TT 61: TR: Nanoelectronics I - Quantum Dots, Wires, Point Contacts 3

Time: Friday 10:30–12:45 Location: HSZ 304

TT 61.1 Fri 10:30 HSZ 304

Spin Relaxation in Silicon Based Quantum Dots — •Martin Raith[1], Peter Stano[2], and Jaroslav Fabian[1] — [1]Institute for Theoretical Physics, University of Regensburg, 93040 Regensburg, Germany — [2]Physics Department, University of Arizona, AZ 85716, USA

Recent progress in manufacturing top-gated quantum dots based on Si/SiGe or Si/SiO_2 systems emphasized the importance of silicon as a possible host material for the creation of spin qubit arrays and the associated idea proposed by Loss and DiVincenzo [1] for the realization of a quantum computer. Silicon is of special interest because of its small spin-orbit coupling and the availability of isotopes with zero nuclear spin. Therefore silicon based quantum dots imply long spin lifetimes and yield promising candidates for quantum information processing. We provide quantitative results of the characteristic energies in the presence of spin-orbit coupling and phonon-induced spin relaxation times for realistic silicon based single and double dot systems using analytical models and numerical methods. This work is supported by the DFG under grant SPP 1285.

[1] D. Loss, and D. P. DiVincenzo, Quantum computation with quantum dots, Phys. Rev. A 57, 120 (1998)

TT 61.2 Fri 10:45 HSZ 304

Negative differential conductance with symmetric set-up ? — •Andrea Donarini, Abdullah Yar, and Milena Grifoni — Universität Regensburg, Germany

We consider a minimal model of transport through a nano-junction in the single electron tunneling regime. We prove that the source-drain asymmetric is not a necessary condition for the appearance of negative differential conductance (NDC). The latter is obtained even for a completely symmetric set up under specific conditions over the "geometrical component" of the tunneling rates. We apply the theory to study the transport characteristics of suspended carbon nanotube quantum dots. The electron-phonon coupling tunes in this case the "geometrical component" of the rates and determines the presence of NDC. Moreover, the interplay of Franck-Condon factors and spin/pseudo-spin degeneracies generates gate asymmetries in the stability diagram.

TT 61.3 Fri 11:00 HSZ 304

Decoherence in a Double-Dot Aharonov-Bohm Interferometer — •Björn Kubala[1], David Roosen[2], Michael Sindel[3], Walter Hofstetter[2], and Florian Marquardt[1] — [1]Institute for Theoretical Physics, Universität Erlangen-Nürnberg, Staudtstr. 7, 91058 Erlangen, Germany — [2]Institut für Theoretische Physik, Goethe Universität, 60438 Frankfurt/Main, Germany — [3]Physics Department, ASC and CeNs, Ludwig-Maximilians-Universität, 80333 Munich, Germany

Coherence in electronic interferometers is typically believed to be restored fully in the limit of small voltages, frequencies and temperatures. However, it is crucial to check this essentially perturbative argument by nonperturbative methods. Here, we use the numerical renormalization group to study ac transport and decoherence in an experimentally realizable model interferometer, a parallel double quantum dot coupled to a phonon mode. The model allows to clearly distinguish renormalization effects from decoherence. We discuss finite frequency transport and confirm the restoration of coherence in the dc limit.

TT 61.4 Fri 11:15 HSZ 304

Adiabatic State Evolution: a new route to nonequilibrium physics — •Marion Moliner and Peter Schmitteckert — Karlsruhe Institute of Technology

In recent years, the development of time dependent simulations of quantum systems have led to major steps in understanding nonequilibrium quantum systems. In these simulations, one typically studies the evolution of a system after a quench. In contrast, analytical approaches like Keldysh techniques can be traced back to the Lippmann-Schwinger equation, which itself is based on the concept of switching on perturbations adiabatically. In this work we present an approach which combines concepts of both techniques. By tracking the response of a system to an external perturbation adiabatically, we are able to access the non-equilibrium regime of a quantum system. We apply this method to interacting fermions in one dimension within the framework of the Density Matrix Renormalization Group technique.

TT 61.5 Fri 11:30 HSZ 304

Time-convolutionless master equation for quantum dots to all orders in the tunneling — •Carsten Timm — Technische Universität Dresden, Germany

Master equations describing the non-equilibrium dynamics of a quantum dot coupled to metallic leads are considered. I derive an exact time-convolutionless master equation for the probabilities of dot states, i.e., a *Pauli* master equation. The derivation naturally leads to an expansion in the tunneling amplitudes between dot and leads, which is obtained to arbitrary order. Relations to the time-nonlocal Nakajima-Zwanzig master equation and to the T-matrix approach are exhibited. The absence of divergences in the time-convolutionless and Nakajima-Zwanzig formalisms is demonstrated for all orders.

15 min. break

TT 61.6 Fri 12:00 HSZ 304

Modeling a scanning tunneling microscope: a nano-DΓA study — •Viktoria Motsch, Angelo Valli, Giorgio Sangiovanni, Alessandro Toschi, and Karsten Held — Institut für Festkörperphysik, TU Wien, Österreich

We apply nano-DΓA [1], a new approach to nanoscopic systems based on Dynamical Vertex Approximation (DΓA)[2], to study the tip of a scanning tunneling microscope (STM). Due to the geometrical confinement, we expect electronic correlations to play a more pronounced role in such a system. Decreasing the hybridization strength between the tip and the surface, the atom forming the contact undergoes a local Mott-Hubbard crossover (i.e. we observe a suppression of the spectral weight at the Fermi level). We study this phenomena and compute the conductance through the tip for different lattice structures and set of parameters.Our finding has important implications for interpreting STM images: The presumed proportionality of the conductance to the local density of states of the material scanned does not necessarily hold for STM tips made out of transition metals.

[1] A. Valli, *et al.*, Phys. Rev. Lett. **104**, 246402 (2010)
[2] A. Toschi, *et al.*, Phys. Rev. B **75**, 045118 (2007)

TT 61.7 Fri 12:15 HSZ 304

Transport measurements on single Bi nanowires at temperatures below 1 K — •C. Reiche[1], T. Peichl[1,2], S. Mueller[3], M.E. Toimil-Molares[3], R. Neumann[3], and G. Weiss[1,2] — [1]Physikalisches Institut, KIT Karlsruhe — [2]Centrum für funktionelle Nanostrukturen, KIT Karlsruhe — [3]GSI Darmstadt

With its large Fermi wavelength and long mean free paths, Bi is a fascinating metal for studies of transport phenomena in samples of reduced dimensions. Previous transport measurements on bundles of crystalline Bi wires with diameters around 100 nm found a remarkable decrease of sample resistance below 300 mK. Localization effects were ruled out as a cause of this decrease, so one might speculate that surface states are able to change the electronic structure of Bi in a way that it may exhibit superconductive properties. Very recently other groups have conducted measurements on single Bi nanowires and found that their data also fit superconductivity, probably induced by a surface layer of Bi oxide or other contaminants on the surface of the wires. Our samples are produced by a template method, using an ion track etched polycarbonate membrane. It has been shown that using these membranes it is possible to extract single wires without oxidation of the surface. From these samples we are preparing single Bi wires and contact them in 2- or 4-point contact geometry. We are conducting transport measurements to study the influence of different surface layers on the transport properties of the Bi wires at temperatures below 1 K. Furthermore we are gathering additional data to decide if the observed behavior may be attributed to superconductivity.

TT 61.8 Fri 12:30 HSZ 304

Cotunneling in the 5/2 fractional quantum Hall regime — •Robert Zielke, Bernd Braunecker, and Daniel Loss — University of Basel

We consider two fractional quantum Hall samples weakly coupled via a quantum dot and investigate whether there are specific signatures for the $\nu = 5/2$ wave functions, especially the Moore-Read wave function, in the tunneling between the edge states through the quantum dot. The focus is specifically on the cotunneling regime, both elastic and inelastic.