of gold nanowires. The nanowires are prepared by electron beam lithography. An automatic feed-back allows to follow a line of constant dissipated power at the nanocontact, which leads to a gradual thinning of the wire until a small gap is formed. The fabricated gaps are smaller than 10 to 20 nm. By following the line of constant power, we estimate an increase of the temperature of the contact from 350 K in the thermal regime at the beginning, to 650 K in the ballistic regime at the end of the overall electromigration process. Due to the lithography process, leftovers such as PMMA remain on the metallic contacts, which eventually affect transport measurements with molecules. We introduce a promising alternative method to fabricate and contact clean metallic nanostructures, using evaporation through a mask under ultra-high vacuum. These structures can eventually be separated by electromigration to accommodate single molecules.

TT 22.33 Wed 14:00 Poster B

Conductance measurements on palladium breakjunctions with superconducting leads — •Stefan Egle, Cécile Bacca, Christian Schirm, and Elke Scheer — Department of Physics, University of Konstanz

We will present our recent results of palladium nanobridges connected by superconducting leads of aluminium. The structures are fabricated by using electron beam lithography and two-step shadow evaporation. By means of the mechanically controllable break junction (MCBJ) technique we are able to open the bridges to a one-atom contact and close again repeatedly at low temperatures, thus obtaining conductance histograms. Studying the properties of these palladium atomic point contacts at 270mK, we show the influence of the superconducting leads onto the electronic properties of palladium (proximity effect) by measuring the differential resistance. As expected, we observe a decrease of the dV/dI for voltages $|V| \leq 120\mu\text{V} < \Delta_{Al} = 180\mu\text{V}$ which increases again when either the external magnetic field or the temperature is raised. Investigating the disappearence of this effect, we determine the critical values B_c and T_c.

TT 22.34 Wed 14:00 Poster B

Reversible Switching Effect in Atomic-Size Contacts — •Christian Schirm, Hans-Fridtjof Pernau, and Elke Scheer — University of Konstanz, Department of Physics, 78457 Konstanz, Germany

We investigate electromigration effects in atomic-size contacts of aluminum fabricated with the mechanically controllable break junction technique at $T \leq 1.5$K. We observe current-driven conductance changes ΔG and analyze their influence on the conductance histogram. In particular situations a reversible switching between two conductance values is observed (> 100 repetitions) which attribute to the formation of preferred atomic configurations. A correlation between these configurations and conductance channels shall be established via the analysis of MAR in the superconducting state [1].

[1] E. Scheer et al., Phys. Rev. Lett. **78** (1997) 3535-3538

TT 22.35 Wed 14:00 Poster B

Breakjunctions on Membranes — •Reimar Waitz, Olivier Schecker, and Elke Scheer — Universität Konstanz, Germany

A so-called "mechanically controlled breakjunction" is made of a metallic wire with a suspended constriction. This constriction can be elongated until having - just before breaking - a diameter of one atom. In this project we developed a new kind of breakjunctions on silicon membranes. The wire is made by electron-beam lithography on top of a 600x600 micrometer crystalline silicon membrane with a thickness of a few hundred nanometers. In contrast to the "standard" breakjunction technique, we use the strain of the membrane to control the elongation of the wire. In our poster we present the process of sample fabrication and a mechanism for controlled breaking, which has successfully been used to measure the conductance of single atom contacts.

TT 22.36 Wed 14:00 Poster B

Bias-dependent electronic transport in nanowires — •Neng-

Ping Wang and Stefan Heinze — Institute of Applied Physics, University of Hamburg, Jungiusstrass 11, 20355 Hamburg, Germany

Transport of electrons in nanoscale structures is of interest from a fundamental as well as an application point of view. Often nanoscale systems display nonlinear current-voltage characteristics, which make them interesting for device applications. Here, we report first principles calculations of bias-dependent ballistic transport in nanowires using the non-equilibrium Greens function method. The system under consideration is divided into a central scattering region attached to semi-infinite left and right leads. First, we use density functional theory (DFT) to calculate the electronic structure of the system. The DFT eigenstates are then transformed into a set of maximally localized Wannier functions (WFs). Using the WFs as localized orbitals, we construct the Hamiltonian of scattering region and leads, which is used for transport calculation. The coupling of the scattering region to the semi-infinite leads is described by the self-energies of the leads which we obtain with the particularly efficient decimation technique. We solve for the Green function of the system and calculate the transmission and current at low bias voltages.

As a first application of our approach, we study the I-V characteristics of Cu wires with a stretched bond as a function of the bond length. In order to explain the transport characteristics, we analyze the potential drop and non-equilibrium charge distribution as a function of the applied bias voltage.

TT 22.37 Wed 14:00 Poster B

Synthesis of Opto-Electronic Compounds from Carbon Nanotubes and Photosystem I — •Markus Mangold[1], Simone Lingitz[1], Itai Carmeli[2], Ludmila Frolov[2], Chanoch Carmeli[2], Shachar Richter[2], and Alex Holleitner[1] — [1]Walter Schottky Institut, TU München, Deutschland — [2]Center for Nanoscience, Tel Aviv University, Israel

The photosystem I (PS I) reaction center is a chlorophyll protein complex located in the thylakoid membranes of chloroplasts and cyanobacteria. PS I mediates a light induced electron transfer through a serial of redox reactions and is central for the photosynthesis in plants and bacteria. Utilizing a unique cysteine (Cys) mutation at the end of PS I, we demonstrate a four-step chemical procedure based on carbodiimide chemistry for covalent binding of PS I proteins to carbon nanotubes (CNTs) [1]. This procedure resulted in linear, circular, and T- shaped CNT-PS I hybrids, which are ideally suited for the integration of the PS I into optoelectronic circuits. We present first measurements of an opto-current generated in the hybrid structures upon illumination with visible light.

We gratefully acknowledge financial support by CeNS and the Nanosystems Initiative Munich, the DFG grant HO-3324/1, and the DFG SFB 486 TP A1.

[1] I. Carmeli, M. Mangold, et al. Advanced Materials, in press (2007).

TT 22.38 Wed 14:00 Poster B

Quantum conductance from the irreducible polarization function — •Swantje Heers, Arno Schindlmayr, Daniel Wortmann, and Stefan Blügel — Institut für Festkörperforschung, Forschungszentrum Jülich, 52425 Jülich, Germany

The standard approach to quantum transport, which involves a combination of *ab initio* density-functional theory and the Landauer formula, successfully describes the conductance of nanojunctions at a qualitative level, but it remains unclear how the Coulomb interaction can best be incorporated into this single-particle picture of ballistic transport. An alternative approach proposed by P. Bokes *et al.* [Phys. Rev. B **69**, 245420 (2004); **76**, 125433 (2007)] that uses a relation between the polarization function and the conductance formally includes such noncoherent effects. In order to demonstrate its applicability in numerical calculations for a semi-infinite scattering setup with proper boundary conditions we investigate transport through model metal-vacuum-metal interfaces with a piecewise constant potential varying in one dimension only. Starting from the non-interactiong Green function we calculate the polarization function and then the conductance. The necessary extrapolation to zero frequency and the dependence on relevant convergence parameters are demonstrated. In the first instance we neglect the electron-electron interaction and find that the conductance in the single-particle picture coincides with the Landauer formula. This scheme is hence a promising avenue to take exchange and correlation effects into account in future transport calculations.

TT 22.39 Wed 14:00 Poster B

Quantum Transport Through Nanowires: Ab Initio Studies Using Plane Waves and Supercells — •Björn Oetzel, Martin Preuss, Frank Ortmann, Karsten Hannewald, and Friedhelm Bechstedt — European Theoretical Spectroscopy Facility and Institut für Festkörpertheorie und -optik, 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. As a first example for the usefulness of the method, we present DFT calculations of transmission functions for various one-dimensional Au nanowires. The results are discussed with respect to future extensions to metal-molecule-metal nanojunctions.

TT 22.40 Wed 14:00 Poster B

Non-Equilibrium Energy Gaps and Inelastic Transport in Carbon Nanotubes: Role of Phonon Symmetries — •Luis Foa Torres[1], Rémi Avriller[2], and Stephan Roche[2] — [1]Institute for Materials Science, Dresden University of Technology, D-01062 Dresden, Germany. — [2]DSM/DRFMC/SPSMS/GT, Commissariat à l'Energie Atomique, 17 rue des Martyrs, 38054 Grenoble, France.

We report on a theoretical study of inelastic basckscattering and transport in metallic carbon nanotubes. A Peierls-type mechanism due to electron-phonon interaction with longitudinal optic as well as K point modes [1] in armchair tubes is shown to induce non-equilibrium energy gaps, which in turn manifest as plateaus in the current-voltage characteristics as soon as optic modes are activated. The precise features of these plateaus depend on the specifics of the coupling with the environment through the thermalization rate of the phonons. These phenomena are unveiled by using a full quantum description of the joined processes of tunneling and phonon-assisted transport and can be seen as the removal of degeneracies in Fock space. Further generalizations to tubes of arbitrary helicity are also outlined [1] thereby giving a much broader reach to previously reported results [2].

[1] L. E. F. Foa Torres, R. Avriller and S. Roche, submitted.

[2] L. E. F. Foa Torres and S. Roche, Phys. Rev. Lett. 97 (2006) 076804.

TT 22.41 Wed 14:00 Poster B

Tunable transport by controlling the structure of an STM molecular junction — •Florian Pump[1], Michael Rohlfing[2], Bo Song[1], Ruslan Temirov[3], Adam Lassise[4], Olga Neucheva[3], Stefan Tautz[3], and Gianaurelio Cuniberti[1] — [1]Institute for Materials Science, Dresden University of Technology, D-01062 Dresden, Germany — [2]Department of Physics, University of Osnabrück, D-49069 Osnabrück, Germany — [3]Institute of Bio- and Nanosystems (IBN), Institute 3: Institute of Thin Films and Interfaces 3 (IBN3), Forschungszentrum Jülich GmbH, D-52425 Jülich, Germany — [4]Jacobs University Bremen, School of Engineering and Science, D-28725 Bremen, Germany

In molecular junctions, the coupling between the electric contacts and the actual molecule is of great importance. Scanning tunneling microscopy (STM) techniques allow, in addition to their imaging possibilities at a high resolution, the option to mechanically manipulate the bonding properties between molecules and metal surfaces and provide the feasibility to subsequently measure transport effects through the molecule. Based on recent experiments studying the lifting of a single PTCDA molecule from an Ag surface, we present the results of our Density Functional Theory based calculations. We discuss the variation of the energies of the molecular levels and the device substrate coupling during the peeling process and describe its effects on the transport properties through the molecule.

TT 22.42 Wed 14:00 Poster B

Dynamical effects in the conductance properties of short DNA molecular wires: a combined study using molecular dynamics and model Hamiltonians — Benjamin Woiczikowski[1], •Rodrigo Caetano[2], Rafael Gutierrez[2], Tomas Kubar[1], Marcus Elstner[1], and Gianaurelio Cuniberti[2] — [1]Institute for Physical and Theoretical Chemistry, Braunschweig University of Technology, D-38106 Braunschweig, Germany — [2]Institute for Materials Science, Dresden University of Technology and Max Bergmann Centre of Biomaterials, D-01062 Dresden, Germany

The potential applications of DNA oligomers in molecular electronics makes of crucial importance to understand the microscopic mechanisms of charge migration. Experimental studies provide very striking results, which range from insulating to superconducting behavior. Theoretically, it is very important to take into account dynamical effects, since DNA is known to be a flexible molecule. In this work, we study charge transport through short Poly(G)-Poly(C) molecules within a minimal tight binding Hamiltonian model. The model parameters are extracted from snapshots along molecular dynamic trajectories and thus effectively include internal and external (soventmediated) dynamical effects. We perform a statistical analysis of the time-dependent onsite energies and electronic hopping integrals and show that they can be fitted to Gaussian functions. We use Green's function techniques in order to calculate the linear conductance and the current-voltage characteristics and demonstrate how the average quantities do depend on the charge tunneling time.

TT 22.43 Wed 14:00 Poster B

Numerical Renormalization Group Calculation of Electronic Transport in the Anderson Holstein Model — •Falk May[1], Maarten R.Wegewijs[2], and Walter Hofstetter[1] — [1]Institut für Theoretische Physik, J. W. Goethe-Universität, D-60438 Frankfurt, Germany — [2]Institut für Theoretische Physik, Lehrstuhl A, RWTH Aachen, D-52056 Aachen, Germany

Since their recent first realizations, molecular transistors attract more and more interest in nanoelectronics due to their rich transport properties. They consist of a molecule connecting two leads where a gate electrode can be used to tune the charge on the molecule. An important point in describing their transport behaviour is the understanding of electron-phonon interactions. We investigate these interactions using an Anderson Holstein Model [1,2] where a single impurity is linearily coupled to a harmonic osillator describing the vibrational degrees of freedom of the molecule. In our work we use the Numerical Renormalization Group [3] to calculate transport properties of the molecular transistor.

[1] P.W.Anderson, Phys. Rev. **124**, 41 (1961)
[2] T.Holstein, Ann. Phys. **8**, 325 (1995)
[3] K.Wilson, Rev. Mod. Phys. **47**, 773 (1975)

TT 22.44 Wed 14:00 Poster B

Time-resolved electron transport of surface state electrons on helium in confined geometry — •Marc Schmid and Paul Leiderer — Department of Physics, University of Konstanz, 78457 Konstanz, Germany

We report on an investigation of the transport of surface state electrons on liquid helium films in restricted geometry. For this purpose we use a source-gate-drain structure, similar to a field effect transistor, which is lithographically prepared on a silicon substrate. The electron densities on both source and drain are determined by an optical measurement of the underlying helium film, whose thickness depends on the surface charge density. For time-resolved measurements, a pulse of electrons from a small filament is first collected on the source area, and then the passage of this pulse through the channel of the split gate towards the drain is monitored. This allows to determine the electron transport of surface state electrons in channels of various dimensions and for a wide range of electron densities.

TT 22.45 Wed 14:00 Poster B

Influence of chopped laser light onto the electronic transport through atomic-sized contacts — •Kerstin M. C. Hans, Daniel C. Guhr, Dennis Rettinger, Johannes Boneberg, Artur Erbe, Paul Leiderer, and Elke Scheer — Universität Konstanz, Konstanz, Germany

In our experiment we investigate the influence of laser irradiation onto the electrical conductance G of Au nanocontacts established with the mechanically controllable breakjunction (MCB) technique [1]. We concentrate on the study of reversible G changes which can be as high as 50%. We compare results of samples fabricated on different substrate materials. On metal substrates, with high reflectivity in the visible light range and insulated from the MCB, we observe an enhancement of G under almost all conditions [2]. In contrast to this, on pure insulating and full light-absorbing substrates we additionally observe a decrease of G, depending on the position of the laser spot on the sample. Within one series of measurements we have also varied intensity, the polarisation and the wavelength. We discuss several physical mechanisms which might contribute to the observed effect including thermal expansion and photon-assisted transport (PAT) [3]. From the analysis of our data we conclude that PAT is the dominating effect in our experiment on metal substrates and thermal expansion on the insulating substrates. First results with Pt structures on insulated metal substrates will also be shown.

[1] J. M. van Ruitenbeek et al., Rev.Sci. Instrum. 67, 108 (1996)
[2] D. C. Guhr et al., PRL 99, 086801 (2007)
[3] J. K. Viljas and J. C. Cuevas, PRB 75, 075406 (2007)

TT 22.46 Wed 14:00 Poster B

Electronic Transport Measurements on Mass-Selected Silicon Clusters — •Jochen Grebing, Rainer Dietsche, Gerd Ganteför, and Elke Scheer — Dept. of Physics, University of Konstanz

We present electronic transport measurements on mass-selected silicon clusters, in particular Si_4 which are supposed to be magic [1].

These clusters are being created using a magnetron sputter source. After mass separation they are soft-landed onto adjustable metallic electrodes fabricated with a MCB technique [2]. Following the deposition a single or a few clusters may be contacted, and their transport properties are being investigated *in situ* by recording conductance histograms and current voltage curves.

The histograms show significant changes in their characteristics after deposition of ≈ 0.1ML of Si_4 clusters. To further investigate whether transport occured through single or few clusters IV-curves have been measured. Calculations predict nonlinearities for a bias $\gtrsim 0.25$V for Si_4 contacted with Au leads [3].

[1] M. Grass et al., Appl. Phys. Lett **81**, 3810 (2002)
[2] MCB: **M**echanically **C**ontrollable **B**reakjunction
[3] C. Roland et al., Phys. Rev. B **66**, 035332 (2002)

TT 22.47 Wed 14:00 Poster B

Effects of curvature on the electronic transport in graphene — •Sebastian Gattenlöhner[1], Mikhail Titov[2], and Wolfgang Belzig[1] — [1]Fachbereich Physik, Universität Konstanz — [2]School of EPS - Physics Department, Heriot-Watt University Edinburgh

As was recently shown experimentally [1], free-standing graphene is not entirely flat but is intrinsically curved. The low-energy electronic excitations in graphene can be described by a Dirac-like Hamiltonian, where the curvature manifests itself in form of additional vector and scalar potentials. We study the effect of these potentials on the electronic transport properties of graphene.

[1] J. C. Meyer et al., The structure of suspended graphene sheets, Nature **446** (2007) 60-63.

TT 22.48 Wed 14:00 Poster B

Electrical Characterization of Molecular Monolayers using Micro-Transfer Printing — •Christian Kreuter, Artur Erbe, Stefan Bächle, and Elke Scheer — Department of Physics, University of Konstanz, D-78457 Konstanz

The formation, characterization and understanding of metal-molecule contacts are necessary preconditions for the development of future molecular-electronic devices. Although in the past 20 years various techniques of contacting single molecules and layers of molecules have been developed, establishing a stable metal-molecule contact is still a challenge. Another serious problem is to separate artifacts which arise from to the used contacting technique from molecule-based properties.

Here we demonstrate a Micro-Transfer Printing (μTP) Technique to contact a molecular monolayer of thiol molecules on GaAs and other substrates. We also present measurements of the current-voltage(I-V) characteristics of a monolayer of dithiolated molecules as a function of temperature and light. At low temperatures, we find asymmetries in the IV-characteristics which can be ascribed to the specific influence of the molecules. Further on, it is shown that the current flow through the device can be strongly affected by light. The dependence of the conductance in relation to the area of contact (typically about 20-100 μm^2) is studied in order to understand the quality of the metal-molecule contact.

TT 22.49 Wed 14:00 Poster B

Conductance through Metal–Molecule Contacts in Solution — •Thomas Kirchner[1], Uta Eberlein[1], Simon Verleger[1], Thomas Huhn[2], Artur Erbe[1], and Elke Scheer[1] — [1]FB Physik, Universität Konstanz, Germany — [2]FB Chemie, Universität Konstanz, Germany

Lithographically defined Mechanically Controllable Break Junctions (MCBJ) are employed to establish metal-molecule contacts at room

temperature. Using a liquid cell containing a molecule solution, and a solvent re-filling system the molecules are kept in a tetrahydrofuran-based solvent throughout the measurement. We investigate oligo phenylene ethynylenes (OPE) with various end groups including pyridine. The conductance can be measured while slowly varying the distance between the electrodes, thus revealing preferred conductance values by statistical analysis. Furthermore, current-voltage characteristics are determined at a constant distance.

TT 22.50 Wed 14:00 Poster B

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

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 [1,2]. The tip electrodes of the MCB are fabricated of Al. The molecule is evaporated onto an opened break-junction under UHV conditions and at low temperatures (10 K). The experiment shows evidence for excitations of Al phonons in the differential conductance. By varying the electrode position we can shift the phonon energy. From the development of the energy we find evidence for longitudinal and transversal phonon modes. With C_{60} between the contacts we observe additional features in the d^2I/dV^2 which we tentatively attribute to vibronic modes of C_{60} previously observed for C_{60} with gold contacts [2]. Furthermore the dI/dV's of Al-C_{60}-Al contacts reveals a Kondo behaviour with a characteristic temperature of approximately 70 K.

[1] T. Böhler et al. Nanotechnology 15 (2004) 465
[2] T.Böhler et al. PRB 76 (2007) 125432

TT 22.51 Wed 14:00 Poster B

Influence of defects on universal conductance fluctuations in diffusive metallic nanowires — •Thomas Schluck[1], Michael Wolz[1], Vojko Kunej[1], Christian Debuschewitz[2], and Elke Scheer[1] — [1]Univ. of Konstanz, Dep. of Phys. — [2]attocube AG

One of the most common methods to study quantum interference effects in diffusive nanostructures is the recording of magneto-resistance curves which exhibit reproducible variations of the resistance due Universal Conductance Fluctuations (UCF). The UCF pattern depends on the configuration of scattering centers for electron wave functions. The question arises how the UCF pattern changes when small artificial defects are added to the scattering configuration and whether a partial correlation between the patterns persists. Therefore we investigate metallic nanowires in the diffusive regime and achieved reproducible UCF patterns at $T = 4.2$K and $T = 2.2$K for magnetic fields up to 5T. To add artificial defects to the metallic nanowires a homebuilt, low-temperature and non-magnetic STM is in use [1]. For positioning the STM-tip with respect to the sample, the STM is equipped with two slip-stick tables. The nanowire structures were fabricated by electron beam lithography, reactive ion etching, wet etching and shadow evaporation (Au, Au/Cu)[2]. With a focussed ion beam we add smooth search patterns to the sample layout as a guide to the nanowire in STM mode. UCF measurements and first successful manipulations of a nanowire are presented.

[1] C. Debuschewitz et al., J. Low Temp. Phys. **147** (2007), p.525
[2] T. Hoss et al., Europhys. Lett. **54** (2001), p.654

TT 22.52 Wed 14:00 Poster B

Fluctuation Correction to Andreev Transport — •Fabian Mohn[1], Wolfgang Belzig[1], and Yuli V. Nazarov[2] — [1]Fachbereich Physik, Universität Konstanz, D-78457 Konstanz — [2]Kavli Institute of Nanoscience, Delft University of Technology, The Netherlands

The quantum mechanical nature of electronic transport at low temperatures is reflected in fluctuations of physical properties due to wave interference in a disordered environment. The superconducting proximity effect describes the superconductivity in the normal parts of a heterostructure induced by the presence of a superconductor and is a consequence of the macroscopic phase coherence. Studying the interplay between this macroscopic interference and the microscopic interference underlying mesoscopic fluctuations is of fundamental interest.

Recently a method to treat quantum corrections to the circuit theory in normal metals was developed by Campagnano and Nazarov [1]. The circuit theory of mesoscopic transport provides an efficient and controlled way to include e.g. superconducting and spin-transport properties. We generalize the method to include superconducting terminals and use it to investigate the quantum corrections to the proximity density of states and the Andreev conductance.

[1] G. Campagnano and Yu. V. Nazarov, Phys. Rev. B **74**, 125307 (2006)

TT 22.53 Wed 14:00 Poster B

Observation of Coulomb blockade in diamond-like carbon films — •Savcho Tinchev[1], Evgenia Valcheva[2], and Sashka Alexandrova[3] — [1]Institute of Electronics, Bulgarian Academy of Sciences, Tzarigradsko Chaussee 72, 1784 Sofia, Bulgaria — [2]Physics Department, Sofia University, J. Bourchier 5, 1164 Sofia, Bulgaria — [3]Institute of Solid State Physics, Bulgarian Academy of Sciences, Tzarigradsko Chaussee 72, 1784 Sofia, Bulgaria

Coulomb blockade of tunneling is a phenomenon observed in low capacitance tunnel junctions usually at low temperatures. To fabricate single electron devices operating at room temperatures it is essential to obtain nano-sized quantum dots or nanostructures with sizes below 10 nm, because the charging energy can overcome the thermal energy only in such small structures. Dimensions below 10 nm are, however, below the resolution limit of the electron beam lithography. Therefore self-organization processes are promising candidates for preparing electron devices operating at room temperatures.

We report here on observation of Coulomb blockade in diamond-like carbon (DLC) films at room temperature. Diamond-like carbon films used in our experiments were amorphous hydrogenated carbon films (a-C:H) made by DC PECVD from a mixture of benzene and argon. Nonlinear current voltage characteristics with a threshold voltage of about 3 volts and in some cases also step-like structures, known as Coulomb staircase were observed in diamond like carbon films. We interpret this observation as a clear manifestation of Coulomb blockade found for the first time in these films.

TT 22.54 Wed 14:00 Poster B

Influence of dephasing to the intrinsic spin Hall effect — •Pei Wang — Institut für Physik, Universität Augsburg und LMU München

The intrinsic spin Hall effect has attracted much attention in recent years, because it can be used to generate spin-polarized currents in paramagnetic semiconductors electronically. In the spin Hall effect, a longitudinal electric field creates a transverse motion of spins with the spin-up and spin-down carriers moving in opposite directions, which leads to a transverse spin current perpendicular to the external electric field. I will introduce the intrinsic spin Hall effect in a 2DEG with Rashba spin-orbit coupling and in p-type semiconductors described by a Luttinger Hamiltonian. The spin Hall conductivity in the presence of nonmagnetic and magnetic impurities is calculated. The critical influence of dephasing (inelastic scattering) to the spin Hall effect is discussed.

TT 22.55 Wed 14:00 Poster B

Quantum transport in ferromagnetic Permalloy wires and films — •Daniel Neumaier, Anton Vogl, and Dieter Weiss — Institut für Experimentelle und Angewandte Physik, Universität Regensburg, Regensburg, Germany

We investigated the transport properties of mesoscopic Permalloy wires and films at milikelvin temperatures. The samples have been fabricated using electron beam lithography and lift-off techniques.

In wires with a width of 40 nm, a thickness of 15 nm and a length of 140 nm and 340 nm we found mesoscopic conductance fluctuations, originating from the electrons wave nature. These fluctuations reveal a phase coherence length of approx. 200 nm at 20 mK and decrease rapidly with increasing temperature.

To search for weak localization we fabricated arrays of wires to suppress conductance fluctuations. The arrays consist of 4 wires in parallel with a length of 4 micron, a width of 20 nm and a thickness of 15 nm. Below 1 K the conductance of the wire array is decreasing with decreasing temperature without an influence of an applied magnetic field. This behaviour can be explained by electron-electron-interaction, a contribution due to weak localization could not be found. In extended films with a thickness of 15 nm also a conductance decrease due to electron-electron interaction and no contribution due to weak localization was observed.

TT 22.56 Wed 14:00 Poster B

A spin ratchet effect in dissipative systems with spin-orbit coupling — •Sergey Smirnov[1], Dario Bercioux[1,2], Milena Grifoni[1], and Klaus Richter[1] — [1]Institut für Theoretische Physik, Universität Regensburg, D-93040 Regensburg, Germany — [2]Physikalische Institut, Albert-Ludwigs-Universität, D-79104 Freiburg, Germany

A possibility to generate fully polarized pure spin currents, a hot topic in modern spintronics, is studied. The idea is to create such spin currents using a spin ratchet effect if it exists. We investigate this question in an ac driven quasi-one-dimensional periodic structure with Rashba's spin-orbit interaction [1] and strong dissipative coupling to an external environment. It is analytically proven that when the quantum transport of electrons is restricted within the sub-bands below the barrier and originating from the same Bloch band, the charge transport is totally absent. In contrast we analytically show that the stationary spin current vanishes for symmetric periodic potentials while it can be finite for asymmetric ones. This confirms the existence of the spin ratchet effect in our system. Moreover, we rigorously show that for a harmonic confinement only one component of the spin current is non-zero, that is the spin current is fully polarized.

[1] S. Smirnov, D. Bercioux, and M. Grifoni, Europhys. Lett. 80, 27003 (2007).

TT 22.57 Wed 14:00 Poster B

Weak localization in a two-dimensional hole gas — •Viktor Krückl, Michael Wimmer, Inanc Adagideli, and Klaus Richter — Institut für Theoretische Physik, Universität Regensburg, 93040 Regensburg

We investigate phase coherent transport through a quasi two-dimensional hole gas in p-doped III-V semiconductors. The problem is treated within a 4-band Luttinger Hamiltonian in a quasi two-dimensional approximation. The transport properties are calculated in an effective tight-binding approximation by means of the Green function method. We consider the influence of coupling between heavy-holes and light-holes in the diffusive regime and ballistic cavities to point out their effect on weak localization.

TT 22.58 Wed 14:00 Poster B

Shot noise in graphene three terminal ballistic devices — •Miriam del Valle[1] and Gianaurelio Cuniberti[2] — [1]Institute of Theoretical Physics, Universität Regensburg — [2]Institute for Materials Science, TU Dresden

Graphene is in the focus of an immense scientific interest due to remarkable quantum properties which may emerge already at room temperature. We present here a study of electronic transport in single-layer graphene ribbons in three-terminal configuration set-ups, where the finite-size effects become of importance. These systems are characterized by much more complex stability diagrams than their nanotube (CNT) counterparts. A symmetry-related suppression of transmission of some states is responsible for the Fabry-Pérot interference patterns obtained for CNT devices, whereas these "dark states" become conducting for graphene. This additional complexity is investigated by analizing shot noise properties.

TT 22.59 Wed 14:00 Poster B

Optimal control of current and shot noise in molecular wires using femtosecond laser pulses — •Guangqi Li[1], Michael Schreiber[2], and Ulrich Kleinekathöfer[1] — [1]Jacobs University Bremen, Campus Ring 1, 28759 Bremen, Germany — [2]Institut für Physik, Technische Universität Chemnitz, 09107 Chemnitz, Germany

The tunneling of electrons through a molecular junction weakly coupled to two leads in the presence of a time-dependent external field is studied using using a master equation approach [1-4]. By combining the theory of optimal control and by using a predefined target current, a laser field can be obtained which does generate a predefined current pattern. The same technique can be applied to control also the shot noise in the system in order to minimize it. For a tight-binding approximation of the molecular wire we show how to compute the laser pulses to switch on and off the current through the wire . With this approach the current flow pattern in time can be chosen in an almost arbitrary fashion.

[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).
[3] G.-Q. Li, M. Schreiber, and U. Kleinekathöfer EPL **79**, 27006/1-6 (2007).
[4] S. Kohler and P. Hänggi, Nature Nanotech. **2**, 675 (2007)

TT 22.60 Wed 14:00 Poster B

General relation between diffusive transport and current-autocorrelation function — •Jochen Gemmer — Universität Osnabrück, Osnabrueck, Germany

The (regular) conductivity relates a current to an external force field. Within linear response theory this coductivity is given by the Kubo formula, i.e., essentially the current-autocorrelation function. The diffusion constant relates a current to a spatial density gradient. We investigate from first principles if and in which sense the diffusion constant can also be calculated from the current-autocorrelation function. In other words, we aim at verifying a generalized Einstein relation on basic quantum mechanical grounds.

TT 22.61 Wed 14:00 Poster B

Approach to transport in modular quantum systems by modelling of reservoirs — •Marcel Ogiewa and Jochen Gemmer — University of Osnabrueck, Osnabrueck, Germany

We investigate the transport behavior in a special class of quantum models, which are essentially of the periodic one-particle type but may nevertheless exhibit regular transport. To induce a current these systems are coupled to different baths at each ending.

The corresponding Lindblad Master Equation is solved by a Monte Carlo stochastic unraveling method in order to find the quasi-stationary state.

Hence we verify the existence of diffusive transport (in a certain parameter range) according to Fourier's law and extract the conductivity. The results are compared to other findings for the same systems derived by entirely different methods.

TT 22.62 Wed 14:00 Poster B

Investigations on transport properties of modular quantum systems based on a perturbative expansion of the current-autocorrelation function — •Christian Bartsch and Jochen Gemmer — Fachbereich Physik, Universität Osnabrück, Barbarastrasse 7, D-49069 Osnabrück, Germany

The dynamics of the spatial variance of the deviation of some density (particles, energy, etc.) from equilibrium can be expressed in terms of the dynamics of the current-autocorrelation function, that also appears in the Kubo formula (see also talk J. Gemmer). We present a systematic perturbation expansion for the current-autocorrelation function whose leading order is based on the diagonalization of finite parts of the system.

Additionally, we introduce a numerically feasible approximation for the next higher order to estimate if and for what times the leading order can be expected to give an adequate description. The analysis is supported by numerical calculations for concrete models.

TT 22.63 Wed 14:00 Poster B

Transport in randomly coupled many-particle quantum systems — •Robin Steinigeweg and Jochen Gemmer — Physics Department, University of Osnabrück, Barbarastr. 7, D-49069 Osnabrück, Germany

Although models for non-interacting particles in ideally ordered structures are rather simple examples of quantum systems, the complete characterization of the available types of transport often remains an unsolved problem. However, such a characterization has recently been done for a certain class of randomly coupled but translational invariant single-particle models [1]. In particular, a transition from diffusive to ballistic transport has been found in the limit of both small and large length scales, e.g., the long-time dynamics always is ballistic for a sufficiently large system. We discuss whether or not these transitions also appear in similarly structured many-particle quantum systems which naturally are much more complex. To this end we correspondingly consider a randomly coupled, translational invariant model and compare the theoretical predictions with the numerical solution of the full time-dependent Schrödinger equation for a range of accessible model sizes.

• [1] R. Steinigeweg, H.-P. Breuer, and J. Gemmer, Phys. Rev. Lett. **99**, 150601 (2007)