HL 72: Quantum dots: Transport properties

Time: Wednesday 15:00–16:15 Location: POT 251

HL 72.1 Wed 15:00 POT 251

Decoherence of an entangled states of a strongly-correlated double quantum dot structure through tunneling processes — •Carlos Alberto Büsser and Fabian Heidrich-Meisner — Department of Physics and Arnold Sommerfeld Center for Theoretical Physics, Ludwig-Maximilians-University Munich, Germany

The entanglement of the spin state of two quantum dots is investigated out of equilibrium. First, we prepare a two-dot system in a perfect singlet state at time $t = 0$. For $t > 0$, one of the dots is tunnel-coupled to leads, including a finite voltage. Using the time-dependent density matrix renormalization group method, we study the time evolution of the spin correlations and the concurrence as a function of time since electrons hopping on and off the tunnel-coupled dot lead to decoherence. We observe that the spin correlation between the dots decays exponentially determining a decoherence rate. A similar rate can be defined for the concurrence. We study the dependence of these rates on voltage, tunnel coupling, and Coulomb repulsion and compare our numerical results to a master-equation approach derived for the weak-coupling limit.

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HL 72.2 Wed 15:15 POT 251

Resonant tunnelling structures for reducing the erase time in a quantum dot-based memory — •Ismail Firat Arikan[1,2], Nathanael Cottet[3], Tobias Nowozin[1], Dieter Bimberg[1], and Nurten Öncan[2] — [1]Institut für Festkörperphysik, Technische Universität Berlin, Hardenbergstrasse 36, 10623 Berlin, Germany — [2]Department of Physics, Faculty of Science, Istanbul University, 34314 Vezneciler, Istanbul, Turkey — [3]ICFP, Departement de Physique, Ecole Normale Superieure, Paris, France

A memory based on self-organized quantum dots (QDs) is a promising candidate to combine the individual advantages of both DRAM and Flash, such as a long storage time (years), a fast write time (ns) and a good endurance. While the results are promising for the write performance, a trade-off exists for the erase performance: If the localization energy of the QDs is increased to further increase the storage time, the erase time also increases due to the increased tunnelling barrier. The solution to eliminate this trade-off between storage and erase time is to use a superlattice structure which implements resonant tunnelling as erasing mechanism. The transparency of such a structure is designed in such a way that it can be switched between very high and very low values by applying a bias voltage. In this work, a scheme for designing such a superlattice structure is presented. The structures are then simulated by using a one-dimensional Poisson-Schrödinger Solver and the Non-Equilibrium Green Function's formalism. For simple structures, first measurements are presented.

HL 72.3 Wed 15:30 POT 251

Spin-Spectroscopy of InAs Quantum Dots Defined in Gated Nanowires — •Sebastian Heedt[1], Thomas Gerster[1], Paul Wenk[2], Stefan Kettemann[3], Werner Prost[4], Jürgen Schubert[1], Detlev Grützmacher[1], and Thomas Schäpers[1] — [1]Peter Grünberg Institute (PGI-9) and JARA-Fundamentals of Future Information Technology, Forschungszentrum Jülich, 52425 Jülich, Germany — [2]Institute for Theoretical Physics, University of Regensburg, 93040 Regensburg, Germany — [3]School of Engineering and Science, Jacobs University Bremen, 28759 Bremen, Germany — [4]Solid State Electronics Department, University Duisburg-Essen, 47057 Duisburg, Germany

The aim of this study is to investigate spin coherence properties of quantum dots defined in InAs nanowires by multiple top-gates and high-k dielectrics. This way, accurate control over the local potential landscape inside the nanowire is achieved and the quantum dots are tuned to the few-electron regime. An external magnetic field applied perpendicular to the nanowire axis strongly affects the quantum dot energy levels. Hence, the electron g factor can be determined and two-electron states exhibit an avoided-crossing in dependence of the magnetic field. The resulting energy gap gives a measure for the spin relaxation length inside the InAs quantum dot, which is compared with results from weak antilocalization in phase-coherent transport measurements. Spin relaxation exhibits a strong dependence on external electric fields yielding a cross-over from weak antilocalization to weak localization. Also, it is substantially affected by the confinement.

HL 72.4 Wed 15:45 POT 251

Two-path Transport Measurements with Bias Dependence on a Triple Quantum Dot — •Monika Kotzian, Maximilian C. Rogge, and Rolf J. Haug — Institut für Festkörperphysik, Leibniz Universität Hannover, Appelstrasse 2, 30167 Hannover, Germany

We present transport measurements on a lateral triple quantum dot with a star-like geometry and one lead attached to each dot. [1] The research on triple quantum dots is motivated by fundamental physics and by the fact that it can work as a single qubit. [2] The structure is made with local anodic oxidation by AFM on a GaAs/AlGaAs heterostructure, the design allowing to simultaneously measure the conductance along two different paths with two quantum dots in each path. Two of the leads are used as source contacts and one lead as a drain contact. Thus the setup provides the possibility of applying two different bias voltages to the system to study the interaction between the paths. By controlling the potentials via the four gates of the device resonances of two and all three dots can be generated. [3,4] Signatures of three dots can be detected in both transport paths. In the region of the triple dot resonance we observe a sharp suppression of the dc current depending on bias voltage, which we attribute to current blocking due to the presence of an interference phenomenon - a dark state.

[1] M. C. Rogge, R. J. Haug, Phys. Rev. B 77, 193306 (2008). [2] P. Hawrylak, M. Korkusinski, Solid State Comm. 136 (2005), pp. 508-512. [3] L. Gaudreau, et al., PRL 97, 036807 (2006). [4] M. C. Rogge, R. J. Haug, New Journal of Physics 11, 113037 (2009).

HL 72.5 Wed 16:00 POT 251

Temperature Driven Current Modulation in a Capacitively Coupled Double Quantum Dot — •Holger Thierschmann[1], Marcel Mittermüller[1], Luis Maier[1], Wolfgang Hansen[2], Hartmut Buhmann[1], and Laurens W. Molenkamp[1] — [1]Physikalisches Institut (EP3), Universität Würzburg, Germany — [2]Insitut für Angewandte Physik und Zentrum für Mikrostrukturforschung, Universität Hamburg, Germany

In recent years multi-terminal devices with interacting quantum dots (QD) have received an increasing attention. Especially subjected to a temperature difference such systems are expected to exhibit interesting effects, e.g. efficiently converting heat into a directed current [1]. Here we present measurements on a QD system consisting of two capacitively coupled dots. One of the QDs (QD1) can exchange energy and particles with a heat reservoir at a temperature T1 while the other (QD2) couples to two electron reservoirs at a lower temperature T2. In the vicinity of the triple points of the charge stability diagram we observe a strong dependence of the current through QD2 on the temperature of the heat reservoir T1. The sign of the current change is determined by the relative position of the dots' chemical potentials with respect to the reservoirs. I(QD2) can be related to the heat induced charge fluctuations.

[1] R. Sánchez and M. Büttiker, Phys. Rev. B 83, 085428 (2011)