INVERSION OF THE PROXIMITY EFFECT IN HYBRID FERROMAGNET-SUPERCONDUCTOR-FERROMAGNET STRUCTURES

A. Buzdin and M. Damens
University Bordeaux I, France

Speaker: A. Buzdin

Date: 11/10/2003, 11:00

Abstract

We propose an exactly solvable model to describe the properties of atomic thickness hybrid ferromagnet-superconductor-ferromagnet (F/S/F) Structures. We show that the superconducting critical temperature is always higher for antiparallel orientation of the ferromagnetic moments. However at low temperature the superconducting gap occurs to be larger for parallel orientation of the ferromagnetic moments. This state corresponds to the minimum energy of the superconducting condensation; while near the critical temperature the antiparallel orientation state have lower energy.
Such behavior contrasts with the case of relatively thick F/S/F structures, where antiparallel ferromagnetic moments alignment is always favorable for superconductivity.

LANDAU-ZENER TRANSITIONS WITH THE FAST NOISE

Valery Pokrovsky
Texas A&M University

Speaker: Valery Pokrovsky

Date: 11/10/2003, 14:00

Abstract

The influence of a classical fast noise onto Landau-Zener transitions is considered based on the analysis of relevant time scales and group-theoretical treatment. We find analytically not only average values of transition probabilities, but also their fluctuations and two-time correlation functions, which determine the linear response of the system to external perturbations.

LEVITATION ON A MAGNETIC MICROCHIP

I. Lyuksyutov
Department of Physics, Texas A&M University

Speaker: I. Lyuksyutov

Date: 11/10/2003, 14:45

Abstract

We demonstrate that micro/nanofabricated magnetic textures allow the trapping and manipulation of micro/nanosize diamagnetic objects, such as microspheres, cells, as well as nanotubes and macromolecules (DNA). The key of this approach is very high gradients of magnetic fields available at micro/nanometer scale. Magnetic textures, which can be used as traps, include films, dots and nanowires, both single and in arrays. Manipulation with trapped objects is possible by using external magnetic, electric and gravitational fields. Microlevitation device can measure and control forces with femtonewton accuracy.

SHUTTLING OF SPIN POLZRIZED ELECTRONS

Robert Shekhter
Chalmers University of Technology and Goteborg Unviersity

Speaker: Robert Shekhter

Date: 11/10/2003, 16:45

Abstract

Resonant tunnelling between ferromagnetic metals with fully polarized electronic states is considered. It is shown that anomalously long time, typical for the resonant tunnelling transmission, allowes for manipulating a spin of tunnelling electron by relatively small (10 - 100 oe) external magnetic fields. This results in a new mechanism for giant magnetotransmittance.The transferring of spin-polarized electrons through nanoelectromechanical shuttle structures allowes for a spectroscopy of nanomechanical vibrations, by studying magnetic field dependent current transmission.

DOMAIN WALL SUPERCONDUCTIVITY IN FERROMAGNETIC SUPERCONDUCTORS AND HYBRID S/F STRUCTURES

A.S.Melnikov, A.Yu.Aladyshkin, A.I.Buzdin, A.A.Fraerman, D.A.Ryzhov, A.V.Sokolov

Speaker: A.S. Melnikov

Date: 11/10/2003, 17:30

Abstract

On the basis of phenomenological Ginzburg-Landau approach we investigate the problem of order parameter nucleation in a ferromagnetic superconductor and hybrid superconductor - ferromagnetic (S/F) systems with a domain structure in applied external magnetic field H. Both the isolated domain boundaries and periodic domain structures in ferromagnetic layers are considered. We study the interplay between the superconductivity localized at the domain walls and between the domain walls and show that such interplay determines a peculiar field dependence of the critical temperature Tc. For a periodic domain structure the behavior of the upper critical field of superconductivity nucleation near Tc is strongly influenced by the overlapping of the superconducting nuclei localized in different domains. We also consider the phase diagram H-T of a superconducting film with magnetic nanoparticles. The oscillating dependence of the critical temperature Tc(H) similar to the Little-Parks effect is obtained. Theoretical predictions are compared with recent experimental data.

CURRENT-DRIVEN MAGNETIZATION SWITCHING AND EXCITATIONS IN MAGNETIC MULTILAYER NANOPILLARS

Sergei Urazhdin
Michigan State University

Speaker: Sergei Urazhdin

Date: 11/10/2003, 18:15

Abstract

Recent progress in nanofabrication let us study the effects of high (~10^8 A/cm) current density on the ferromagnetic layers in magnetic multilayers. Large currents generate magnetic excitations, and in some cases lead to reorientation of magnetization. I will show our results for the dependence of these phenomena on the applied field, temperature, coupling between the magnetic layers, and the multilayer details. I will also outline our model, which describes current-driven excitation and switching in terms of the current-dependent magnetic temperature T_m, that can differ substantially from the ambient (phonon) temperature.

COULOMB BLOCKADE AND TRANSPORT IN GRANULAR ARRAYS

Alex Kamenev
University of Minnesota

Speaker: Alex Kamenev

Date: 11/11/2003, 9:00

Abstract

We consider thermodynamic and transport properties of 1D and 2D arrays of strongly coupled metallic grains. It is shown that the low temperature properties are determined by formation of spatially large solutions of unit charge. The solution density is controlled by a gate voltage and exhibits second order transition from solution-free insulating phase to a solution lattice phase.

ANOMALIES IN THE PHASE-COHERENT TIME OF ELECTRONS IN DIFFUSIVE SYSTEMS

Zvi Ovadyahu
Racah Institute of Physics and National High Magnetic Field Laboratory

Speaker: Zvi Ovadyahu

Date: 11/11/2003, 9:45

Abstract

The phase-coherent times of electrons in diffusive systems exhibit some puzzling features. In this talk we give three examples of such anomalies. In particular, the dependence on disorder is sometimes anomalous. It will also be shown that the main reason for apparent saturation of the dephasing rate at low temperatures is related to the difficulty in maintaining linear-response conditions in the measurements. When care is taken to ensure equilibrium conditions, the dephasing rate vanishes at the absolute zero of temperatures.

How universal are the electron-electron interaction effects in various 2D systems?

V. M. Pudalov, P.N. Lebedev
Physics Institute, Moscow, Russia

Speaker: V. M. Pudalov

Date: 11/11/2003, 14:00

Abstract

In search for adequate description of unusual transport properties of strongly interacting 2D electron systems, considerable progress has been achieved recently in quantifying the electron-electron interactions. Fermi-liquid (FL) renormalization of the spin susceptibility, effective mass, and g-factor Lande has been determined in different experiments in the range of r_s up to 10. The experimental data obtained for various materials seem to diverge substantially, making an impression of the complete lack of Universal description of the 2D systems in terms of the FL coupling constants. The aim of this talk is to demonstrate that this divergence is mainly caused by different interpretation of the raw data. When treated on the same footing, a large body of experimental data does agree with each other. The remaining disagreement between data for 2D holes in GaAs and 2D electrons in Si- and in GaAs-structures indicates the presence of effects of screening by other groups of carriers and requires refining on a theory of electron-electron interaction in the 2D hole system.

COHERENT CONTROL OF FRACTIONAL CHARGES IN QUANTUM ANTIDOT DEVICES

Vladimir J Goldman
SUNY, Stony Brook

Speaker: Vladimir J Goldman

Date: 11/12/2003, 9:00

Abstract

A quantum antidot (QAD) electrometer has been used in the first direct observation of a fractionally quantized electric charge (of Laughlin quasiparticles). In a parallel development, topological computation with Abelian and non-Abelian quasiparticles of two-dimensional interacting electron systems has been suggested as a way of implementing intrinsically fault-tolerant quantum computation. Topological computation employs a fractional statistical phase created by the transfer of one quasiparticle of the system around another to perform quantum logic. Such a phase is fixed by the topological properties of the system wave function and should be insensitive to environment-induced perturbations of the quasiparticle dynamics. The most thoroughly studied and realistic example of a two-dimensional system with fractional statistics of quasiparticles is provided by incompressible electron liquids of the fractional quantum Hall (FQH) effect. I will review the basic physics of quantum antidots in the i=1 and f =1/3 QH states, and then discuss the experimental determination of the quasiparticle coherence time in a QAD ``molecule''. The invariance of quasiparticle charge has been demonstrated in recent experiments. In these experiments, the Laughlin quasiparticle charge has been found to be e*=e/3 \pm 1.2%, independent of temperature, tunneling current and conductance in a wide range of experimental parameters. Thus our experimental results imply robustness of Laughlin quasiparticles localized on QADs, and we conclude that it is possible to control and manipulate fractional quasiparticles in QAD devices in a manner similar to electrons in quantum dots. The objective of future research is to study possibility of using the controlled transport of FQH quasiparticles in structures with multiple antidots to perform quantum logic operations. The most important question to be answered by the future work is to what extent the topological nature of the statistical phase of fractionally charged quasiparticles helps to alleviate the decoherence problem in quantum computation. The future research should result in a detailed understanding of topological quantum computation and should clarify issues relevant to its eventual practical implementation using FQH systems.

ENVIRONMENT EFFECTS IN THE THIRD MOMENT OF VOLTAGE FLUCTUATIONS OF A TUNNEL JUNCTION

Daniel Prober and Bertrand Reulet*
Dept. of Applied Physics, Yale University

Speaker: Daniel Prober

Date: 11/12/2003, 9:45

Abstract

We present the first measurements of the third moment of voltage fluctuations in a conductor. This technique can provide new and complementary information on the electronic transport in a conducting sample, and on the electromagnetic environment. The measurement was performed on non-superconducting tunnel junctions as a function of voltage bias, for various temperatures and bandwidths up to 1 GHz. The data demonstrate the significant effect of the electromagnetic environment of the sample.

* B.Reulet, J. Senzier, and D.E. Prober, to appear in Physical Review Letters, cond-mat/0302084

QUANTUM MEASUREMENT OF a TWO-LEVEL SYSTEM

A. Shelankov

Speaker: A. Shelankov

Date: 11/12/2003, 11:00

Abstract

Motivated by the problem of qubit read-out, the measurement of a general quantum state of a two-level system (TLS) is analysed in the model where the TLS modulates the transmission amplitudes of a tunnel junction. The system of equations for the TLS density matrices conditioned by the transfered charge is derived by the method of the charge projection operators, previously suggested in the context of full counting statistics. The equations are applied to the von Neumann type measurement.

H/E MAGNETIC FLUX MODULATION OF THE ENERGY GAP IN NANOTUBE QUANTUM DOTS

Alexey Bezryadin
University of Illinois

Speaker: Alexey Bezryadin

Date: 11/12/2003, 16:00

Abstract

We report experiments on a quantum dot single-electron-tunneling transistor, made out of a short multi-wall carbon nanotube and threaded by the Aharonov-Bohm flux. By measuring the differential conductance, we observe a magnetically induced gap at the Fermi level, thus providing evidence for a metallic-semiconducting interconversions induced by the AB flux. Whereas the linear conductance of long MWNT's yields period h/2e oscillations, for our short MWNT's we find evidence for h/e variations in the energy spectrum. A comparison with a tight-binding calculation results will be given.

SCALING APPROACH TO SCALING APPROACH TO ITINERANT QUANTUM CRITICAL POINTS

Revas Ramazashvili
Argonne National Laboratory

Speaker: Revas Ramazashvili

Date: 11/12/2003, 17:30

Abstract

Based on phase space arguments, we develop a simple power counting approach to a quantum critical point in an itinerant magnet. The approach enables us to derive certain critical properties without integrating the fermions out of
the partition function.

Nondemolition measurements of a single quantum spin by use of Josephson Oscillations

L. Bulaevskii, M. Hruska, A. Shnirman and D. Smith
Los Alamos National Laboratory

Speaker: M. Hruska

Date: 11/13/2003, 9:00

Abstract

We consider a singlet-pairing superconducting loop with inserted Josephson
Junction containing a single localized spin 1/2 between electrodes. When a DC magnetic field parallel to the z-axis acts on the spin and voltage is induced across the junction, the magnetic flux starts to oscillate after the spin-dependent matrix element is switched on at t=0. The amplitude of flux
oscillations depends on the initial z-component of the spin at t=0. The
measurement of this amplitude is a nondemolition one at low temperatures when the effects of quasiparticles may be neglected.

THICKNESS DEPENDENT CHARACTERISTICS AND PHASE-SENSITIVE TESTS OF SFS JOSEPHSON JUNCTIONS

V.Ryazanov, V.A.Oboznov, A.S.Prokofiev, V.V.Bolginov
Institute for Solid State Physics, Chernogolovka, Russia
&
S.M. Frolov, D.J. Van Harlingen
University of Illinois at Urbana-Champaign

Speaker: V. Ryazanov

Date: 11/13/2003, 9:45

Abstract

Characteristics of planar SF-structures, SFS junctions and superconducting loops with SFS-junctions have been studied. It is shown that, due to the oscillations of the induced superconducting order parameter in a ferromagnet, the critical temperature of SF bilayers (Nb-Cu/Ni) becomes minimal when the thickness of the ferromagnetic layer is close to a quarter of the period of spatial oscillations. We had a possibility to compare the period with the results obtained in the experiments with the Josephson SFS sandwiches, in which the same composition of Cu/Ni alloy was used as a Josephson ferromagnetic interlayer and the same sputtering technique was applied. The transition to the \pi-state, in which the order parameter has different signs on different banks of the SFS sandwich, occurs for the ferromagnetic interlayer thickness close to a half-period of the order parameter spatial oscillations. We discuss obtained nonmonotonic critical current thickness dependence for the Josephson SFS junctions. A special design of interferometer for studies of the SFS junction current-phase
relation was developed. A family of periodical magnetic flux vs current dependences inclusive of the SFS junction current-phase relation was obtained. Temperature transition of the SFS junctions to the \pi-state has manifested itself in the half-period shift of the dependences.

RE-ENTRANT LOCALIZATION OF SINGLE PARTICLE TRANSPORT IN DISORDERED ANDREEV WIRES

N.B. Kopnin, A.S. Melnikov, and V. M. Vinokur

Speaker: N.B. Kopnin

Date: 11/13/2003, 14:00

Abstract

We study effects of disorder on the low energy single particle transport in a normal wire surrounded by a superconductor. We show that the heat conductance includes the Andreev diffusion decreasing with increase in the mean free path l and the diffusive drift produced by a small particle-hole asymmetry, which increases with increasing l. The conductance thus has a minimum as a function of l which leads to a peculiar re-entrant localization as a function of the mean free path.

VORTEX MATTER IN FERROMAGNET/SUPERCONDUCTOR NANOSTRUCTURES

J. Bekaert, M. Morelle, M. Lange, D.S. Golubovic, W.V. Pogosov, M.J. Van Bael, V.V. Moshchalkov, V. Metlushko, G. Borghs°*

Nanoscale Superconductivity and Magnetism Group, Laboratorium voor Vaste-Stoffysica en Magnetisme, University of Leuven,Celestijnenlaan 200D, 3001 Leuven, Belgium

**Department of Electrical and Computer Engineering, University of Illinois, Chicago, Illinois 60607, US*

°Inter-University Micro-Electronics Center (IMEC), Kapeldreef 75, 3001 Leuven, Belgium

Speaker: J. Bekaert

Date: 11/13/2003, 14:45

Abstract

At room temperature, a high resolution scanning Hall probe microscope was used as a non-invasive technique to visualize the magnetization reversal in an array of Co rings [1]. Stable vortex and onion states were observed. To rule out possible influence of interactions between ring elements in the magnetization process, an isolated Co ring was deposited on top of a Hall magnetometer and extremely sharp transitions from onion to vortex and vortex to onion states were resolved. MOKE magnetization measurements and micromagnetic simulations support these results.

At low temperatures, the magnetization of individual superconducting aluminum squares and triangles was measured by Hall magnetometry. Quantized flux entry and exit was observed, and stable vortex configurations were revealed at decreasing fields by the delay of specific vortex exits. A comparison between the two different geometries is made.

Magnetic-field-induced superconductivity is demonstrated by using a nanoengineered lattice of magnetic dots with perpendicular magnetization (Co/Pd) on top of a superconducting Pb film [2]. In this hybrid system, the perpendicular critical fields of the film have been strongly enhanced due to the compensation of the applied field between the dots by the stray field of the dipole array. By switching between the magnetic states of our 'field-compensator', the critical parameters of the superconductor can be effectively controlled.

As a second hybrid system, we have studied the nucleation of superconductivity in a mesoscopic Al disk with a Co/Pd magnetic dot placed on the top [3]. Measurements of the normal/superconducting phase boundary have revealed a pronounced asymmetry with respect to the direction of the applied magnetic field, indicating an enhancement of the critical field when an applied magnetic field is oriented parallel to the magnetization of the dot.

This work is supported by the Fund for Scientific Research - Flanders (FWO), the European ESF Vortex Program, the Belgian Inter-University Attraction Poles (IUAP), and the Flemish Concerted Actions (GOA) programs. J.B., M.M. and W.V.P. are postdoctoral fellows of the Research Council of the K.U. Leuven.

[1] J. Bekaert et al., Appl. Phys. Lett. 81, 3413 (2002).
[2] M. Lange et al., Phys. Rev. Lett. 90, 197006 (2003).
[3] D.S. Golubovic et al., Appl. Phys. Lett. 83, 1593 (2003).

CONSERVATION OF ANGULAR MOMENTUM IN THE DYNAMICS OF THE MAGNETIC FLUX IN SUPERCONDUCTORS

E.M.Chudnovsky

Speaker: E.M. Chudnovsky

Date: 11/13/2003, 16:00

Abstract

Conservation of angular momentum makes profound effects on classical and quantum dynamics of the magnetic flux in superconductors. One [1] is a large contribution of the transversal displacements of the crystal lattice to the inertial mass of the Abrikosov vortex. Another [2] is a parameter-free mechanism of decoherence of quantum oscillations of the superconducting current between opposite directions in a SQUID.

[1] E.M.Chudnovsky and A.B.Kuklov, Phys. Rev. Lett. 91, 067004 (2003).
[2] E.M.Chudnovsky and A.B.Kuklov, Phys. Rev. B67, 064515 (2003).

IMPURITY MEDICATED CONDUCTION OF MULTI-WALL CARBON NANOTUBES

Venkat Chandrasekhar
Department of Physics and Astronomy
Northwestern University

Speaker: Venkat Chandrasekhar

Date: 11/14/2003, 11:00

Abstract

There has been tremendous interest in the transport properties of carbon nanotubes, both from their potential for use in future nanodevices, and from their role as canonical models of one-dimensional electron transport. While individual intrinsic single-walled nanotubes are expected to show either semiconducting or metallic behavior depending on their chirality, the presence of impurities, defects and interactions will modify this behavior. We report here on electrical measurements on individual multi-walled carbon nanotubes that show that the presence or movement of a single impurity or defect in the carbon nanotube can radically change its low temperature transport characteristics. This effect arises from the interference of conduction channels corresponding to direct transmission through the nanotube and resonant transmission through the impurity.

ZEEMAN-LOCALIZED STATES IN DILUTED MAGNETIC SEMICONDUCTOR - PERMALLOY HYBRIDS*

Boldizsar Janko

University of Notre Dame and MSD, Argonne National Laboratory

Speaker: Boldizsar Janko

Date: 11/14/2003, 14:45

Abstract

Most magnetic semiconductors exhibit large Zeeman response even at moderate external magnetic fields. I will discuss the feasibility of using this property to trap and to manipulate spin-polarized carriers in diluted magnetic semiconductors. An example of such a hybrid system is a diluted magnetic semiconductor thin film decorated with arrays of lithographically patterned permalloy disks. I will argue that the ferromagnetic vortex state of a submicron-sized permalloy disk is capable of producing Zeeman localization in a magnetic semiconductor. I will present the results of our calculations for the energy spectrum and wave functions of these Zeeman-localized states, and discuss the various possibilities for experimental detection.

* Work done in collaboration with Mona Berciu, Gyorgy Csaba, Tatiana Rappoport (theory), and Jacek Furdyna, Margaret Dobrowolska, Vitali Metlushko, Albert Chang (experiment). Supported by NSF, DOE and the Alfred P. Sloan Foundation.