HL 52: Transport properties

Time: Friday 11:00–13:30 Location: H14

HL 52.1 Fri 11:00 H14

Electronic spin precession and interferometry from spin-orbital entanglement in a double quantum dot — •Pascal Simon[1] and Denis Feinberg[2] — [1]Department of Physics, university of Basel (Switzerland) and LPMMC, University Joseph Fourier & CNRS, Grenoble (France) — [2]laboratoire Louis Néel, CNRS & University Joseph Fourier, Grenoble (France)

A double quantum dot inserted in parallel between two metallic leads allows to entangle the electron spin with the orbital (dot index) degree of freedom. An Aharonov-Bohm orbital phase can then be transferred to the spinor wavefunction, providing a geometrical control of the spin precession around a fixed magnetic field. A fully coherent behaviour is obtained in a mixed orbital/spin Kondo regime. Evidence for the spin precession can be obtained, either using spin-polarized metallic leads or by placing the double dot in one branch of a metallic loop.

HL 52.2 Fri 11:15 H14

Carrier-carrier interaction in 2D and 1D ferromagnetic (Ga,Mn)As — •Daniel Neumaier, Konrad Wagner, Stefan Geissler, Ursula Wurstbauer, Janosch Sadowski, Matthias Reinwald, Werner Wegscheider, and Dieter Weiss — Institut für Experimentelle und Angewandte Physik, Universität Regensburg, Regensburg, Germany

We investigated the temperature dependency of conductance G of ferromagnetic (Ga,Mn)As mesoscopic wires and films (Tc˜100K) below 1K. The quasi two dimensional samples have a width of 10μm and a length of 60μm, while the quasi one dimensional samples have a width of only 40nm and a length of 7,5μm. The thickness was in both cases between 20nm and 50nm, smaller than the phase coherence length and thermal diffusion length at low T. At low temperatures the conductance of the (Ga,Mn)As samples decreases with decreasing temperature, often ascribed to the Kondo effect. This temperature dependency of G is independent of an externally applied magnetic field in a wide temperature range. A weak localization contribution was only found in some samples below 50mK. By comparing the temperature dependency of the conductance of quasi 2D samples with quasi 1D samples and by applying an external magnetic field, we show that the conductance's temperature dependence can be explained well in terms of enhanced electron-electron interaction, displaying universal behaviour.

HL 52.3 Fri 11:30 H14

Wechselwirkung von Quantenpunkten mit ein- & zweidimensionalen Elektronensystemen — •Bastian Marquardt[1], Marco Russ[1], Cedrik Meier[1], Axel Lorke[1], Dirk Reuter[2] und Andreas Wieck[2] — [1]Festkörperphysik, Universität Duisburg-Essen, D-47048 Duisburg — [2]Lehrstuhl für Angewandte Festkörperphysik, Ruhr-Universität Bochum, D-44799 Bochum

In diesem Beitrag werden die Ergebnisse der Untersuchung der Wechselwirkung von geladenen selbstorganisierten InAs-Quantenpunkten mit einem zweidimensionalen Elektronengas (2DEG) vorgestellt. In Transportmessungen an makroskopischen Leitfähigkeitskanälen wird ein geringer Einfluss der geladenen Quantenpunkte (QP) beobachtet. Um eine Verstärkung des Effektes der QP auf das 2DEG zu erreichen, werden Proben präpariert, in denen das 2DEG durch Split-Gates oder eine geätzte Steg-Struktur in einer weiteren Dimension räumlich eingeschränkt wird. In der Leitfähigkeit, welche an einer Split-Gate Geometrie gemessen worden sind, werden Effekte beobachtet, die auf den Einfluss geladener QP zurückzuführen sind. Desweiteren ist eine Messmethode genutzt worden, mit der es möglich ist den 1D-Leitfähigkeitskanal lateral zu verschieben. So ist man in der Lage das 2DEG über einen größeren Bereich eindimensional abzutasten, um so den Zustand zu erreichen, bei dem der 1D-Kanal durch das Coulomb-Potenzial eines QP vollständig abgeschnürt wird. Der Einfluss des Coulomb-Potenzials eines geladenen QP auf das 2DEG äußert sich in einem leichten Ansteigen der 1D-Leitfähigkeit, wenn die Quantenpunkte kapazitiv geladen werden.

HL 52.4 Fri 11:45 H14

High frequency quantised charge transport through a periodically formed quantum dot — •B. Kästner[1,2], M. D. Blumenthal[2,3], L. Li[2], S. Giblin[2], T. J. B. M. Janssen[2], and M. Pepper[3] — [1]PTB, 38100 Braunschweig, Germany — [2]NPL, Teddington TW11 0LW, UK — [3]University of Cambridge, Cambridge CB3 0HE, UK

We present experimental results on a novel approach to quantised charge pumping. Single electrons are transported through a periodically formed decoupled quantum dot. Phase-shifted sinusoidal radio frequency (RF) signals applied directly to two metallic gates are used to pump electrons through the dot at a current level of 0.54 nA, over an order of magnitude higher than in present single electron pumps. The relative amplitudes of the RF signals applied to the gates determines the direction of the pumped current. This new approach represents an alternative path to the realization of a high current high accuracy quantum standard for electrical current.

HL 52.5 Fri 12:00 H14

Edge effects and elastic scattering in magnetic barriers — Mihai Cerchez[1], •Stefan Hugger[1], Thomas Heinzel[1], and Nico Schulz[2] — [1]Heinrich-Heine Universität, 40225 Düsseldorf — [2]Frauenhofer Institut für angewandte Festkörperphysik, 79108 Freiburg

We have studied the electronic transport through magnetic barriers in two-dimensional electron gases. The experiments were performed on magnetic barriers originating from the stray field of magnetized dysprosium platelets on top of a GaAs-AlGaAs heterostructure. We observed that even for high magnetic barriers, the resistance across the magnetic barrier shows a saturation behavior above a critical barrier amplitude [1]. We simulated the experiments by a semiclassical model based on the Landauer-Büttiker formalism [3], taking into account both edge effects as well as elastic scattering. [2]. The simulations are in excellent quantitative agreement with the experimental results, in particular considering that the model does not contain any fit parameters.

[1] T. Vancura, et al, Phys. Rev. B 62, 5074 (2000)
[2] M. Büttiker, Phys. Rev. Lett. 57, 1761 (1986)
[3] M. Cerchez et al, submitted to Phys. Rev. B.

HL 52.6 Fri 12:15 H14

Quality improvement of MBE grown 2D hole systems in GaAs/AlGaAs — •Christian Gerl, Johannes Bauer, Dieter Schuh, and Werner Wegscheider — Institut für Experimentelle & Angewandte Physik, Universität Regensburg

By introducing carbon as p-dopant for GaAs/AlGaAs heterosystems, restrictions from formerly used acceptor materials like beryllium and silicon have been overcome [1]. The carrier mobility in 2 dimensional hole systems (2DHS) reached values of 1.2x10ˆ6 cmˆ2/Vs and 1.1x10ˆ6 cmˆ2/Vs in the (001) and (110) growth directions, respectively [2]. This enhancement in sample quality is essential for detailed investigations on the non parabolic dispersion relation of 2DHSs.

We present magnetotransport measurements of ultra high mobility quantum well and modulation doped single interface structures directly revealing the effect of the structure inversion asymmetry on the Rashba spin-splitting. In addition promising ways to increase the sample quality even further and to prevent a hysteretic dependence of the hole density when an external electric field is applied are suggested.

[1] C. Gerl et al., Appl. Phys. Lett 86, 252105 (2005)
[2] S. Schmult et al. Appl. Phys. Lett 86, 202105 (2005)

HL 52.7 Fri 12:30 H14

CoTiSb as a thermoelectric material — •Joachim Barth[1], Rosa Robert[2], Anke Weidenkaff[2], Kristian Kroth[1], and Claudia Felser[1] — [1]Johannes Gutenberg Universität 55128 Mainz Staudinger Weg 9 — [2]EMPA CH-8600 Dübendorf Überlandstraße 129

The C1b compound CoTiSb has been investigated as a thermoelectric material for power generation. LMTO calculations of the undoped compound are presented. The samples have been prepared by arc-melting under argon atmosphere. Ti has been substituted with V or Y to optimize the figure of merit. The Seebeck coefficient, the thermal conductivity and the electrical conductivity have been measured in the temperature range from 2-600 K.

HL 52.8 Fri 12:45 H14

Photo-induced charge transport in metal–insulator–metal

(MIM) multilayer structures — •Domocos Kovacs[1], Jörg Winter[1], and Detlef Diesing[2] — [1]Institut für Experimentalphysik II, Ruhr-Universität Bochum, 44801 Bochum — [2]Institut für Physikalische Chemie, Universitat Duisburg-Essen, 45141 Essen

The dependence of the photoinduced current in aluminium– alumina–top metal tunnel structures was investigated as a function of the bias voltage at three different wavelengths (266, 355, and 532 nm) of a Nd-YAG laser. With the top metal (Ag, Au) being illuminated, a net current flowing from the top electrode to the bottom electrode at zero bias for all wavelengths is measured. The photocurrent can be modified by a bias voltage applied between the two metals. For each wavelength there is a certain bias value for which the net photo current vanishes. The dependence of the measured current-voltage curves on the top electrode material and on its thickness is reported. The experimental results are compared with the calculations of a model which includes photo-absorption, electronic excitation, and charge transport in both metal electrodes represented by free electron gases and in the oxide layer described by an asymmetric tunnel barrier allowing both electron and hole tunnelling. Based on this model the influence of the metal thickness on the bias dependence of the photo-current will be discussed in terms of the photo-excited carriers lifetime.

HL 52.9 Fri 13:00 H14

Microwave investigations of electronic correlations in the electron glass Si:P — •Elvira Ritz and Martin Dressel — 1.Physikalisches Institut, Universität Stuttgart, Pfaffenwaldring 57, 70550 Stuttgart, Germany

Electronic correlations influence the charge transport in Si:P at low energy scales. We study the frequency-dependent complex conductivity of Si:P in a large range of phosphorus concentrations below the metal-insulator transition (MIT). At low temperatures (down to 1.2 K) and low frequencies (50 MHz - 20 GHz) the charge transport in the insulatig Si:P is by hopping between the impurity sites with localized electronic states. The electrodynamic response of this system serves as a model for the so-called electron glasses. The effects of the electron-electron interactions is a crucial issue. We observe the power law corresponding to the Coulomb glass in the lower part of the conductivity spectrum as well as a frequency independent permittivity with a critical behavior in the vicinity of the MIT. The temperature dependence of the dynamical response is also discussed.

HL 52.10 Fri 13:15 H14

Quantum capacitance controlled switching field in in-plane gated Y-branch switches — •Stefan Lang, Lukas Worschech, and Alfred Forchel — Technische Physik, Universität Würzburg, Am Hubland, D-97074 Würzburg, Germany

We have studied the threshold characteristics and gate efficiencies of in-plane gated electron Y-branch switches controlled by different in-plane gates. Pronounced non-linearities in the threshold voltages indicate that the pinch-off region can be tuned by the side-gates from the stem into the branches. In order to explain the threshold shifts we propose a model based on coupled quantum capacitances and geometrical capacitances including charge trapping. In addition, the model also provides gate-voltage induced changes of the gate efficiency in very good agreement with the experimental findings.