TT 20: Transport: Nanoelectronics I - Quantum Dots, Wires, Point Contacts 1

Time: Tuesday 14:00–15:30 Location: EB 202

Invited Talk TT 20.1 Tue 14:00 EB 202

Adiabatic pumping in nanostructures — •Michele Governale — Institut für Theoretische Physik III, Ruhr-Universität Bochum, D-44780 Bochum, Germany

A DC current can be driven through a mesoscopic conductor in the absence of an applied transport voltage by changing periodically in time some of the properties of the conductor. This transport mechanism is known as pumping. If the time-dependent parameters vary slowly as compared to the characteristic internal time scales of the system, pumping is adiabatic, and the average transmitted charge per cycle depends only on the area of the cycle but not on its detailed timing.

In this talk we present the main theoretical concepts in the field and describe some recent developments, such as pumping trough interacting systems [1,2] and in hybrid superconducting-normal structures [3].

[1] J. Splettstoesser, M. Governale, J. König, and R. Fazio, Phys. Rev. Lett. **95**, 246803 (2005).
[2] J. Splettstoesser, M. Governale, J. König, and R. Fazio, Phys. Rev. B **74**, 085305 (2006).
[3] M. Governale, F. Taddei, R. Fazio, and F. W. J. Hekking, Phys. Rev. Lett. **95**, 256801 (2005).

TT 20.2 Tue 14:30 EB 202

Cooper pair pumping in presence of dissipation — •Valentina Brosco[1], Alexander Shnirman[1,2], Rosario Fazio[3,4], and Gerd Schön[1] — [1]Institut für Theoretische Festkörperphysik and DFG Center for Functional Nanostructures (CFN), Universität Karlsruhe, Karlsruhe, Germany — [2]Institut für Theoretische Physik, Universität Innsbruck, Innsbruck, Austria — [3]International School for Advanced Studies (SISSA), Trieste, Italy — [4]NEST-CNR-INFM and Scuola Normale Superiore, Pisa, Italy

In a Cooper pair pump charge transport is obtained via an adiabatic and periodic manipulation of Josephson couplings or gate voltages and it is a coherent process. Several works investigated the connection between Cooper pair pumping and the geometric and topological properties of the pumping cycle in the parameters space [1]. Recently the predicted relation between Berry's phase and pumped charge was demonstrated experimentally [2]. In the present work we analyze the effects of noise on Cooper pair pumping and we show that dissipation may induce a new geometric contribution in the transferred charge. We show that this contribution can be experimentally distinguished both from the usual pumped charge and from the supercurrent contribution and we propose an experiment where the theory can be probed.

[1] M. Aunola and J. J. Toppari, Phys. Rev. B **68**, 020502 (2003); V. Brosco, R. Fazio, F. W. J. Hekking, and A. Joye, cond-mat/0702333.
[3] M.Mottonen, J. J. Vartiainen, and J. P. Pekola, cond-mat/0710.5623.

TT 20.3 Tue 14:45 EB 202

Adiabatic pumping in a quantum dot-Aharonov-Bohm interferometer — •Bastian Hiltscher, Michele Governale, and Jürgen König — Institut für Theoretische Physik III, Ruhr-Universität Bochum, 44780 Bochum, Germany

We study adiabatic pumping in Aharonov-Bohm interferometers, where a quantum dot is embedded in one or in both arms. Charge pumping occurs if two parameters are changed periodically in time. The limit of small frequencies defines the adiabatic regime.

For our calculations we use a real-time diagrammatic technique and combine the properties of AB interferometers [1] with the properties of adiabatic pumping [2] for dots with strong Coulomb interaction. By performing a perturbation expansion in the pumping frequency and in the tunnel-coupling strength we calculate the magnetic-flux dependence of the pumped charge and compare it with the results for rectification of an AC voltage, which may yield an effective DC current as well.

We get information about the character of adiabatic pumping, which could be interpreted as peristaltic, but phase-coherent. Furthermore we find, that adiabatic pumping and rectification show different symmetries and, thereby, are distinguishable.

[1]J. König and Y. Gefen, Phys. Rev. B **65**, 045316 (2002).
[2]J. Splettstoesser, M. Governale, J. König, and R. Fazio, Phys. Rev. B **74**, 085305 (2006).

TT 20.4 Tue 15:00 EB 202

Non-local Andreev reflection in quantum dots — •David Futterer, Michele Governale, and Jürgen König — Institut für Theoretische Physik III, Ruhr-Universität Bochum, 44780 Bochum, Germany

We consider a single-level quantum dot attached to one superconducting and two ferromagnetic leads. The transport through this system is influenced by the interplay of proximity effect, spin accumulation, Coulomb interaction and non-equilibrium due to finite bias voltage.

We employ a real-time diagrammatic technique that accounts for coupling both to ferromagnetic[1] and superconducting[2] leads. We perform a systematic expansion in the tunnel-couplings to the leads. In the limit of large superconducting gap, all orders in the tunnel-coupling strength with the superconductor can be resummed. We calculate the transport properties of the system and identify schemes for detection of non-local Andreev reflection.

[1] M. Braun, J. König, and J. Martinek, Phys. Rev. B **70**, 195345 (2004)
[2] M. G. Pala, M. Governale, and J. König, New J. Phys. **9**, 278 (2007)

TT 20.5 Tue 15:15 EB 202

Cross-Correlations in transport through two parallel quantum dots — •Sebastian Haupt[1,2], Jasmin Aghassi[1], Matthias Hettler[2], and Gerd Schön[1,2] — [1]Institut für theoretische Festkörperphysik, Universität Karlsruhe, 76218 Karlsruhe — [2]Forschungszentrum Karlsruhe, INT, Postfach 3640, 76201 Karlsruhe

We study cross-correlations of currents through two parallel quantum dots coupled to four independent electrodes. The quantum dots are coupled by intra-dot Coulomb interactions but tunneling between the dots is forbidden. The transport is calculated within second-order pertubation expansion in the coupling Γ to the electrodes within a diagrammatic technique. We allow for an intermediate coupling regime up to coupling constants of $\Gamma \sim k_B T$ (where k_b is the Boltzmann constant and the temperature is T). The level energy of the two quantum dots can be independently controlled via gate voltages. [1,2] The cross-correlations show different signs depending on the relation of transport process through the dots. For higher temperatures, the regions of equal sign have a spherical shape, whereas at lower temperature, an anglular "L-shape" is observed. This can be explained by the analysis of the relevant transport processes.

[1] D.T. McClure *et al.*, Phys. Rev. Lett. **98**, 056801 (2007)
[2] J. Aghassi *et al.*, Appl. Phys. Lett. **89**, 052101 (2006), Phys. Rev.B **73**, 195323 (2006)