TT 89: Transport: Quantum Dots, Quantum Wires, Point Contacts 1 (jointly with HL)

Time: Thursday 11:00–13:00 Location: A 053

TT 89.1 Thu 11:00 A 053

Interference of real and virtual transitions in quantum dot chains — •Fernando Gallego-Marcos, Rafael Sánchez, and Gloria Platero — Instituto de Ciencia de Materiales de Madrid (ICMM-CSIC), Spain

We analyzed long-range transport through an ac driven triple quantum dot. Resonant transitions between separated and detuned dots are mediated by the exchange of n photons with the time-dependent field. An effective model is proposed in terms of higher-order transitions which involve the virtual only occupation of the intermediate dot [1]. The ac driving modulates the tunneling processes within the quantum dot system [2]. We investigate the interplay between real transitions through the centre dot and virtual long-range tunneling. We find configurations where the two paths interfere destructively and totally block the current. The effect of the driving phase will be emphasized.

[1] R. Sánchez, F. Gallego-Marcos, G. Platero,
Phys. Rev. B 89, 161402 (2014)
[2] F. Gallego-Marcos, R. Sánchez, G. Platero, arXiv:1408.4923

TT 89.2 Thu 11:15 A 053

Photon creation of a double quantum dot strongly coupled to the environment — •Michael Marthaler[1], Yasuhiro Utsumi[2], and Dmitri Golubev[3] — [1]Institut für Theoretische Festkörperphysik , Karlsruhe Institute of Technology, D-76128 Karlsruhe, Germany — [2]Department of Physics Engineering, Faculty of Engineering, Mie University, Japan — [3]O.V. Lounasmaa Laboratory, Aalto University School of Science, Finnland

We study a model which can describe a double quantum dot coupled to a transmission-line resonator. The charge eigenstates of the double dot couple strongly to the electromagnetic environment or phonons. We consider a situation where a transport voltage is applied and photons are created in the transmission-line resonator. Here we study the dependence of the average photon number in the resonator on the spectral function of the electromagnetic environment. We focus on three important cases, a strongly coupled environment with a small cut-off frequency, a structured environment peaked at a specific frequency and 1/f noise. We find that the electromagnetic environment can have a substantial impact on the photon creation. Resonance peaks are in general broadened and additional resonances can appear.

TT 89.3 Thu 11:30 A 053

Unconventional Superconductivity in Double Quantum Dots — Björn Sothmann[1], •Stephan Weiss[2], Michele Governale[3], and Jürgen König[2] — [1]Departement de Physique Theorique, Universite de Geneve, CH-1211 Geneve 4, Switzerland — [2]Theoretische Physik, Universität Duisburg-Essen and CENIDE, 47048 Duisburg, Germany — [3]School of Physical and Chemical Sciences, Victoria University of Wellington, New Zealand

The formation of electron pairs is a prerequisite of superconductivity. The fermionic nature of electrons yields four classes of superconducting correlations with definite symmetry in spin, space and time. Here, we suggest double quantum dots coupled to conventional s-wave superconductors in the presence of inhomogeneous magnetic fields as a model system exhibiting unconventional pairing [1]. We propose two detection schemes for unconventional superconductivity, based on either Josephson or Andreev spectroscopy.

[1] B. Sothmann, S. Weiss, M. Governale, and J. König,
Phys. Rev. B **90**, 220501(R) (2014).

TT 89.4 Thu 11:45 A 053

Shot noise of a triple quantum dot transistor: Blurred polygons and enhancement at blockade — •Andreas Trottmann, Michael Niklas, Andrea Donarini, and Milena Grifoni — Institute for Theoretical Physics, University of Regensburg, D-93040 Regensburg, Germany

A single-electron transistor model with triangular triple quantum dot as central element is studied by means of a Bloch-Redfield-type method with counting fields. Such a device is known to exhibit Coulomb as well as interference blockade due to the presence of orbital degeneracies [1]. Computed Fano factors follow a blurred polygonal pattern as function of the voltages, tend to behave oppositely as against average current, and are enhanced in certain blockade regions in particular. Expressions in an interference blockade region elucidate a counteraction between real and virtual transitions, a blocking condition, and a loss of purity. These effects can be captured describing the orbitally degenerate states based on a pseudospin within a Bloch sphere. Gate and bias thresholds in the Fano factor pattern reflect disparate connectivities, especially a lifting of an interference blockade due to the reachability of a second orbitally degenerate level in the latter case. Blurring is caused by the voltages dependence of axes and frequencies controlling the precession of the pseudospin.

[1] A. Donarini, G. Begemann, and M. Grifoni,
Phys. Rev. B 82, 125451 (2010).

TT 89.5 Thu 12:00 A 053

Circular-polarization-sensitive metamaterial based on triple quantum-dot molecules — •Panagiotis Kotetes[1], Pei-Qing Jin[2], Michael Marthaler[1], and Gerd Schön[1] — [1]Karlsruhe Institute of Technology — [2]Shanghai Maritime University

We propose a new type of chiral metamaterial based on an ensemble of artificial molecules formed by three identical quantum-dots in a triangular arrangement [1]. A static magnetic field oriented perpendicular to the plane breaks mirror symmetry, rendering the molecules sensitive to the circular polarization of light. By varying the orientation and magnitude of the magnetic field one can control the polarization and frequency of the emission spectrum. We identify a threshold frequency Ω, above which we find strong birefringence. In addition, Kerr rotation and circular-polarized lasing action can be implemented. We investigate the single-molecule lasing properties for different energy-level arrangements and demonstrate the possibility of circular polarization conversion. Finally, we analyze the effect of weak stray electric fields or deviations from the equilateral triangular geometry.

[1] P. Kotetes, P.-Q. Jin, M. Marthaler, and G. Schön, to appear in Phys. Rev. Lett. (arXiv:1406.6432).

TT 89.6 Thu 12:15 A 053

Electronic Transport through Cerium Nanocontacts — •Sebastian Kuntz[1], Oliver Berg[1], Christoph Sürgers[1], and Hilbert v. Löhneysen[1,2] — [1]Physikalisches Institut, Karlsruher Institut für Technologie, D-76128 Karlsruhe — [2]Institut für Festkörperphysik, Karlsruher Institut für Technologie, D-76021 Karlsruhe

We report on conductance measurements of Ce nanocontacts in mechanically controlled break-junctions (MCBJ) made from polycrystalline wires. The wires were cut from two different Ce ingots. One ingot was taken as-prepared after cooling from the melt and one ingot was carefully annealed over $\sim$ one week. We investigate the effect of cooling rate and γ-β-α-phase transformation on the conductance G of the nanocontacts measured at low temperatures. From a number of measurements of $G(\Delta x)$ where Δx is the distance between the two electrodes, we obtain conductance histograms. We focus on the conductance G^* of the "last plateau" before, with increasing Δx, G drops to zero. For Ce, different G^* values between 0.6 and 1.7 G_0 ($G_0 = 2e^2/h$) are observed, while for other rare-earth metals like Gd and Dy the last plateau occurs at $G^* \simeq 0.6$ G_0 and $G^* \simeq 0.9$ G_0, respectively. A possible explanation for the different G^* values of Ce is the additional contribution from the $4f$ state to the conductance whose distance from the Fermi level depends on the phase at low temperatures (α or β) and, hence, on the cooling rate of the sample.

TT 89.7 Thu 12:30 A 053

coherent single charge transport in MBE-grown InSb nanowire — •ning kang[1], sen li[1], dingxun fan[1], yuqing huang[1], libing wang[1], philippe caroff[2], and hongqi xu[1,2] — [1]Key Laboratory for the Physics and Chemistry of Nanodevices, Department of Electronics, Peking University, Beijing 100871, P. R. China. — [2]Solid State Physics, Lund University, Box 118, S-221 00 Lund, Sweden

InSb nanowire have unique properties, such as a narrow bandgap, strong spin-orbit interaction, large bulk mobility and a small effective mass. Here, we report fabrication and low-temperature electrical transport studies of InSb nanowires grown by MBE. Individual nanowire devices exhibit Coulomb blockade oscillations characteristic of single charge transport on length scales up to 700 nm. Detailed finite-bias transport measurements demonstrate coherent electron transport through discrete quantum levels. In the few electron regime, strong

signatures of higher order inelastic cotunneling occur which can directly be assigned to excited states. With this spectroscopy we extract the main characteristics of a single InSb nanowire, namely, the Lande factor and the the magnitude of the spin-orbit interaction. We also present initial experimental studies of devices composed of superconductor in proximity to single InSb nanowire. We observed gate-tunable supercurrent flowing through the InSb nanowire and multiple Andreev reflection characteristics. Our results demonstrate that the InSb nanowires can provide an ideal platform to exploring phase coherence quantum transport and topological electronics in a solid state system.

TT 89.8 Thu 12:45 A 053

Heat current as a tool to study quantum dot decay rates — •Jens Schulenborg[1], Roman Saptsov[2,3], Janine Splettstoesser[1], and Maarten R. Wegewijs[2,3,4] — [1]Department of Microtechnology and Nanoscience (MC2), Chalmers University of Technology, Göteborg, Sweden — [2]Peter Grünberg Institut, Forschungszentrum Jülich, 52425 Jülich, Germany — [3]JARA - Future Information Technologies, Germany — [4]Institut für Theorie der Statistischen Physik, RWTH Aachen University, Germany

Over the past years, potential applications in nanoelectronics, metrology and quantum information sparked great interest in studying the *dynamics* of time-dependently driven quantum dots. Recently, we investigated the decay rates of an interacting single-level quantum dot, weakly tunnel coupled to an electronic reservoir and brought out of equilibrium by a step pulse[1,2]. In particular, the *fermion-parity rate*[1] was found to be an additional time scale, besides the spin- and charge decay rate, of which the value is fundamentally restricted[2].

This work shows that the *time-dependent heat current* emitted from the dot gives new insights into the physics described by the fermion-parity rate. Using a master equation for the dot coupled to an electrode, we extract the decay rates and determine how they influence the decay of charge- and heat current. We find that, while the fermion-parity rate does not at all enter the charge current, it is the dominant time scale for the *dissipation of interaction energy* carried by the heat current.

[1] L. D. Contreras-Pulido et al., Phys. Rev. B **85**, 075301 (2012).
[2] R. Saptsov et al., Phys. Rev. B **90**, 045407 (2014).