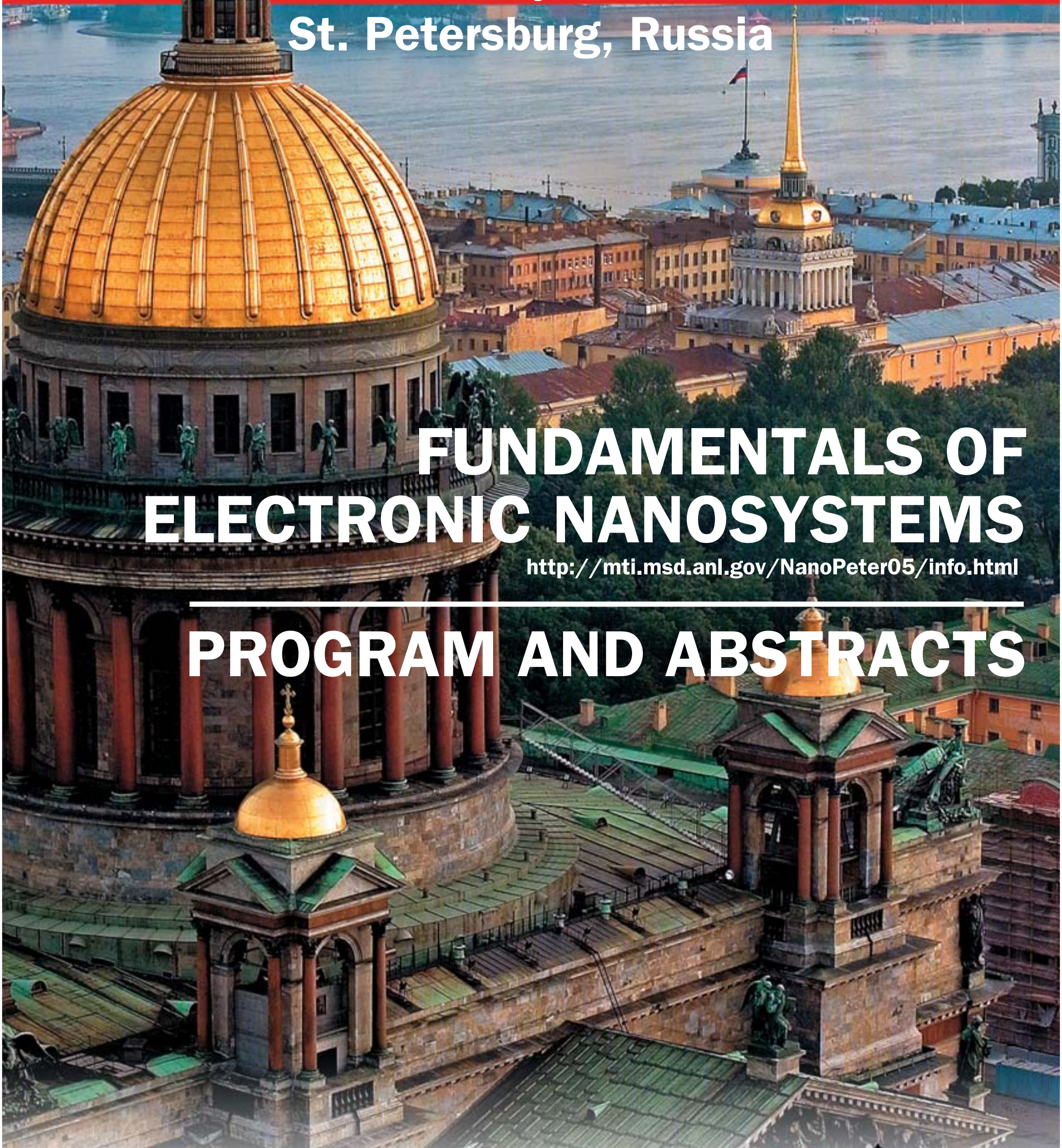
Advanced Research Workshop

NANOПитер

June 25 – July 1 2005

St. Petersburg, Russia



FUNDAMENTALS OF ELECTRONIC NANOSYSTEMS

http://mti.msd.anl.gov/NanoPeter05/info.html

PROGRAM AND ABSTRACTS

Chicago Materials Research Center

http://mrsec.uchicago.edu

BROOKHAVEN NATIONAL LABORATORY

Ioffe Physico-Technical Institute

SCIENTIFIC DIRECTORS

Veniamin Kozub, Ioffe Physico-Technical Institute, Saint-Petersburg, Russia
Valerii Vinokur, Argonne National Laboratory, USA

PROGRAM COMMITTEE

Yaroslav Blanter, Delft University of Technology, the Netherlands
Yuval Gefen, Weizmann Institute of Science, Rehovot, Israel
Veniamin Kozub, Ioffe Physico-Technical Institute, Saint-Petersburg, Russia
Alexander Mirlin, Forschungszentrum Karlsruhe, Germany, and Petersburg Nuclear Physics Institute, Russia
Valerii Vinokur, Argonne National Laboratory, USA
Igor Lerner, University of Birmingham, UK

ADVISORY COMMITTEE

Boris Altshuler, Princeton University, USA
Yuri Galperin, University of Oslo, Norway, and Ioffe Physico-Technical Institute, Saint-Petersburg, Russia
Frank Hekking, Universite Joseph Fourier and CNRS, Grenoble, France
Heinrich Jaeger, University of Chicago, USA
Vladimir Kravtsov, The Abdus Salam ICTP, Trieste, Italy, and Landau Institute for Theoretical Physics, Moscow, Russia
Alexei Tsvelik, Brookhaven National Laboratory, USA
Andrei Varlamov, University Tor Vergata, Rome, Italy

LOCAL ORGANIZING COMMITTEE

Yuri Kumzerov, Ioffe Physico-Technical Institute, Saint-Petersburg, Russia (Chair)
Lidia Kozub, Ioffe Physico-Technical Institute, Saint-Petersburg, Russia
Aleksandra Kochina, Ioffe Physico-Technical Institute, Saint-Petersburg, Russia
Tatiana Rozenberg, Ioffe Physico-Technical Institute, Saint-Petersburg, Russia
Victor Semkin, Ioffe Physico-Technical Institute, Saint-Petersburg, Russia

SPONSORS

Ministry of Education and Science of Russian Federation
Forschungszentrum Karlsruhe
Argonne National Laboratory
Brookhaven National Laboratory
Weizmann Institute of Science
Office of Naval Research Global
The Abdus Salam Center for Theoretical Physics
Chicago Materials Research Center
Ioffe Physico-Technical Institute
European Office of Aerospace Research and Development of the USAF
Dynasty Foundation
Russian Foundation for Basic Research
Centre National de la Recherche Scientifique
Princeton University
USAITC-A, European Research Office
Alexander von Humboldt Foundation

CONFERENCE SCHEDULE

Saturday, June 25 18.00-21.00 WELCOME PARTY

Sunday, June 26

Duration of talks is 25 minutes followed by 5 minutes discussion!

Session: TRANSPORT IN SUPERCONDUCTING NANOSTRUCTURES 1

08.00-09.00 Registration
09.00-09.15 Opening
09.15-09.45 Yu. Galperin, Charge transport through the interface between superconductor and hopping insulator
09.45-10.15 K. Efetov, Exotic properties of superconductor-ferromagnet structures
10.15-10.45 H. Takayanagi, Observation of giant thermal noise due to multiple Andreev reflection in ballistic InGaAs-based superconducting weak links
10.45-11.15 COFFEE BREAK
11.15-11.45 M. Feigelman, Theory of superconductive pairing near the mobility edge
11.45-12.15 I. Beloborodov, Suppression of Superconductivity in Granular Metals
12.15-13.00 **LUNCH**

Session: DISORDER AND INTERACTION IN ELECTRON TRANSPORT

14.00-14.30 V. Pudalov, Interaction Effects in Partially Polarized 2D Electron System
14.30-15.00 A. Savchenko, Effect of disorder on the compressibility of two-dimensional electron systems
15.00-15.30 J. Smet, Recent Progress on Microwave Induced Magnetoresistance Phenomena
15.30-16.00 COFFEE BREAK
16.00-16.30 Z. Ovadyahu, Anderson Insulators as Quantum Glasses
16.30-17.00 T. Giamarchi, Transport and Aging in Wigner glass
17.00-17.30 V. Gurevich, Instability of quasi-local oscillations in glasses and general features of their densities of states
17.30-18.00 V. Yudson, Universalities in Electron Scattering on Large-scale Inhomogeneities

Monday, June 27

Duration of talks is 25 minutes followed by 5 minutes discussion!

Session: TRANSPORT IN ID STRUCTURES

09.00-09.30 A. Kamenev, Transport in ID Coulomb Systems
09.30-10.00 D. Polyakov, Dephasing of interacting electrons in quantum wires: Fermi vs Luttinger
10.00-10.30 P. Wiegmann, Non-linear effects in transport in low-dimensional quantum systems
10.30-11.00 COFFEE BREAK
11.00-11.30 A. Tsvelik, Finite temperature dynamics of integrable models
11.30-12.00 K. Matveev, Exchange Coupling in a One-Dimensional Wigner Crystal
12.00-13.00 **LUNCH**

Session: SPIN TRANSPORT, SPINTRONICS

14.00-14.30 V. Falko, Spin relaxation in lateral quantum dots
14.30-15.00 A. Finkelstein, Diffuse emission in the presence of the spin-orbit interaction
15.00-15.30 S. Katsumoto, Fano-Kondo resonance in quantum dot - wire hybrids
15.30-16.00 COFFEE BREAK

16.00-16.30 K. Ensslin, Probing the Kondo density of states in a three-terminal quantum ring
16.30-17.00 R. Konik, Kondo Physics in Double Quantum Dots: Results from the Exact Solution
17.00-17.30 M. Kiselev, Interplay of Spin and Charge Channels in Zero Dimensional System
17.30-18.00 L. Glazman, Energy-resolved inelastic electron scattering off a magnetic impurity

Tuesday, June 28

Duration of talks is 25 minutes followed by 5 minutes discussion!

Session: QUANTUM INFORMATION, QUBITS
09.00-09.30 B. Altshuler, to be announced
09.30-10.00 G. Schön, Decoherence Processes in Quantum Devices
10.00-10.30 I. Lerner, Low-Temperature Decoherence of Qubit Coupled to Background Charges
10.30-11.00 COFFEE BREAK
11.00-11.30 C. Beenakker, Optimal quantum entanglement pump
11.30-12.00 A. Shnirman, Geometric nature of the environment-induced Berry phase and geometric dephasing

EXCURSION AND CONFERENCE DINNER
14:00. Departure from the hotel; glimpse of the city.
15:00-16:45 Excursion to the St. Isaac's Cathedral and over the vicinity.
17:00-21:00 Boat excursion over the Neva River and the Conference Dinner
22:00 Bus return to the Hotel

Wednesday, June 29

Duration of talks is 25 minutes followed by 5 minutes discussion!

Session: COHERENCE, CORRELATIONS AND NOISE IN NANOSTRUCTURES
09.00-09.30 R. Fazio, Quantum pumping in normal and superconducting nanostructures
09.30-10.00 L. Levitov, Mesoscopic Fermi-Edge Singularity
10.00-10.30 G. Montambaux, Anomalous diffusion and decoherence in rings connected to networks
10.30-11.00 COFFEE BREAK
11.00-11.30 V. Kravtsov, Dynamic localization in quantum dots
11.30-12.00 D. Prober, Quantum Shot Noise of a Diffusive Wire - Third Moment and Driven Response
12.00-13.00 **LUNCH**

Session: TRANSPORT IN SUPERCONDUCTING NANOSTRUCTURES 2
14.00-14.30 F. Hekking, to be announced
14.30-15.00 M. Skvortsov, Superconductivity in disordered thin films: giant mesoscopic fluctuations
15.00-15.30 A. Ustinov, Vortices in long Josephson nano-junctions
15.30-16.00 COFFEE BREAK
16.00-16.30 A. Mel'nikov, Giant mesoscopic oscillations of Andreev levels
17.00-19.30 POSTER SESSION (accompanied by beverages and snacks)

Thursday, June 30

Duration of talks is 25 minutes followed by 5 minutes discussion!

Session: MOLECULAR ELECTRONICS, NANOMECHANICS, NONEQUILIBRIUM PROPERTIES
09.00-09.30 H. van der Zant, Coupling between electronic and mechanical degrees of freedom in suspended nanotubes

09.30-10.00 F. von Oppen, Nonequilibrium vibrations in transport through single molecules
10.00-10.30 R. Shekhter, Nanoelectromechanical single-electron transistor with spin-polarized leads
10.30-11.00 COFFEE BREAK
11.00-11.30 H. Bouchiat, Transport in disordered wires with few conducting channels: GaAs/GaAlAs quantum wires and ropes of carbon nanotubes
11.30-12.00 B. Spivak, Effects of interactions on nonlinear I-V characteristics of mesoscopic systems

12.00-13.00 **LUNCH**

Session: SPIN AND INTERACTIONS IN QUANTUM DOTS
14.00-14.30 H. Weidenmüller, Transmission phase of a quantum dot in the Kondo regime
14.30-15.00 J. Weiss, Kondo and Fano Effect in Quantum Dot Systems
15.00-15.30 Y. Oreg, RKKY and magnetic field interactions in coupled Kondo quantum dots
15.30-16.00 COFFEE BREAK
16.00-16.30 C. Marcus, Spin and charge dephasing in double quantum dots
16.30-17.00 J. König, Nonmonotonic charge occupation in double dots
17.00-17.30 Y. Alhassid, to be announced
17.30-17.45 Concluding remarks

LIST OF PARTICIPANTS

Yoram Alhassid, Yale University, USA, yoram.alhassid@yale.edu
Boris Altshuler, Princeton University, USA, bla@princeton.edu
Lionel Angers, Universite Paris Sud, Orsay, France, angers@lps.u-psud.fr
Dmitry Aristov, University of Karlsruhe, Germany, and Petersburg Nuclear Physics Institute, Russia, aristov@tkm.physik.uni-karlsruhe.de
Dmitry Bagrets, University of Karlsruhe, Germany, bagrets@tfp.physik.uni-karlsruhe.de
Carlo Beenakker, Leiden University, the Netherlands, beenakker@lorentz.leidenuniv.nl
Igor Beloborodov, Argonne National Laboratory, USA, beloborodov@anl.gov
Pierre-Marie Billangeon, Universite Paris Sud, Orsay, France, pierre.billangeon@laposte.net
Yaroslav Blanter, Delft University of Technology, the Netherlands, blanter@tnntwl4.tn.tudelft.nl
Helene Bouchiat, Universite Paris Sud, Orsay, France, bouchiat@lps.u-psud.fr
Gabriele Campagnano, Delft University of Technology, the Netherlands, G.Campagnano@tnw.tudelft.nl
Olga Dimitrova, Landau Institute for Theoretical Physics, Moscow, Russia, olgadim@itp.ac.ru
Alexander Dmitriev, Ioffe Physico-Technical Institute, Saint-Petersburg, Russia, dmitriev.vipl@mail.ioffe.ru
Ivan Dmitriev, Forschungszentrum Karlsruhe, Germany, and Ioffe Physico-Technical Institute, St.Petersburg, Russia, dmitriev@tkm.physik.uni-karlsruhe.de
Konstantin Efetov, Ruhr-Universitat Bochum, Germany, and Landau Institute for Theoretical Physics, Moscow, Russia, efetov@tp3.ruhr-uni-bochum.de
Klaus Ensslin, ETH Zurich, Switzerland, ensslin@solid.phys.ethz.ch
Vladimir Falko, Lancaster University, UK, v.falko@lancaster.ac.uk
Rosario Fazio, Scuola Normale Superiore, Pisa, Italy, fazio@sns.it
Mikhail Feigelman, Landau Institute for Theoretical Physics, Moscow, Russia, feigel@landau.ac.ru
Raffaello Ferone, Universite Joseph Fourier, Grenoble, France,

Raffaello.Ferone@grenoble.cnrs.fr
Alexander Finkelstein, Weizmann Institute of Science, Rehovot, Israel, alexander.finkelstein@weizmann.ac.il
Yuri Galperin, University of Oslo, Norway, and Ioffe Physico-Technical Institute, St. Petersburg, Russia, iouri.galperine@fys.uio.no
Antonio Garcia Garcia, Princeton University, USA, ag3@princeton.edu
Yuval Gefen, Weizmann Institute of Science, Rehovot, Israel, Yuval.Gefen@weizmann.ac.il
Thierry Giamarchi, University of Geneva, Switzerland, Thierry.Giamarchi@physics.unige.ch
Francesco Giazotto, NEST-INFM and Scuola Normale Superiore, Pisa, Italy, f.giazotto@sns.it
Saul Ginzburg, Petersburg Nuclear Physics Institute, Russia, ginzburg@thd.pnpi.spb.ru
Leonid Glazman, University of Minnesota, Minneapolis, USA, glazman@umn.edu
Igor V. Gornyi, Forschungszentrum Karlsruhe, Germany, and Ioffe Physico-Technical Institute,
Saint-Petersburg, Russia, gornyi@tkm.physik.uni-karlsruhe.de
Michele Governale, NEST-INFM and Scuola Normale Superiore, Pisa, Italy, governale@sns.it
Daniel Greenbaum, Weizmann Institute of Science, Rehovot, Israel, daniel.greenbaum@weizmann.ac.il
Vadim Gurevich, Ioffe Physico-Technical Institute, Saint-Petersburg, Russia, Vadim.Gurevich@mail.ioffe.rssi.ru
Dmitry Gutman, University of Chicago, USA, gutman@uchicago.edu
Frank Hekking, Universite Joseph Fourier, Grenoble, France, Frank.Hekking@grenoble.cnrs.fr
Manuel Houzet, CEA Grenoble, France, houzet@drfmc.ceng.cea.fr
Valentin Kachorovskii, Ioffe Physico Technical Institute, Saint-Petersburg, Russia, kachor.vipl@mail.ioffe.ru
Alex Kamenev, University of Minnesota, Minneapolis, USA, kamenev@physics.umn.edu
Shingo Katsumoto, University of Tokyo, Japan, kats@issp.u-tokyo.ac.jp
Mikhail Kiselev, Ludwig-Maximilians University, Munich, Germany, kiselev@physik.uni-wuerzburg.de
Jürgen König, Ruhr-Universitat Bochum, Germany, koenig@tp3.ruhr-uni-bochum.de
Robert Konik, Brookhaven National Laboratory, USA, rmk@bnl.gov
Veniamin Kozub, Ioffe Physico-Technical Institute, Saint-Petersburg, Russia, ven.kozub@pop.ioffe.rssi.ru
Vladimir Kravtsov, The Abdus Salam ICTP, Trieste, Italy, and Landau Institute for Theoretical Physics, Moscow, Russia, kravtsov@ictp.trieste.it
Andrei Lebedev, Landau Institute for Theoretical Physics, Moscow, Russia, alebedev@itp.ac.ru
Igor Lerner, University of Birmingham, UK, ivl@th.ph.bham.ac.uk
Leonid Levitov, Massachusetts Institute of Technology, Cambridge, USA, levitov@mit.edu
Ilya Lyubinskiy, Ioffe Physico-Technical Institute, Saint-Petersburg, Russia, ilyalyu@mail.ru
Yuriy Makhlin, Landau Institute for Theoretical Physics, Moscow, Russia, makhlin@landau.ac.ru
Charles Marcus, Harvard University, Cambridge, USA, marcus@harvard.edu
Florian Marquardt, Ludwig-Maximilians University, Munich, Germany, Florian.Marquardt@yale.edu
Konstantin Matveev, Argonne National Laboratory, USA, matveev@anl.gov
Dganit Meidan, Weizmann Institute of Science, Rehovot, Israel, dganit.meidan@weizmann.ac.il
Aleksander Mel'nikov, Institute for Physics of Microstructures RAS, Nizhny Novgorod, Russia, melnikov@ipm.sci-nnov.ru
Julia Meyer, Argonne National Laboratory, USA, jmeyer@anl.gov
Grigory Minkov, Institute of Metal Physics RAS, Ekaterinburg, Russia, grigori.minkov@usu.ru
Alexander Mirlin, Forschungszentrum Karlsruhe, Germany, and Petersburg Nuclear Physics Institute, Russia, mirlin@tkm.physik.uni-karlsruhe.de
Gilles Montambaux, Universite Paris Sud, Orsay, France, montambaux@lps.u-psud.fr
Boris Narozhny, The Abdus Salam ICTP, Trieste, Italy, narozhny@ictp.trieste.it

Zoltan Nemeth, Weizmann Institute of Science, Rehovot, Israel, nza@ector.elte.hu
Felix von Oppen, Freie Universitat Berlin, Germany, vonoppen@physik.fu-berlin.de
Yuval Oreg, Weizmann Institute of Science, Rehovot, Israel, yuval.oreg@weizmann.ac.il
Alexander Ossipov, The Abdus Salam ICTP, Trieste, Italy, aossipov@ictp.trieste.it
Pavel Ostrovsky, Landau Institute for Theoretical Physics, Moscow, Russia, ostrov@itp.ac.ru
Zvi Ovadyahu, The Hebrew University, Jerusalem, Israel, zvi@vms.huji.ac.il
Dmitry Polyakov, Forschungszentrum Karlsruhe, Germany, and Ioffe Physico-Technical Institute, St.Petersburg, Russia, polyakov@int.fzk.de
Daniel Prober, Yale University, USA, daniel.prober@yale.edu
Ivan Protopopov, Landau Institute for Theoretical Physics, Moscow, Russia, ipro@itp.ac.ru
Vladimir Pudalov, Lebedev Physics Institute, Moscow, Russia, pudalov@maill.lebedev.ru
Denis Ryzhov, Institute for Physics of Microstructures RAS, Nizhnii Novgorod, Russia, ryzhov@ipm.sci-nnov.ru
Alexander Savchenko, University of Exeter, UK, A.K.Savchenko@exeter.ac.uk
Nataliya Savitskaya, Petersburg Nuclear Physics Institute, Russia, savitska@thd.pnpi.spb.ru
Alexey Samokhvalov, Institute for Physics of Microstructures RAS, Nizhnii Novgorod, Russia, samokh@ipm.sci-nnov.ru
Gerd Schön, University of Karlsruhe, Germany, gerd.schoen@phys.uni-karlsruhe.de
Robert Shekhter, University of Gothenburg, Sweden, shekhter@fy.chalmers.se
Alexander Shnirman, University of Karlsruhe, Germany, shnirman@tfp.physik.uni-karlsruhe.de
Mikhail Skvortsov, Landau Institute for Theoretical Physics, Moscow, Russia, skvor@itp.ac.ru
Jurgen Smet, Max-Planck-Institut far Festkorperforsehung, Stuttgart, Germany, J.Smet@fkf.mpg.de
Boris Spivak, University of Washington, Seattle, USA, spivak@dirac.phys.washington.edu
Fabio Taddei, NEST-INFM and Scuola Normale Superiore, Pisa, Italy, f.taddei@sns.it
Hideaki Takayanagi, NTT Basic Research Laboratories, Japan, takayanagi@nttbrl.jp
Christophe Texier, Universite Paris Sud, Orsay, France, texier@lptms.u-psud.fr
Mikhail Titov, Max Planck Institute for Physics of Complex Systems, Dresden, Germany, and Petersburg Nuclear Physics Institute, Russia, titov@idefix.mpipks-dresden.mpg.de
Olga Tkachenko, Institute of Semiconductor Physics, Novosibirsk, Russia, otkach@list.ru
Alexei Tsvelik, Brookhaven National Laboratory, USA, tsvelik@bnl.gov
Alexey Ustinov, Universitat Erlangen-Nurnberg, Germany, ustinov@physik.uni-erlangen.de
Valery Vinokur, Argonne National Laboratory, USA, vinokour@anl.gov
Hans Weidenmüller, Max-Planck-Institut fur Kernphysik, Heidelberg, Germany, hans. weidenmueller@mpi-hd. mpg.de
Jurgen Weis, Max-Planck-Institut fur Festkorperforsehung, Stuttgart, Germany, J.Weis@fkf.mpg.de
Pavel Wiegmann, University of Chicago, USA, wiegmann@uchicago.edu
Andrey Yashenkin, Petersburg Nuclear Physics Institute, Russia, ayash@thd.pnpi.spb.ru
Vladimir Yudson, Institute of Spectroscopy RAS, Troitsk, Russia, yudson@isan.troitsk.ru
Herre van der Zant, Delft University of Technology, the Netherlands, herre@qt.tn.tudelft.nl

ORAL PRESENTATIONS

Title not provided
Yoram Alhassid
Yale University, USA

Title not provided
Boris Altshuler
Princeton University, USA

Optimal quantum entanglement pump
Carlo Beenakker
Leiden University, the Netherlands

A nonperturbative theory is presented for the creation by an oscillating potential of spin-entangled electron-hole pairs in the Fermi sea. In the weak potential limit, considered earlier by Samuelsson and Buttiker, the entanglement production is much less than one bit per cycle. We demonstrate that a strong potential oscillation can produce an average of one Bell pair per two cycles, making it an efficient source of entangled flying qubits.

Suppression of Superconductivity in Granular Metals
Igor Beloborodov
Argonne National Laboratory, USA

We investigate the suppression of superconducting transition temperature in granular metallic systems due to (i) fluctuations of the order parameter (bosonic mechanism) and (ii) Coulomb repulsion (fermionic mechanism) assuming large tunneling conductance between the grains $g_T \gg 1$. We find the correction to the superconducting transition temperature for *3d* granular samples and films. We demonstrate that if the critical temperature $T_C > g_T\delta$, where δ is the mean level spacing in a single grain the bosonic mechanism is the dominant mechanism of the superconductivity suppression, while for critical temperatures $T_C > g_T\delta$ the suppression of superconductivity is due to the fermionic mechanism.

Transport in disordered wires with few conducting channels: GaAs/GaAlAs quantum wires and ropes of carbon nanotubes
M.Ferrier, A.Kasumov, L.Angers, S.Gueron, and H. Bouchiat
Universite Paris Sud, Orsay, France

Exotic properties of superconductor-ferromagnet structures
S.Bergeret[1], A.F. Volkov[1], and K. B. Efetov[1,2]
[1]Ruhr-Universitat Bochum, Germany
[2]Landau Institute for Theoretical Physics, Moscow, Russia

Three different but related phenomena that should exist in superconductor-ferromagnet structures are reviewed. The first one is generation of a triplet component of the superconducting condensate due to ihomogeneities of the exchange field. The triplet condensate function is odd in frequency and insensitive to disorder. It can penetrate the ferromagnet over long distances. The second phenomenon is the screening of the exchange field by spins of electrons of Cooper pairs. This phenomenon is

complementary to the conventional Meissner screening and can be dominant in certain situations. The third phenomenon is an enhancement of the Josephson current by the presence of an exchange field. In all the cases the superconductivity is assumed to be initially singlet with s-pairing for the Cooper pairs. Several relevant experiments are discussed.

Probing the Kondo density of states in a three-terminal quantum ring

R. Leturcq[1], A. Fuhrer[1], T. Ihn[1], K. Ensslin[1], and W. Wegscheider[2]
[1]ETH Zurich, Switzerland; [2] University of Regensburg, Germany

The Kondo effect is investigated in a many-electron quantum ring as a function of magnetic field. For fields applied perpendicular to the plane of the ring a modulation of the Kondo effect with the Aharonov-Bohm period is observed. This effect is discussed in terms of the energy spectrum of the ring and the parametrically changing tunnel coupling. In addition, we use gate voltages to modify the ground state spin of the ring. The observed splitting of the Kondo related zero bias anomaly in this configuration is tuned with an in-plane magnetic field. It has been shown that the dot-lead coupling can be determined quantitatively for quantum dots connected to three terminals. The Kondo effect is studied in a three-terminal quantum ring. By measuring the currents through the differently biased terminals it can be determined which lead has Kondo correlations with the dot and which does not. This way we can measure a so-called zero bias anomaly which is related to the Kondo effect through a lead with no or weak Kondo correlations. The possibility to probe the density of states in the Kondo regime using a three-terminal configuration is discussed.

Spin relaxation in lateral quantum dots

Vladimir Falko
Lancaster University, UK

We present theoretical results for inelastic spin relaxation of electrons in few-electron lateralquantum dots, both in the high and low magnetic field regimes. At high fields (with the field oriented in the plane of heterostructure), the process is mediated by phonon emission, whereas in the low-field regime it is dominated by scattering of thermal phonons with a small energy transfer. In both cases, spin-flip of an electron is caused by spin-orbit coupling in combination wih the time-reversal symmetry breaking by a magnetic field.

Quantum pumping in normal and superconducting nanostructures

M. Governale[1], J. Konig[2], J. Splettstoesser[1,2], F. Taddei[1], and R. Fazio
[1]Scuola Normale Superiore, Pisa, Italy
[2]Ruhr Universitat Bochum, Germany

I will present recent results we obtained for quantum pumping in nanostructures. I will discuss the case of pumping through an interacting quantum dot and the case of pumping through a superconducting point contact.

Theory of superconductive pairing near the mobility edge

Mikhail Feigelman
Landau Institute for Theoretical Physics, Moscow, Russia

Theory of superconductive correlations between Anderson-localized electron states is developed. Both insulating and superconductive states are considered. In the insulating state, a single-particle spectral gap is shown to be the consequence of Cooper attraction of localized electrons, in agreement with experimental observations of Arrenius low-temperature resistivity in indium oxide films. Superconductive state formed out of Anderson insulator is characterized by a pseudogap-type phenomenology with anomalously large ratio of single-particle gap to superconductive transition temperature.

Diffuse emission in the presence of the spin-orbit interaction

Alexander Finkelstein
Weizmann Institute of Science, Rehovot, Israel

A lateral interface connecting two regions with different strengths of the Bychkov-Rashba spin-orbit interaction can be used as a spin polarizer of electrons in two dimensional semiconductor heterostructures. In this work we consider the case when one of the two regions is ballistic, while the other one is diffusive. We generalize the technique developed for the solution of the problem of the diffuse emission to the case of the spin dependent scattering at the interface, and determine the distribution of electrons emitted from the diffusive region. It is shown that the diffuse emission is an effective way to get electrons propagating at small angles to the interface that are most appropriate for the spin filtration and a subsequent spin manipulation.

Charge transfer between a superconductor and a hopping insulator

V. I. Kozub[1,2], A. A. Zuzin[1], Yu. M. Galperin[1,2,3], and V. M. Vinokur[2]
[1]A. F. Ioffe Physico-Technical Institute of Russian Academy of Sciences,
194021 St. Petersburg, Russia
[2]Argonne National Laboratory, 9700 S. Cass Av., Argonne, IL 60439, USA
[3]Department of Physics, University of Oslo, PO Box 1048 Blindern, 0316 Oslo, Norway

A theory of the low-temperature charge transfer between a superconductor and a hopping insulator is analyzed, and the corresponding interface resistance is calculated.
We have analyzed low-temperature charge transfer between a superconductor and a hopping insulator and calculated the interface resistance. This resistance is dominated by Andreev-type processes involving localized states in the insulator. We emphasize that only these processes allow low-temperature measurements of hopping transport using superconducting electrodes. Even in the case when the interface contribution is less than the typical resistance of the hopping system the former can be separated by a relatively weak magnetic field which drives the superconductor to the normal state, but does not affect the hopping transport.

Transport and Aging in Wigner glass

Thierry Giamarchi
University of Geneva, Switzerland

In two dimension electron-electron interactions can lead to a Wigner crystal phase, with quite different properties from a standard Fermi liquid. In the presence of disorder this crystal gets pinned. The competition between disorder and the elasticity of the crystal leads in addition to glassy properties. I will discuss here the physical properties of such a system both for the transport and also for thermodynamic quantities such as the compressibility. As in any glass, the presence of many metastable states, allows in principle for the existence of aging phenomena, in which the response of the system depends on the time it was in the glassy state. Possibility to observe this property in the Wigner glass will be discussed.

Energy-resolved inelastic electron scattering off a magnetic impurity

Leonid Glazman
University of Minnesota, Minneapolis, USA

We investigate the loss of energy by an electron scattered off a magnetic impurity in a metal. If the initial electron energy E (measured from the Fermi level) is high compared to the Kondo temperature, then the scattering is predominantly inelastic. However, the characteristic energy loss in the scattering event is of the order of the Kondo energy scale (*i.e.*, small compared to E). We find the full energy dependence of the corresponding scattering cross-section by relating it to the dissipative part of susceptibility of the magnetic impurity. Effects of a magnetic field and temperature on the energy-resolved scattering cross-section are fully characterized. This cross-section may be extracted from experiments with hot electrons in nanowires and quantum dots.

Instability of quasi-local oscillations in glasses and general features of their densities of states

Vadim Gurevich
Ioffe Physico-Technical Institute, Saint-Petersburg, Russia

Title not provided

Frank Hekking
Universite Joseph Fourier, Grenoble, France

Transport in ID Coulomb Systems

Alex Kamenev
University of Minnesota, Minneapolis, USA

In many quasi ID system such as ion channels in living cells, nanopores in silicon, nanowires etc. the carriers interact through the true ID Coulomb potential. This happens due to the large mismatch of the dielectric constants, that makes the electric field to stay inside the channel. We discuss peculiar thermodynamics and transport properties of such systems with the emphasis on the cooperative many-body effects.

Fano-Kondo resonance in quantum dot - wire hybrids

Shingo Katsumoto
Institute for Solid State Physics, University of Tokyo 5-1-5 Kashiwanona, Kashiwa, Chiba 277-8581, Japan

A quantum dot with an odd number of electrons works as a magnetic impurity for electrons in electrodes attached to it. Hence one can investigate phenomena peculiar to magnetic impurities, such as the Kondo effect, through single quantum dots. The Kondo effect is a typical many body effect, which originates from multiple spin-scattering by a magnetic impurity and results in the formation of a Kondo state in resonance with the Fermi level of the surrounding electrons. When a Kondo system reaches the unitary limit, the phase shift of the electron through the impurity should be $\pi/2$ because the Fermi surface is in complete resonance with the Kondo state.
This phase shift of $\pi/2$ is hence very important evidence to certificate the resonance feature of the Kondo effect. The simplest way to measure phase shift of a Kondo state is to embed it to an interferometer. This experiment also gives important information on the coherence of a Kondo state. It is theoretically predicted and experimentally confirmed that a spin scattering of an electron on a quantum dot leads to quantum decoherence. Although a Kondo state results from multiple spin-scattering and is formed through entanglement of a large number of

freedom, it is considered to be coherent due to «asymptotic strong coupling».
While the Kondo effect is a resonance due to a many-body effet, the Fano resonance is a kind of geometrically induced resonance. We have confirmed the coherence and the $\pi/2$ phase shift through the Fano-Kondo resonance, a combination of these two different kinds of resonances in hybrid systems of quantum dots and quantum wire interferometers. In this talk, I would like to present our experimental results on the Fano-Kondo effect and compare them with theories from a practical view point.

The Interplay of Spin and Charge Channels in Zero Dimensional System

Mikhail Kiselev[1] and Yuval Gefen[2]
[1]Physics Department, Arnold Sommerfeld Center for Theoretical Physics and Center for Nano-Science, Ludwig-Maximilians University, Munich, Germany
[2]Department of Condensed Matter Physics, The Weizmann Institute of Science, Rehovot 76100, Israel

We consider the interplay of the charge and spin zero-mode interactions in quantum dots. The non-perturbative effects of zero-mode interaction are described in terms of propagation of gauge bosons associated with charge and spin fluctuations in the dot. The Coulomb and longitudinal spin components are accounted for exactly, while transverse fluctuations are studied perturbatively (with the easy axis anisotropy). These fluctuations become important as one approaches the Stoner instability. We study the influence of spin on differential conductance as well as the dynamic spin susceptibility.
*) This work is partially supported by EC HPRN-CT-2002-00302-RTN, BSF and Israel Academy of Science (YG), SFB-410 and RITA-CT-2003-506095 (MK).

Nonmonotonic charge occupation in double dots

Jürgen König[1] and Yuval Gefen[2]
[1]Institut fur Theoretische Physik III, Ruhr-Universitat Bochum, 44780 Bochum, Germany
[2]Department of Condensed Matter Physics, The Weizmann Institute of Science, 76100 Rehovot, Israel

We study the occupation of two electrostatically-coupled single-level quantum dots with spinless electrons as a function of gate voltage. While the total occupation of the double-dot system varies monotonically with gate voltage, we predict that the competition between tunneling and Coulomb interaction can give rise to a nonmonotonic filling of the individual quantum dots. This non-monotonicity is a signature of the correlated nature of the many-body wavefunction in the reduced Hilbert space of the dots. We identify two mechanisms for this nonmonotonic behavior, which are associated with changes in the spectral weights and the positions, respectively, of the excitation spectra of the individual quantum dots. An experimental setup to test these predictions is proposed.
[1] J. König and Y. Gefen, cond-mat/0408691.

Kondo Physics in Double Quantum Dots: Results from the Exact Solution

Robert Konik
Brookhaven National Laboratory, USA

Dynamic localization in quantum dots

Vladimir Kravtsov
The Abdus Salam ICTP, Trieste, Italy, and Landau Institute for Theoretical Physics, Moscow, Russia
The energy absorption in quantum dot with electron interaction subject to AC perturbation is considered for closed quantum mesoscopic systems and for a quantum dot in the regime of

Coulomb blockade. It is shown that for almost harmonic perturbation the absorption rate can be substantially reduced (dynamic localization) due to the quantum interference effects. Arbitrary weak electron interaction affects the dynamic localization making it a transient effect in closed systems. In the Coulomb blockade regime of open quantum dots the signature of dynamic localization is the plateau in the conductance vs gate voltage dependence.

Low-Temperature Decoherence of Qubit Coupled to Background Charges

Igor Lerner
University of Birmingham, UK

We present an exact expression for the decoherence rate of a qubit coupled to fluctuating background charges. At low temperatures T the decoherence rate is linear in T while at high temperatures our expression coincides with a known classical solution which is, however, reached in the strong coupling regime at surprisingly high T. A comparison of experimental data with our predictions would give an unambiguous indication of whether the experimentally observed decoherence of a Josephson-junction qubit is due to background charges.

Mesoscopic Fermi-Edge Singularity

Leonid Levitov
Massachusetts Institute of Technology, Cambridge, USA

Spin and charge dephasing in double quantum dots

Charles Marcus
Harvard University, Cambridge, USA

We discuss recent measurements of spin and charge dephasing in GaAs double quantum dot systems. For spin dephasing, the principle mechanism at low field is hyperfine interaction. Theory and experiment are in very good agreement.

Exchange Coupling in a One-Dimensional Wigner Crystal

Konstantin Matveev
Argonne National Laboratory, USA

We consider a long quantum wire at low electron densities. In this strong interaction regime a Wigner crystal may form, in which electrons comprise an antiferromagnetic Heisenberg spin chain. The coupling constant J is exponentially small, as it originates from tunneling of two neighboring electrons through the segregating potential barrier. We study this exponential dependence, properly accounting for the many-body effects and the finite width of the wire.

Giant mesoscopic oscillations of Andreev levels

N. B. Kopnin[1, 2], A. S. Mel'nikov [3, 4], V. I. Pozdnyakova [3], D. A. Ryzhov [3], I. A. Shereshevskii [3], and V. M. Vinokur [4]
[1] Low Temperature Laboratory, Helsinki University of Technology, P.O. Box 2200, FIN-02015 HUT, Finland
[2] L. D. Landau Institute for Theoretical Physics, 117940 Moscow, Russia
[3] Institute for Physics of Micro structures, Russian Academy of Sciences, 603950, Nizhny Novgorod, GSP-105, Russia
[4] Argonne National Laboratory, Argonne, Illinois 60439, USA

The interplay of geometrical and Andreev quantization in mesoscopic superconductors leads to giant mesoscopic fluctuations of sub-gap energy states as functions of the Fermi momentum and/or sample size. General quantization rules are formulated for closed quasiparticle trajectories which appear in the presence of normal scattering at the sample boundaries. Two particular examples of mesoscopic systems are studied: (i) superconductor/normal-metal/superconductor (SNS) structure in a quantum box, (ii) a single vortex in a mesoscopic cylinder.

Anomalous diffusion and decoherence in rings connected to networks

G. Montambaux[1] and C. Texier[1, 2]
[1] Laboratoire de Physique des Solides, Associé au CNRS,
[2] Laboratoire de Physique Théorique et Modèles Statistiques, Associé au CNRS, Université Paris Sud, F-91405 Orsay, France

We consider the harmonics content of the weak-localization oscillations (Altshuler-Aronov-Spivak) for a ring connected to a network. We show that the presence of wires connected to the ring modifies the winding of the Brownian trajectories around the ring, and thus modifies the harmonics content. The physical origin of this new behaviour is the anomalous diffusion of Brownian trajectories around the ring, in the presence of the wires. More generally we study the winding properties of Brownian curves connected to an arbitrary network. This analysis is based on the formalism of the spectral determinant and on the introduction of an effective perimeter probing the different time scales.
Then we study the effect of electron-electron interaction on the weak-localization correction for a ring pierced by a magnetic flux, attached or not to connecting wires. We calculate exactly the magnetoconductance of the isolated ring and analyze in details the behavior of the harmonics in several limiting cases. We give simple arguments to understand the geometry dependence of the decoherence rate.

Nonequilibrium vibrations in transport through single molecules

Felix von Oppen
Freie Universität Berlin, Germany

Charge transport through single molecules is generally associated with the excitation of vibrational modes (phonons). In this talk, I discuss the effects of vibrational nonequilibrium on transport in the limit of slow vibrational relaxation (large currents) within a generic «local-polaron» model for the molecule. In the regime of strong electron-phonon coupling, charge transport at low bias is shown to occur via avalanches of large numbers of electrons. These avalanches consist of smaller avalanches, leading to a self-similar hierarchy. This unusual mode of transport is reflected in giant Fano factors, a power-law shot noise spectrum, and strongly non-Gaussian full counting statistics. In the regime of weak electron-phonon coupling, we find that surprisingly, the stationary phonon distribution broadenes with weakening electron-phonon coupling. The width of the phonon distribution exhibits a power-law divergence in the limit of vanishing electron-phonon coupling, with voltage-dependent non-integer exponents. In certain cases, we obtain analytical expressions for the complete phonon distribution by a mapping to a Fokker-Planck equation.

RKKY and magnetic field interactions in coupled Kondo quantum dots

Yuval Oreg
Weizmann Institute of Science, Rehovot, Israel

We investigate theoretically the transport properties of two independent artificial Kondo impurities. They are coupled together via a tunable Ruderman-Kittel-Kasuya-Yoshida (RKKY) interaction. For strong enough antiferromagnetic RKKY interaction, the impurity density of states increases with the applied in-plane magnetic field. This effect can be used to distinguish between antiferromagnetic and ferromagnetic RKKY interactions. These results may be relevant to explain some features of recent experiments by Craig et al. (cond-mat/0404213).

Anderson Insulators as Quantum Glasses

Zvi Ovadyahu
The Racah Institute of Physics, The Hebrew University, Jerusalem, Israel

The out-of-equilibrium transport properties of Anderson insulators exhibit many glassy features. These include slow relaxation, slow approach to a steady state, ageing, and other memory effects that are common characteristics of other types of glasses. The typical relaxation time of this, so called electron glass, may be controlled by disorder, magnetic field, and carrier concentration. Due to the absence of metallic screening, the inter-electron interaction strength increases with the concentration of carriers, which in turn slows down the relaxation processes in this medium. Interestingly, in contrast with most other glasses, the system dynamics does not slow down upon cooling below a *glass-temperatures*, a feature consistent with the behavior expected of a quantum glass.

Dephasing of interacting electrons in quantum wires: Fermi vs Luttinger

D.G. Polyakov[1, 2], I.V. Gornyi[1, 2], and A.D. Mirlin[1, 3]
[1] Institut fur Nanotechnologie, Forschungszentrum Karlsruhe, 76021 Karlsruhe, Germany
[2] A.F. Ioffe Physico-Technical Institute, 194021 St.Petersburg, Russia
[3] Petersburg Nuclear Physics Institute, 188350 Gatchina, St. Petersburg, Russia

Recent progress on dephasing phenomena due to Coulomb interaction in one dimension will be reviewed from the perspective of both the Fermi-liquid and Luttinger-liquid theories. The underlying physics is made transparent by calculating the dephasing rate that governs the strength of Anderson-localization effects in a single-channel quantum wire in the presence of disorder (inhomogeneous Luttinger liquid). The dephasing rate that describes the decay of Aharonov-Bohm oscillations in a ring geometry will also be discussed. I will outline a rich crossover behavior between two limiting cases, the single-channel Luttinger liquid and a wide many-channel quantum wire. A mechanism of strong magnetoresistance in a single-channel quantum wire in a perpendicular magnetic field will be considered, related to the strong dependence of the dephasing rate on spin polarization. Finally, I will discuss the dephasing and Anderson-localization effects in a system of quantum Hall edges, coupled by both inter-edge interaction and a disorder-induced inter-edge tunneling.

Quantum Shot Noise of a Diffusive Wire - Third Moment and Driven Response

P. E. Prober[1] and B. Reulet[1, 2]
[1] Yale University, USA
[2] Universite Paris-Sud, France

We present some new methods to measure the third moment of the shot noise, recognizing that the correlations between different frequency components reveal information about the sample's internal physics which is absent in the second moment. This also allows us to understand the predictions of the frequency dependence of the third moment in systems with a finite dwell time. We then show that the second moment noise, under conditions of an external ac drive, reveals similar information about the dwell time and internal dynamics of a nanosystem. Such a measurement allows us to access internal dynamics that is not revealed in the (undriven) second moment, such as the diffusion time of a wire, the dwell time of a cavity, or the electron-phonon time. The second moment by itself is unaffected by the dynamics associated with these times.

Interaction Effects in Partially Polarized 2D Electron System

Vladimir Pudalov
P.N. Lebedev Physics Institute, Moscow, 119991 Russia

I shall report on experimental studies of electron-electron interaction effects in 2D at low temperatures (in the diffusive regime), with emphases on electron transport in the presence of a parallel field, and on renormalization of the electron parameters in spin-polarizing field. A quantitative agreement with theory of interaction corrections (persisting in the ballistic regime) is lost in the diffusive regime. In order to understand the origin of the disagreement, we applied an in-plane magnetic field and investigated how the triplet contributions of e-e interaction vanish as Zeeman energy increases. Experimental magnetoresistance *R(T)* data (for various *B*) is qualitatively similar to the theory, but deviates quantitatively from the calculated interaction corrections.
For the strong in-plane field (spin polarization up to 60%) we compared the partial renormalization of the effective electron parameters in the minority and majority subbands. We observed that the electrons in the minority and majority subbands have almost the same effective mass, quantum life time, and *g*-factor, even when the difference in the population of majority/minority subbands is of order 1. This is in contrast with that expected from the perturbative calculations within the Fermi-liquid theory. Our result evidences that the interaction takes place between all electrons in 2D rather than in each spin-subband separately, whatever large the Zeeman splitting is.

Effect of disorder on the compressibility of two-dimensional electron systems

A. K. Savchenko, E. A. Galaktionov, and G. D. Allison
University of Exeter, UK

The compressibility has been studied in 2D electron and hole gases near the apparent 'metal-to-insulator' transition (MIT). This thermodynamic property is compared with the results in [1] where an upturn in the inverse compressibility ($d\mu/dn$) of a 2DHG was observed at the MIT, and interpreted as a signature of a phase transition.
Two types of GaAs/AlGaAs heterostructure have been studied at temperatures down to 0.03K: a double-layer 2DEG system and a single-layer 2DHG. They have very different values of the interaction parameter r_s: less than 2.5 in the 2DEG and from 10 to 30 in the 2DHG. In the case of the 2DEG, both the direct capacitance and penetration-field techniques [2] are used and shown to give close results.
The results on the 2DEG show that with decreasing electron concentration negative $d\mu/dn$ experiences an upturn to positive values, which can be explained by the rapid, disorder-driven proliferation of depletion regions [3]. In spite of much larger r_s-values, the behaviour of $d\mu/dn$ in the 2DHG appears to be still in agreement with [3]. This suggests that the upturn is caused not by interactions but disorder.
[1] S. C Dultz and H. W. Jiang, Phys. Rev. Lett. 84, 4689 (2000)
[2] J. P. Eisenstein and L. N. Pfeiffer and K. W. West, Phys. Rev. Lett. 68, 674 (1992)
[3] A. L. Efros, F. G. Pikus, and V. G. Burnett, Phys.Rev. B 47, 2233 (1993); M. M. Fogler, Phys. Rev. B 69, 121409 (2004)

Decoherence Processes in Quantum Devices

Gerd Schon and Alexander Shnirman
Institut fur Theoretische Festkoperphysik, Universitat Karlsruhe, D-76128 Karlsruhe, Germany

Motivated by recent experiments with Josephson-junction circuits [1], we analyse the influence of various noise sources on the dynamics of quantum two-level systems. We focus on the experimentally relevant $1/f$ and Ohmic noise power spectra as well as quasi-static noise. We also study decoherence at optimal operation points where the linear longitudinal coupling to low-frequency fluctuations is suppressed. The remaining quadratic coupling leads after a short initial period to a power-law decay of the free induction signal. If the $1/f$ spectrum extends to high enough frequencies, the decay law crosses over into a simple exponential one; otherwise, in the quasi-static case, the power-law dependence persists [2]. We discuss the decay of the echo signal at the optimal point. We also provide an explanation for the observed relation between the low- and high-frequency noise, in terms of a model where a bath of two-level systems is coupled to the qubit both transversely and longitudinally [3].

[1] G. Ithier, E. Collin, P. Joyez, P. Meeson, D. Vion, D. Esteve, F. Chiarello, A. Shnirman, Y. Makhlin, and G. Schön, *Decoherence in a quantum bit superconducting circuit, in preparation*
[2] Yu. Makhlin and A. Shnirman, Phys. Rev. Lett. 92, 178301 (2004)
[3] A. Shnirman, G. Schön, I. Martin, and Yu. Makhlin, *Relation between high and low frequency noise*, cond-mat/0412668

Nanoelectromechanical single-electron transistor with spin-polarized leads

Robert Shekhter
University of Gothenburg, Sweden

We study the effect of coupling between the spin degree of freedom of electrons and the shuttle phenomena in a nanoelectromechanical single-electron transistor with spin-polarized leads. It is shown that in such a system the shuttle effects can be controlled via external magnetic field. Different stable regimes of the spintronic NEM-SET operation are found and analyzed. Two types of transitions between stable states as a function of the magnetic and electric field are found.

Geometric nature of the environment-induced Berry phase and geometric dephasing

Robert S. Whitney[1], Yuriy Makhlin[2, 3], Alexander Shnirman[2], and Yuval Gefen[4]
[1] Département de Physique Théorique, Université de Genève, 24 Quai Ernest-Ansermet, CH 1211 Genève 4, Switzerland
[2] Institut für Theoretische Festköperphysik, Universität Karlsruhe, D-76128 Karlsruhe, Germany
[3] L.D.Landau Institute for Theoretical Physics, Kosygin str. 2, Moscow, 119334, Russia
[4] Department of Condensed Matter Physics, the Weizmann Institute of Science, Rehovot 76100, Israel

We investigate the geometric phase or Berry phase (BP) acquired by a spin-half which is both subject to a slowly varying magnetic field and weakly-coupled to a dissipative environment (either quantum or classical). We study how this phase is modified by the environment and find that the modification is of a geometric nature. While the original BP (for an isolated system) is the flux of a monopole-field through the loop traversed by the magnetic field, the environment-induced modification of the BP is the flux of a quadrupole-like field. We find that the environment-induced phase is complex, and its imaginary part is a geometric contribution to dephasing. Its sign depends on the direction of the loop. Unlike the BP, this geometric dephasing is gauge invariant for open paths of the magnetic field.

Superconductivity in disordered thin films: giant mesoscopic fluctuations

M. A. Skvortsov and M. V. Feigel'man
Landau Institute for Theoretical Physics, Moscow, Russia

We discuss intrinsic inhomogeneities of superconductive properties of uniformly disordered thin films with large dimensionless conductance g. It is shown that mesoscopic fluctuations, which usually contain a small factor $1/g$, are crucially enhanced near the critical conductance gcp $g_{cF} \gg 1$ where superconductivity is destroyed at $T = 0$ due to the "fermionic" mechanism. This leads to strong spatial fluctuations of the local transition temperature and thus to percolative nature of the thermal superconductive transition.

Recent Progress on Microwave Induced Magnetoresistance Phenomena

Jürgen Smet
Max-Planck-Institut für Festkörperforschung, 70569 Stuttgart, Germany

The recent discovery of zero resistance induced by microwave radiation in ultra-clean two-dimensional electron systems over extended regions of an applied perpendicular magnetic field has revived the general interest in microwave photoconductivity and has triggered a remarkably large and diverse body of theoretical works. The sheer multitude of theoretical models and their divergence underline that no consensus has been reached on the precise origin of this non-equilibrium phenomenon. In order to assist in isolating the proper microscopic picture, we have carried out a detailed polarization dependent study using an all-optical approach to guide the microwave radiation onto the sample and to produce any circular or linear polarization state. Circular polarization offers for instance the perspective of activating and deactivating the cyclotron resonance absorption by reversing the rotation for a given magnetic field orientation. Knowledge of the influence of the microwave polarization state on the microwave induced resistance oscillations may turn out an important litmus test to exclude certain theoretical models. We have also investigated the influence of microwave radiation on the magnetoresistance in the regime beyond the zero resistance states when the cyclotron frequency exceeds the radiation frequency as some drastic changes do occur in this regime. Radiation below 30 GHz causes a strong suppression of the resistance over a wide magnetic field range, whereas higher frequencies produce a non-monotonic behavior in the damping of the Shubnikov-de Haas oscillations. These observations are captured well by assuming that intra-Landau level transitions establish a non-equilibrium distribution function. Finally, we report preliminary results on the use of local probe methods in the context of these microwave induced magnetoresistance phenomena. Such methods appear promising to measure microwave induced changes in the local electrostatic potential as well as the compressibility and, hence, may be particularly powerful to unravel the microscopic origin.
*This work has been carried out in collaboration with S. Dorozhkin, C. Jiang, B. Gorshunov, A. Yacoby, B. Verdene, V. Umansky, L. Pfeiffer, K. West, M. Dressel and K. von Klitzing.

Effects of interactions on nonlinear I-V charactersistics of mesoscopic systems

Boris Spivak
University of Washington, Seattle, USA

I will discuss nonlinear parts of I-V charactersistics of mesoscopic systems which are proportional to the magnetic field and quadratic in the electric field. These parts of I-V charcteristics are absent in a single electron approximation. Thus they are entirely due to electron-electron interaction.

Observation of giant thermal noise due to multiple Andreev reflection in ballistic InGaAs-based superconducting weak links

Hideaki Takayanagi
NTT Basic Research Laboratories, Japan

We have experimentally obtained clear evidence of giant thermal noise in a ballistic superconductor-normal metal-superconductor (SNS) junction with an InGaAs-based two-dimensional electron gas (2DEG). The thermal noise was estimated from a comparison of measured IV characteristics with an extended Ambegaokar and Halperin theory. As a consequence, we have observed the giant thermal noise which is much larger than that with normal reservoirs. This giant thermal noise can be explained by the theory considering both the ballistic transport of the 2DEG and the thermal fluctuation in the coherent multiple Andreev reflection regime.

Finite temperature dynamics of integrable models

B. Altshuler[1] and A. Tsvelik[2]
[1] Princeton University, USA
[2] Brookhaven National Laboratory, USA

We provide the Bethe ansatz derivation of finite T correlation functions in integrable models with spectral gaps. There are two types of operators: those whose dynamics is ballistic and those whose dynamics at lowest temperatures is semiclassical, as described by Sachdev and Yang, PRL 78, 2220 (1998). The latter behavior is almost universal depending on the semilocality index of the operator.

Vortices in long Josephson nano-junctions

Alexey Ustinov
Universitat Eriangen-Numberg, Germany

We investigate the dynamics on vortices and electromagnetic cavity modes in few hundred micron long and some hundred nanometer wide Josephson junctions. The local theory based on the sine-Gordon equation breaks down when the fields outside the junction contribute significantly to its energy, as occurs for very narrow long junctions. There have been several theoretical approaches treating the nonlocal electrodynamics of long Josephson junctions. Our study is the first attempt to experimentally verify the proposed models. We have fabricated and measured long Al-AlOx-Al and Nb-AlOx-Nb Josephson junctions of width ranging from 4000 nm to 100 nm. Experiments with open ended junctions show that the voltage spacing between Fiske steps on the current-voltage characteristics increases as the junction gets narrower, while the critical magnetic field for penetration of vortices into the junction is decreasing. These effects are due to stray electromagnetic fields outside the junction. The nonlocal theory developed by Ivanchenko [1] is in good agreement with the experimental data. By using an energy balance and a variational approach, we calculate the current-voltage characteristic of a single vortex and compare it with direct numerical simulations of the nonlocal sine-Gordon model. We find that the vortex velocity increases as the junction width decreases. The nonlocal dispersion of Josephson plasma oscillations leads to a radiation of Cherenkov waves by fast vortices. In an annular junction the excited Cherenkov waves induce resonances on the current voltage characteristics, which we find in numerical simulations. We also observed these resonances in experiment with annular junction, in a qualitative agreement with our analysis and simulations.

This work was done in collaboration with A. A. Abdumalikov, M. V. Fistul, V. V. Kurin, C. Helm, A. De Col, and Y. Koval.

[1] Yu. M. Ivanchenko, Phys. Rev. B 52, 79 (1995)

Transmission phase of a quantum dot in the Kondo regime

Hans Weidenmüller
Max-Planck-Institut fur Kernphysik, Heidelberg, Germany

This phase has been measured in Aharonov-Bohm (AB)rings, with results that have not yet been understood theoretically. We calculate the phase in terms of both, the sd-model and the Anderson model, taking account of the topology of the AB ring from the outset. In the former model, we can only determine the phase in the middle between two Coulomb-resonance peaks while in the latter model, a complete analysis is possible. In both cases, the phase is affected by closed loops of the electron around the AB ring which cause a dependence on the transmission phase on the AB phase. We assume that scattering of electrons passing through the AB ring is chaotic. Then the Kondo temperature itself and the transmission phase become random variables. The parameter dependence of these variables will be discussed.

Kondo and Fano Effect in Quantum Dot Systems

Jurgen Weis
Max-Planck-Institut für Festkörperforschung, Stuttgart, Germany

The Anderson impurity model has been used to describe the Kondo effect observed in metals with magnetic impurities. In recent time, single quantum dot systems have shown Kondo physics due to the spin-degenerate ground state found in the quantum dot. To get access to the spectral properties on the quantum dot site, a third lead has been added to the quantum dot. Our recent result on this arrangement will be presented - in the Kondo regime, but also in the Fano regime where the tunnel coupling to two leads is strong. In addition, our experimental results on two electrostatically coupled quantum dots with separate leads will be presented which map under circumstances onto the Anderson impurity model in terms of a pseudo-spin presentation. As expected, a Kondo resonance develops at low temperature due to correlated electron tunneling through both electrostatically interacting quantum dots. The role of the real spin as an additional degree of freedom in the system will be discussed.
This work has been done in collaboration with Alexander Hiibel, David Quirion, Armin Welker, and Klaus von Klitzing.

Non-linear effects in transport in low-dimensional quantum systems

Pavel Wiegmann
University of Chicago, USA

Transport in low-dimensional quantum systems is controlled mostly by Fermi-statistics or interactions which causing coherence. The very nature of these interactions causing transport to be non-linear. However in realistic cases nonlinear-effects are weak and often neglected by a good reason. This situation is about to change due to advances in fabrication long carbon nanotubes and and trapped quantum gases. Is there a room for nonlinear effects to develop, one can observe dramatic phenomena. Indeed, almost any smooth density packet, after some time develop shock-wave type singularities. We present a theory which describes Fermi systems in terms of hydrodynamics modes, where nonlinear corrections are taken into account. In a sence this theory is corrected version of "bosonization" - a popular method in studying Fermi systems- where nonlinear terms had not been mneglected. We also give a qualitative picture of singularities developing in non-linear kinetics of fermionic systems in restriced geometry.

Universalities in Electron Scattering on Large-scale Inhomogeneities

Dmitrii Maslov[1] and Vladimir Yudson[2]
[1] Department of Physics, University of Florida, P.O. Box 118440 Gainesville, FL 32611, USA
[2] Institute of Spectroscopy, Russian Academy of Sciences, Troitsk, Moscow region, 142190 Russia

We study electron propagation through a random array of rare strong scatterers (for instance, quantum antidots). For a wide class of scatterer's shapes, it is shown that in the quasi-classical limit $k_f a \gg 1$ (k_f is the Fermi wave number, a is a typical geometrical size of scatterers), the ratio $\eta = \tau_{tot}/\tau_{tr}$ of the transport, $1/\tau_{tr}$, and the total, $1/\tau_{tot}$, elastic scattering rates does not depend on the scatterer's shape. In particular, for specular scattering, this ratio is a universal constant determined only by the dimensionality (d) of the system: $\eta = 1/2$ for $d = 3$ and $\eta = 2/3$ for $d = 2$. Possible experimental manifestations are discussed.

Coupling between electronic and mechanical degrees of freedom in suspended nanotubes

Herre van der Zant
Delft University of Technology, the Netherlands

POSTER PRESENTATIONS

Photovoltaic effect in an Aharonov-Bohm ring

Lionel Angers
Université Paris Sud, Orsay, France

In a non centro-symetric mesoscopic sample the current is not simply an odd function of bias voltage. The current-voltage characteristic exhibits a rectifying contribution, which is quadratic in voltage. Its amplitude is directly linked to the Universal Conductance Fluctuations. In particular the response to a high frequency excitation exhibits a DC component called the photovoltaic effect. We studied this effect in details, in an Aharonov Bohm ring composed by a 2D electron gas as a function of: temperature, magnetic field and frequency (several Giga-Hertz). We showed that this response contains at all frequency a component which is asymmetric in magnetic field. It can be related to the current-induced distortion of the disorder potential. Moreover the frequency response exhibits narrow peaks which could be the signature of the resonance of two level systems weakly coupled to the 2D electron gas.

Coulomb drag by small momentum transfer between quantum wires : Bosonization approach

Dmitry Aristov[1,2]
[1] Institut für Theorie der kondensierten Materie, Universität Karlsruhe, 76128 Karlsruhe, Germany
[2] Petersburg Nuclear Physics Institute, 188350 Gatchina, St. Petersburg, Russia

I calculate the drag conductivity between the quantum wires within the bosonization approach. At larger interwire distances the backscattering component of the interwire Coulomb interaction is exponentially small and the remaining intra- and interwire interactions are treated exactly within the Luttinger liquid scheme. The drag effect is caused by the curvature of the fermionic dispersion, which corresponds to cubic terms in fermionic density in bosonized action. I treat these irrelevant terms as perturbation, to obtain the optical conductivity for finite temperatures. The optical sum rule and refined perturbation theory are used to estimate the shape of the Drude peak in transconductivity.

Statistics of Current Fluctuations and Coulomb Interaction in Diffusive Conductors

Dmitry Bagrets
Institut für Theoretische Festköperphysik, Universität Karlsruhe, D-76128 Karlsruhe, Germany

I evaluate the full current statistics (FCS) in the low dimensional (1D and 2D) diffusive conductors in the incoherent regime, $eV \gg 1/\tau_D$, τ_D being the diffusion time through the conductor [1]. It is shown that Coulomb interaction substantially enhances the probability of big current fluctuations for short conductors with $\tau_D \ll \tau_E$, τ_E being the voltage dependent energy relaxation time, leading to the exponential tails in the current distribution. These tails arise from the correlated fluctuations of the currents of electron-hole pairs which are excited by the low frequency classical fluctuations of the electromagnetic field in the system. The strongest current fluctuations occur for temperatures below $1/\tau_D$, provided $\tau_D \sim \tau^*(V)$, where the time scale $\tau^*(V)$ is parametrically smaller than the energy relaxation time $\tau_E(V)$. Remarkably, the time $\tau^*(V)$ transforms to the decoherence time $\tau_\varphi(T)$, known from the theory of weak localization [2], if one substitutes voltage for the temperature.

Detection of emission/absorption properties of mesoscopic devices

Pierre-Marie Billangeon
Université Paris Sud, Orsay, France

Statistical properties of a disordered cavity with non-ideal leads

Gabriele Campagnano
Delft University of Technology, the Netherlands

We consider a quantum cavity connected to non-ideal leads. Among possible ways to study such a system we consider circuit theory (semiclassical approximation in the Green's function) and random matrix theory. We point out the differences in the results provided by these two methods and give a possible explanation for this discrepancy.

SNS junction with Rashba 2DEG

Olga Dimitrova
Landau Institute for Theoretical Physics, Moscow, Russia

Non-equilibrium phenomena in a 2D electron gas under microwave radiation: Magnetooscillations in the photoconductivity and compressibility and the emergence of zero-resistance states

Ivan Dmitriev[1,2]
[1] Institut fur Nanotechnolgie, Forschungszentrum Karlsruhe, 76021 Karlsruhe, Germany
[2] A.F. Ioffe Physico-Technical Institute, 194021 St.Petersburg, Russia

Non-equilibrium phenomena in a 2D electron gas under microwave radiation: Magnetooscillations in the photoconductivity and compressibility and the emergence of zero-resistance states
We have shown that microwave irradiation of a two-dimensional electron gas (2DEG) in a magnetic field yields a non-equilibrium correction to the distribution function which oscillates with both (i) the ratio of energy to the cyclotron frequency and (ii) the ratio of the radiation frequency to the cyclotron frequency. The oscillations are induced by interplay of Landau quantization and disorder and their strength is controlled by inelastic electron-electron scattering. Even a small correction to the distribution function may lead to a dramatic effect in the photoconductivity; in particular, to the development of recently observed zero-resistance states. We discuss various temperature regimes of the photoconductivity oscillations as well as the effect of microwaves on magnetoconductivity below the cyclotron resonance. The non-equilibrium electron distribution also induces strong oscillations in the 2DEG compressibility. Local probe measurements of the compressibility are expected to provide information about the domain structure of the zero-resistance states.

LA. Dmitriev, A.D. Mirlin, and D.G. Polyakov, Phys. Rev. Lett. 91, 226802 (2003); Phys. Rev. B 70, 165305 (2004).
I. Dmitriev, M.G. Vavilov, I.L. Aleiner, A.D. Mirlin, and D.G. Polyakov, Physica E 22, 260 (2004); Phys. Rev. B 70, 161306(R) (2004); Phys. Rev. B 71, 115316 (2005).

Superconducting Fluctuation Corrections to the Thermal Current in Granular Metals

Raffaello Ferone
Universite Joseph Fourier, Grenoble, France

The first order superconducting fluctuation corrections to the thermal conductivity of a granular metal are calculated. A suppression of thermal conductivity proportional to $T_C/(T-T_C)$ is observed in a region not too close to the critical temperature. As $T \simeq T_C$, a saturation of the correction at a value $-(3z\pi^2)/(g_T)$ is found, where g_T is the macroscopic dimensionless conductance, and z the number of nearest neighbors. In both regimes, the Wiedemann-Franz law is violated.

The Anderson transition in non-random Hamiltonians

Antonio Garcia Garcia
Princeton University, USA

We investigate the effect of classical singularities in the quantum properties of non-random Hamiltonians. We present explicit results for the case of a kicked rotator with a non-analytical potential though extensions to higher dimensionality or conservative systems are straightforward. It is shown that classical singularities produce anomalous diffusion in the classical phase space. Quantum mechanically, the eigenstates of the evolution operator are power-law localized with an exponent universally given by the type of classical singularity. For logarithmic singularities, the classical motion presents $1/f$ noise and the quantum properties resemble those of an Anderson transition, namely, multifractal eigenstates and critical statistics. Neither the classical nor the quantum properties depend on the details of the potential but only on the type of singularity. It is thus possible to define new universality class in quantum chaos by the relation between classical singularities (anomalous diffusion) and quantum power-law localization.

Nonequilibrium Electron Transport in Superconducting Microrefrigerators and Mesoscopic Josephson Transistors Controlled by Quasiparticle Injection

Francesco Giazotto
NEST-INFM and Scuola Normale Superiore, Pisa, Italy

Coolers are in general characterized by their cooling power, efficiency and operating temperature under various conditions. In order to assign a temperature to a system it is necessary to assume that the energy relaxation within the system is faster than any rate associated with the heat flux between the considered system and its surroundings. When this condition fails, the quasiparticle distribution function in the structure is non-thermal, and applying the concept of temperature is inappropriate. This limit can be achieved in nanocoolers at low temperatures. We present experimental results on superconductor(S)-insulator(I)-normal metal(N) double nanocoolers. In particular we demonstrate two phenomena occurring in such structures at low temperature, i.e., evidence of non-thermal energy distribution of the cooled quasiparticles and reentrant behavior with anomalous heating at low-bias voltages, the latter due to the presence of states within the superconducting gap. Then we theoretically show how the distinctive quasiparticle distribution existing under nonequilibrium in a SINIS mesoscopic line can be used as a novel tool to control the supercurrent intensity in long Josephson SNS weak links. Supercurrent enhancement and suppression, including a marked transition to a p-junction are striking features leading to a fully tunable structure. The role of the degree of nonequilibrium and temperature, as well as features like noise and gain are also addressed. We present the experimental results of this transistor realized in the hot-electron regime. Both enhancement of the supercurrent by more than a factor of two and fast suppression have been achieved by varying the cooler bias demonstrating large current gain (~ 20) and low power dissipation. We conclude by describing an all-superconducting Josephson transistor whose operation principle relies on the manipulation of the electron distribution in one of the junction superconducting electrodes.

Interaction effects in Magnetooscillations in a two-dimensional electron gas

Yu. Adamov[1,2], I.V. Gornyi[1,3], and A.D. Mirlin[1,4]
[1] Institut für Nanotechnologie, Forschungszentrum Karlsruhe, Germany
[2] Brookhaven National Laboratory, USA
[3] Ioffe Physico-Technical Institute, 194021 St.Petersburg, Russia
[4] Petersburg Nuclear Physics Institute, 188350 Gatchina, St. Petersburg, Russia

Motivated by recent experiments on 2D structures showing an apparent metal-insulator transition, we consider effects of electron-electron interactions on the damping of magneto-oscillations in a 2D electron gas. We study both long-ranged and short-ranged interactions in a whole range of temperatures, from the diffusive to the ballistic regime. We show that in the experimentally relevant ballistic regime, the dominant effect on the damping comes from the renormalization of the electron mass due to the interplay of disorder and interactions, while the interaction-induced correction to the single-particle scattering time yields a subleading contribution. We calculate the correction to the effective mass which behaves logarithmically as a function of temperature. This makes it possible to extract the value of the effective mass from the magneto-oscillations data.

Rashba effect in quantum networks

Michele Governale[1] Dario Bercioux[2,3], Vittorio Cataudella[3], and Vincenzo Marigliano Ramaglia[3]
[1] NEST-INFM & Scuola Normale Superiore, Piazza dei Cavalieri 7, I-56126 Pisa, Italy
[2] Institut für Theoretische Physik, Universität Regensburg, D-93040, Germany
[3] Coherentia-INFM & Dipartimento di Scienze Fisiche Università degli Studi "Federico II", I-80126 Napoli, Italy
[4] NEST-INFM & Scuola Normale Superiore, Piazza dei Cavalieri 7, I-56126 Pisa, Italy

We introduce a formalism to study quantum networks made up of quantum wires with Rashba spin-orbit coupling. For a particular one-dimensional lattice (chain of square loops connected at one vertex), we show that the Rashba effect induces electron localization[l]. This localization phenomenon is due to the combined effect of quantum-mechanical interference and of the geometry of the lattice. We present results for the spectral properties of the infinite chain, and for linear transport through a finite-size chain connected to leads. Furthermore, we investigate transport in two-dimensional networks in the presence both of spin-orbit coupling and of a perpendicular magnetic field. Finally, the effect of disorder on the transport properties of finite-size networks is investigated within a model where the bond lengths are allowed to fluctuate.

[1] D. Bercioux, M. Governale, V. Cataudella, and V. Marigliano Ramaglia, Phys. Rev. Lett 93, 056802 (2004).

Spin Transport in Paramagnetic Systems

Daniel Greenbaum
Weizmann Institute of Science, Rehovot, Israel

We have studied the transport of magnetization and energy in systems of spins 1/2 on a lattice at high temperature. This work was motivated by recent experiments which observed spin diffusion among the dipolar coupled nuclear spins of the insulator calcium fluoride, under conditions where it was appropriate to neglect the coupling to any heat reservoir. The dynamics under these conditions is coherent and reversible, yet signatures of irreversibility (i.e. diffusion) are typically observed. This state of affairs poses a formidable conceptual puzzle. We approach this problem by studying transport in two tractable limits, that where the XY term of the spin Hamiltonian is dominant, and that where it can be treated as a perturbation compared to the Ising term. We calculate diffusion coefficients for magnetization and energy in these two limits,

using Redfield's phenomenological moment method for the first and a linear response formalism for the second. In the case of dipolar couping, both limits are found to show slightly more rapid diffusion of inter spin energy than magnetization, in qualitative agreement with experiments.

[1]. D. Greenbaum, M. Kindermann, C. Ramanathan, and D. G. Cory, Phys. Rev. B 71, 054403 (2005).
[2] D. Greenbaum, Ph.D. Thesis, MIT (2004). (unpublished).

Hydrodinamic description of correlation functions in Calogero-Sutherland model

Dmitry Gutman
University of Chicago, USA

Quantum Charge Fluctuation in a Superconducting Grain

Manuel Houzet
CEA Grenoble, France

We consider charge quantization in a small superconducting grain that is contacted by a normal-metal electrode and is controlled by a capacitively coupled gate. At zero temperature and zero conductance G between the grain and the electrode, the charge Q as a function of the gate voltage V_g changes in steps. The step height is e if the superconducting gap of the grain is smaller than its charging energy. Quantum charge fluctuations at finite conductance remove the discontinuity in the dependence of Q on V_g and lead to a finite step width, proportional to G^2. The resulting shape of the Coulomb blockade staircase is of a novel type. The grain charge is a continuous function of V_g while the differential capacitance, dQ/dV_g, has discontinuities at certain values of the gate voltage. We determine analytically the shape of the Coulomb blockade staircase also at non-zero temperatures. Collaboration with D. Pesin, A. Andreev, and L. Glazman.

Classical and Quantum Memory Effects on Spin Dynamics in Two-Dimensional Systems

Valentin Yu. Kachorovskii
Ioffe Physico-Technical Institute, Saint-Petersburg, Russia

Entanglement in Noninteracting Mesoscopic Structures

A. V. Lebedev[1], G. Lesovik[1,2], and G. Blatter[2]
[1] L.D. Landau Institute for Theoretical Physics RAS, 119334 Moscow, Russia
[2] Theoretische Physik, ETH-Hönggerberg, CH-8093 Zürich, Switzerland

We analyze the origin and degree of entanglement in a mesoscopic normal-metal ballistic conductor where an incident current of free fermions is split into two spatially separated particle streams. We determine the non-local in time and space current-current cross correlator $\langle \hat{I}(x_1,t_1)\hat{I}(x_2,t_2)\rangle$ and show how it is used in the Bell inequality test of spin-entangled electron pairs. In the tunneling limit, our general formula for the Bell parameter can be simplified and expressed through the zero frequency noise correlator. Away from the tunneling limit a short time measurement of current fluctuations is required in order to violate the Bell inequality. We identify the role of fermionic statistics and projective measurement in the generation of these spin-entangled electrons.

Classical and Quantum Memory Effects on Spin Dynamics in Two-Dimensional Systems

Ilya Lyubinskiy
Ioffe Physico-Technical Institute, Saint-Petersburg, Russia

Avoiding decoherence in Josephson quantum circuits

Yuriy Makhlin
Landau Institute for Theoretical Physics, Moscow, Russia

Various strategies for extending coherence times of superconducting qubits have been proposed. We analyze the effect of fluctuations on a qubit operated at an optimal point in the free-induction decay and the spin-echo-like experiments. Motivated by the recent experimental findings we consider low-frequency flicker noise with low or high, soft or hard ultraviolet cut-off, in one or several independent channels.

Decoherence in degenerate Fermi systems coupled to quantum environments

Florian Marquardt
Ludwig-Maximilians University, Munich, Germany

Up to now, the study of decoherence effects has focussed mainly on a two-level system or a single particle coupled to a fluctuating environment. However, in electronic transport experiments we have to deal with a degenerate system of fermions instead. This brings in many-body features if such a system is coupled to a quantum environment instead of merely classical noise sources. I will give a general introduction to these issues and then focus on the Mach-Zehnder interferometer, which represents the simplest possible two-way interference setup. I will present a theoretical analysis of decoherence of fermions moving inside such an interferometer under the subject of any quantum-mechanical environment. Using an equations-of-motion approach particularly suited to this problem, I will discuss the energy-resolved dephasing rate both in and out of equilibrium, the connection to the theory of dephasing in weak-localization, and the importance of Pauli blocking. Results for the shot noise correction due to the environment will also be presented and compared with simpler models of dephasing, including classical noise sources. Finally I will comment on the relevance of these results for experiments being carried out at the Weizmann institute [cf. Yi et al., Nature 422, 415 (2003)].

Multiple Particle Scattering in Quantum Point Contacts

Dganit Meidan
Weizmann Institute of Science, Rehovot, Israel

Recent experiments preformed on weakly pinched quantum point contacts, have shown a resistance that tend to decrease at low source drain voltage. We show that enhanced Coulomb interactions, prompt by the presence of the point contact, may lead to anomalously large multiple-particle scattering at finite bias voltage. These processes tend to decrease at low voltage, and thus may account for the observed reduction of the resistance. When multiple-particle scattering dominate the conductance, the shot noise of the system will correspond to multiple-charge transfer events. This distinctive hallmark may be tested experimentally. We concentrate on the case of a normal point contact, and model it by a spinful interacting Tomonaga-Luttinger, with a single impurity. We find that long range interactions create and enhance two-electron scattering, so as these dominate the conductance. The effective charge, measured by the shot noise of such a system, is shown to approach a value proportional to $e^* = 2e$ at sufficiently large backscattering current. We discuss possible applications of this model to experiments conducted on hall bars.

Spin properties of a double-chain Wigner crystal

A.D. Klironomos, K.A. Matveev, and J. S. Meyer
Argonne National Laboratory, USA

A number of recent experiments point to the possibility of a ferromagnetic ground state in quantum wires. While the Lieb-Mattis theorem forbids ferromagnetism in strictly one-dimensional systems, no such restriction exists for quasi-one-dimensional systems. We study the magnetic properties of a low-density electron system in the Wigner crystal regime confined by a parabolic potential. At a certain critical density the one-dimensional crystal becomes unstable towards formation of a double-chain structure. In this regime, we find that multi-particle ring exchanges are important. In particular, there is a density interval where the 3-particle ring exchange dominates, leading to a ferromagnetic ground state.

Anderson localization in center-doped quantum well structures: From weak to strong localization

Grigory Minkov
Institute of Metal Physics RAS, Ekaterinburg, Russia

The crossover from the conductivity over delocalized states to the conductivity over the localized states with the increasing disorder and/or decreasing temperature is still under debate. The heavily center-doped quantum well structures is unique object for the study of the crossover: the high electron density insures the large Drude conductivity $\kappa_F l$ > 1, while the strong disorder leads to the large value of the weak localization (WL) correction. These peculiar properties give a possibility to trace the role of WL over the wide temperature interval up to 50 K. We have experimentally studied the temperature dependence of the conductivity, transverse magnetoresistance, Hall effect and conductivity nonlinearity in the gated, center-doped GaAs/InGaAs/GaAs structure with electron density (1.3-0.4) 10^1 2 cm^{-2}. The analysis of the negative magnetoresistance shows that at $\kappa_F l$ > 3 the value of the WL correction is $G_0 ln\ (\tau/\tau_{phi})$ with $1/\tau_{phi}\ T(\tau, \tau_{phi}$ are the mean free and phase breaking time respectively). At $\kappa_F l$ < 3 another scale becomes important, namely $\tau_\xi = \xi^2/D$ where $\xi = l\exp(\kappa_F l/2)$ and D are localization radius and diffusion coefficient respectively. Under this condition the WL correction is $G_0 ln(\tau/\tau_{phi} + \tau/\tau_\xi)$. Thus down to the low temperature conductivity $10^{-2} - 10^{-3} e2/h$ all effects can be understand in the framework of the model of the conductivity over delocalized states. This conclusion is supported by analysis of the conductivity nonlinearity which shows that transition to the conductivity over localized states occurs at $\sigma < 10^{-3} e2/h$.

Title not provided

Boris Narozhny
The Abdus Salam ICTP, Trieste, Italy

Effect of a lattice upon a correlated electron system

Zoltan Adam Nemeth
Weizmann Institute of Science, Rehovot, Israel

The ground state of an electron gas is characterized by the interparticle spacing to the effective Bohr radius ratio $r_s = \alpha/\alpha^*_B$. For polarized electrons on a two dimensional square lattice with Coulomb repulsion, we study the threshold value r_s^* below which the lattice spacing s becomes a relevant scale and r_s ceases to be the scaling parameter. Three criteria giving similar values for r_s^* are proposed. The thermodynamic limit of physical systems of different α^*_B is qualitatively discussed, before quantitatively studying the lattice effects occurring at large r_s. Using a few particle system, we compare exact numerical results obtained with a lattice and analytical perturbative expansions obtained in the continuum limit.
Reference: European Physics Journal B 39, 93 (2004.)

Supersymmetry approach to strong localization

Alexander Ossipov
The Abdus Salam ICTP, Trieste, Italy

A novel field theoretical model based on the supersymmetric approach is derived for a Gaussian random matrix ensemble with an arbitrary spatial structure. This model, being exact and dual to the standard supersymmetric non-linear sigma model, is most efficient in the strong localization regime. Applications of the general formalism to the particular problems are discussed.

Title not provided

Pavel Ostrovsky
Landau Institute for Theoretical Physics, Moscow, Russia

Theory of 4e versus 2e supercurrent in frustrated Josepshon-junction rhombi chain

Ivan V. Protopopov and Mikhail V. Feigel'man
L.D.Landau Institute for Theoretical Physics,Kosygin str. 2, Moscow, 119334, Russia

We consider a chain of Josepshon-junction rhombi in quantum regime, and in the realistic case when charging effects are determined by junction capacitances. In the maximally frustrated case when magnetic flux through each rhombi Φ_r is equal to one half of superconductive flux quantum Φ_0, Josepshon current is due to correlated transport of *pairs of Cooper pairs*, i.e. charge is quantized in units of $4e$. Sufficiently strong deviation $\delta\Phi \equiv |\Phi_r - \Phi_0/2| > \delta\Phi^c$ from the maximally frustrated point brings the system back to usual $2e$-quantized supercurrent. We present detailed analysis of Josepshon current in the fluctuation-dominated regime (sufficiently long chains) as function of the chain length, E_j/E_c ratio and flux deviation $\delta\Phi$. We provide estimates for the set of parameters optimized for the observation of $4e$-supercurrent.

The local density of the quasiparticle states in the vortex core near the superconductor-normal metal interface

Denis Ryzhov
Institute for Physics of Micro structures RAS, Nizhnii Novgorod, Russia

I develop the quasiclassical description of the electron structure of the vortex core near the superconductor-normal metal interface, which leads to the suppression of the superconducting order parameter near the boundary. The local density of the quasiparticle states on the normal metal film thickness are studied.

Commensurability effects in Josephson junctions coupled with a magnetic dots array

Alexey Samokhvalov
Institute for Physics of Micro structures RAS, Nizhnii Novgorod, Russia

We study properties of short Josephson junctions placed in a small-scale periodic field produced by an array of magnetic nanoparticles. A strongly inhomogeneous magnetic field partially penetrates into the superconductor and the weak link, and disturbs the phase difference across the junction barrier. The methods of creation of phase perturbations for overlap and edge Josephson junctions are discussed. It is shown that the presence of periodic phase defects in Josephson junctions leads to pronounced commensurability effects, when the number of flux quanta of applied magnetic field H_0 in the junction is an integral multiple of the number of defects. The effects results in the additional peaks of magnetic-field-induced diffraction pattern

$J_c(H_0)$. The positions of the commensurability peaks are determined by the space resonance of the Josephson current wave and periodic phase modulation produced by the magnetic particles. The current-voltage characteristic of the Josephson junctions coupled with magnetic dots array display additional sharp steps compared to the defect-free junction, due to the nonlinear interaction of the current wave and electromagnetic modes of the junction in the presence of the periodical lattice of phase defects.

Superconductivity-induced nonequilibrium magnetism

F. Taddei, F. Giazotto, Rosario Fazio, and F. Beltram
NEST-INFM and Scuola Normale Superiore, I-56126 Pisa, Italy

We show that the magnetization of a mesoscopic paramagnetic conductor driven far from equilibrium can be electrostatically manipulated making use of the Zeeman splitting of the quasiparticle density of states (DOS) of a superconducting film subjected to a static in-plane magnetic field. Unexpected spin-dependent effects like magnetization suppression, *diamagnetic-like* response of the susceptibility as well as spin-polarized current generation are the most remarkable features. The effect of potentially detrimental processes, like inelastic scattering with arbitrary strength, has been addressed too.

Dephasing due to electron-electron interaction in a diffusive ring

Christophe Texier and Gilles Montambaux
Universite Paris Sud, Orsay, France

We consider the effect of electron-electron interaction on the weak localization correction of a ring pierced by a magnetic flux. Following the approach of Al'tshuler, Aronov and Khmel'nitzki (AAK) for an infinite wire, Ludwig & Mirlin (LM) have recently derived some interesting behaviour for the magnetoconductance harmonics of a ring by using an instanton method. We follow a different approach and give an exact derivation of the path integral for the isolated ring. We show that the prefactor found by LM must be corrected. We also analyze our result in a time representation. Then we discuss the effect of connecting wires in the two different regimes of small and large coherence length (compared to the ring perimeter).

Anomalous thermoelectric properties of a superconducting bridge attached to a mesoscopic normal-metal wire

Mikhail Titov[1,2]
[1] Max Planck Institute for Physics of Complex Systems, Dresden, Germany
[2] Petersburg Nuclear Physics Institute, 188350 Gatchina, St. Petersburg, Russia

A setup consisting of a superconducting bridge attached to a mesoscopic normal-metal wire can have anomalous thermoelectric properties. We calculate the thermopower of the wire in the framework of quasiclassical theory with the emphasis on the effects of spin-orbit scattering and Zeeman splitting. Our results can partially explain recent experimental data by Jiang and Chandrasekhar, cond-mat/0501478.

Realistic modeling of submicron ballistic structures

O.A. Tkachenko, V.A. Tkachenko, and D.G. Baksheyev
Institute of Semiconductor Physics, Novosibirsk 630090, Russia

Research of submicron structures reveals the underlying physics and determines the limits of future development of nanoelectronics. Electrical and magnetotransport properties of such devices are sensitive to distribution of frozen charge and structural imperfections. Realistic modeling of submicron structures starting from material composition and geometry fills in the

gap between theoretical, experimental, and technological research. We report self-consistent modeling of electrostatic potential, capacitances, one-dimensional subbands, wave functions and conductance as a function of gate voltages, magnetic field and temperature. We explain new physical effects and compare numerical results with experiment for the following tasks:
1) Quantum transport in a ballistic one-dimensional channel[1]. Deviation from exact conductance quantization in a short adiabatic constriction[2].
2) Effects of charging and coherent scattering in a small three-terminal quantum dot[3-6]. Mesoscopic behavior of Aharonov-Bohm oscillations in a small ring interferometer[5-7].
3) Single-electron conductance oscillations in an open quantum dot[8,9].
[1]. Tkachenko O.A., Tkachenko V.A., Baksheyev D.G., Pyshkin K.S., Harrell R.H., Linfield E.H., Ritchie D.A., Ford C.J.B., J. Appl. Phys. 89(9) 4993 (2001).
[2]. Liang C-T., Tkachenko 0. A., Tkachenko V. A., Baksheyev D. G., Simmons M. Y., Ritchie D. A. and Pepper M., Phys. Rev. B 70, 195324 (2004).
[3]. Tkachenko V.A., Kvon Z.D., Tkachenko O.A., Baksheev D.G., Estibals O., Portal J.C. JETP Lett. 76(12) 720 (2002).
[4]. V.A.Tkachenko, O.A.Tkachenko, Z.D.Kvon, D.G.Baksheyev, A.L.Aseev, and J.C.Portal. JETP Letters 80(9), 588 (2004).
[5]. Tkachenko V.A., Bykov A.A., Baksheev D.G., Tkachenko O.A., Litvin L.V., Latyshev A.V., Gavrilova T.A., Aseev A.L., Estibals O., Portal J.C. JETP 97(2) 317-330 (2003).
[6]. O. A. Tkachenko, V. A. Tkachenko, and D. G. Baksheev. JETP Lett. 79(6) 293 (2004).
[7]. V. A. Tkachenko, Z. D. Kvon, D. V. Sheglov, A. V. Latyshev, A. I. Toropov, O. A. Tkachenko, D. G. Baksheyev, and A. L. Aseev. JETP Lett. 79(3) 136 (2004).
[8]. O.A.Tkachenko, D.G.Baksheyev, V.A.Tkachenko, C.-T.Liang, M.Y.Simmons, C.G.Smith, D.A.Ritchie, Gil-Ho Kim, M.Pepper, J. Phys. Condens. Matt. 13(42) 9515-9534 (2001).
[9]. Tkachenko V.A., Baksheyev D.G., Tkachenko O.A., Liang C.-T. JETP Lett. 74(4) 209 (2001).

Quantum to Classical Crossover in Chaotic Transport

Robert Whitney
University of Geneva, Switzerland

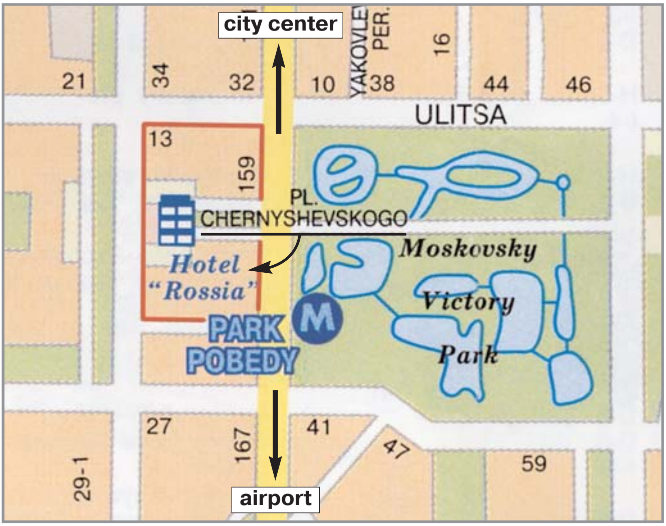
We present a semiclassical theory for the scattering matrix of a chaotic ballistic cavity at finite Ehrenfest time. Using a phase-space representation coupled with a multi-bounce expansion, we show how the Liouville conservation of phase-space volume decomposes the scattering matrix as $S^{\mathrm{cl}} \oplus S^{\mathrm{qm}}$. The short-time, classical contribution S^{cl} generates deterministic transmission eigenvalues $T = 0$ or 1, while quantum ergodicity is recovered within the subspace corresponding to the long-time, stochastic contribution S^{qm}. This provides a microscopic foundation for the two-phase fluid model, in which the cavity acts like a classical and a quantum cavity in parallel, and explains recent numerical data showing the breakdown of universality in quantum chaotic transport in the deep semiclassical limit. We show that the Fano factor of the shot-noise power vanishes in this limit, while weak localization remains universal.
R.S. Whitney and Ph. Jacquod, Phys. Rev. Lett. 94, 116801 (2005).

Title not provided

Andrey Yashenkin
Petersburg Nuclear Physics Institute, Saint-Petersburg, Russia

Venue

Venue: Hotel «Rossia» («Россия»).
Chernyshevskogo Square, No. 11 - near the subway station «Park Pobedy» («Парк Победы»).



Transportation

Transportation:
- from Pulkovo-2 (international) to Moskovskaya bus No.13 and minibuses K-13 and K-213;
- from Pulkovo-1 (domestic) to Moskovskaya bus No.39 and minibus K-39;

then either subway (next stop) or ground transportation (Bus No. 3 or minibus 39, 213. 226) to the «Park Pobedy» («Парк Победы») stop.