HL 77: Transport in High Magnetic Fields

Time: Thursday 14:45–16:30 Location: POT 112

HL 77.1 Thu 14:45 POT 112

Topological Entanglement in Two-Dimensional Electron Gases Under Perpendicular Magnetic Fields — •Daniel Hernangómez-Pérez[1,2], Thierry Champel[2], and Serge Florens[3] — [1]Institut für Theoretische Physik, Universität Regensburg, D-93053 Regensburg, Germany — [2]Université Grenoble Alpes/CNRS, Laboratoire de Physique et Modélisation des Milieux Condensés, B.P. 166, 38042 Grenoble Cedex 9, France — [3]Institut Néel, CNRS and Université Grenoble Alpes, B.P. 166, 38042 Grenoble Cedex 9, France

Inspired by a recently developed single-particle vortex state formalism, we pinpoint a non-trivial long-range bipartite entanglement of electron cyclotron motions which can occur in two-dimensional electron gases under perpendicular magnetic fields. The entanglement is achieved through the introduction of bicomplex spinorial eigenstates of the clean Hamiltonian describing a four-dimensional (4D) singular hydrodynamic flow. We show that the topological origin of the entanglement, as well as the winding and parity quantum numbers describing the quantum states, suggests that 4D vortices of electron pairs are good candidates for stable quasiparticles at high magnetic fields. The relevance of this approach is discussed in the context of the fractional quantum Hall effect.

HL 77.2 Thu 15:00 POT 112

Geometrically disordered network models, quenched quantum gravity, and critical behavior at quantum Hall plateau transitions — Ilya A. Gruzberg[1], •Andreas Klümper[2], Win Nuding[2], and Ara Sedrakyan[3] — [1]Ohio State University, USA — [2]Wuppertal University, Germany — [3]Yerevan Physics Institute, Armenia

Recent results for the critical exponent of the localization length at the integer quantum Hall transition (IQHT) differ considerably between experimental ($\nu_{\rm exp} \approx 2.38$) and numerical ($\nu_{\rm CC} \approx 2.6$) values obtained in simulations of the Chalker-Coddington (CC) network model. The difference is at least partially due to effects of the electron-electron interaction present in experiments. Here we propose a mechanism that changes the value of ν even within the single-particle picture. We revisit the arguments leading to the CC model and consider more general networks with structural disorder. Numerical simulations of the new model lead to the value $\nu \approx 2.37$. We argue that in a continuum limit the structurally disordered model maps to free Dirac fermions coupled to various random potentials (similar to the CC model) but also to quenched two-dimensional quantum gravity. This explains the possible reason for the considerable difference between critical exponents for the CC model and the structurally disordered model. We extend our results to network models in other symmetry classes.

HL 77.3 Thu 15:15 POT 112

Phase transition induced by impurities in GaAs/AlGaAs single quantum wells — •Eddy P. Rugeramigabo, Lina Bockhorn, and Rolf J. Haug — Institute for Solid State Physics, Leibniz Universität Hannover

We report on a phase transition in two-dimensional electron gases (2DEG) interacting with specific background impurities. These are silicon atoms which have been intentionally incorporated in high quality single GaAs/AlGaAs quantum wells confining the 2DEG. The reference 2DEG, without any additional impurities, has an electron mobility μ_E of $3.2 \cdot 10^6\,\mathrm{cm}^2/\mathrm{Vs}$ and a 2D electron density n_E of $2.9 \cdot 10^{11}\,\mathrm{cm}^{-2}$ at low temperature. The incorporated impurities induce a decrease in the sample quality, observed in the lowering of μ_E. However at high magnetic fields they induce a phase transition. The new phase has a metastable equilibrium between 7 T and 13 T ($2 < \nu > 1$). It is characterized by better developed fractional filling factors, e.g. $\nu = 5/3$ and $\nu = 4/3$. The phase transition is shown to be related to nuclear spin polarization.

Coffee Break

HL 77.4 Thu 15:45 POT 112

Interlayer magnetotransport phenomena of double quantum wells — •Gunnar L. Schneider[1], Rolf J. Haug[1], and Werner Dietsche[2] — [1]Institut für Festkörperphysik, Leibniz Universität Hannover, Germany — [2]Max Planck Institut für Festkörperphysik, Stuttgart, Germany

We study the transport phenomena of two parallel 2-dimensional electron systems in a magnetic field, especially at the v_T=1 state of excitonic condensation. These systems are realized by a GaAs/AlGaAs double quantum well separated by an AlAs isolation layer and defined by the ratio of the layer-to-layer distance d to the magnetic length l_B. Hallbar geometry in combination with selective field gating allow an independent characterization of each layer's magnetotransport properties, investigating the interlayer electron-electron Coulomb interaction and measuring the magneto dependent interlayer I/V tunnel current [1].

The existence of a BEC excitonic state was raised over 40 years ago and our used sample geometry has been proven to contain such a condensate [2]. Our measurements show evidences that we are able to create a BEC excitonic state and the signals correlate to the d/l_B -value. In addition we performed highly resolved magneto dependent I/V tunnel characteristics from zero up to two Tesla at which we see the v_T=1 BEC excitonic state and an underlying pattern due to the Coulomb interaction between the layers and quantum Hall physics.

[1] L. Tiemann et al., New J. of Phys. 10, 045018 (2008)
[2] J. P. Eisenstein and A. H. MacDonald, Nature 432, 691 (2004)

HL 77.5 Thu 16:00 POT 112

Calculations of Quantum Capacitance of The Two Dimensional Electron System — •Eren Güvenilir[1], Özge Kiliçoğlu[2], Afif Siddiki[3], and Deniz Eksi[4] — [1]Istanbul Technical University, Istanbul, Turkey — [2]Işik University, Istanbul, Turkey — [3]Mimar Sinan Fine Arts University, Istanbul, Turkey — [4]Yeni Yuzyil University, Istanbul, Turkey

In this work we investigate the electrostatic properties of two dimensional electron system (2DES) in the integer quantum Hall regime. The alternating screening properties of the compressible and the incompressible strips are formed due to edge effects. We consider the effects of impurities on the 2DES via density of states calculations. As it is well known, the Landau Levels emerge due to strong perpendicular magnetic field and the levels are broadened which stem from impurities. At a first order approximation the density of state takes two different forms when considering impurities, these are the Gaussian and the semi-elliptic forms calculated within the self consistent Born approximation. Having in hand the density of states, we calculate both the longitudinal and Hall conductivities utilizing Thomas-Fermi-Poisson approximation. Since, the definition of capacitance is closely related with the charging energy; the compressibility of 2DES is extremely important. Here we numerically simulate the experimental observations and can predict local capacitance. We obtained numerically the local capacitances of a 2DES subject to perpendicular magnetic field. Our findings are in perfect agreement with the experiment which is based on a dynamic scanning capacitance microscopy.

HL 77.6 Thu 16:15 POT 112

THz radiation induced analog of microwave-induced resistance oscillations in GaAs heterostructures — •Tobias Herrmann[1], Ivan A. Dmitriev[1,2], Dmitriy A. Kozlov[2], Martin Schneider[1], Bruno Jentzsch[1], Ze Don Kvon[4], Peter Olbrich[1], Vasily V. Bel'kov[3], Andreas Bayer[1], Dieter Schuh[1], Dominique Bougeard[1], Thomas Kuczmik[1], Martin Oltscher[1], Dieter Weiss[1], and Sergey D. Ganichev[1] — [1]University of Regensburg, Regensburg, Germany — [2]Universitätsstr. 31 — [3]Rzhanov Institute of Semiconductor Physics, Novosibirsk, Russia — [4]Novosibirsk State University, Novosibirsk, Russia

We report on the study of terahertz (THz) radiation induced oscillations of magneto-resistivity in AlGaAs/GaAs two dimensional electron systems, the THz analog of microwave induced resistivity oscillations (MIRO). Our experiments answer two most intriguing questions on MIRO, the effect of radiation helicity and the role of the edges yielding crucial information for understanding of the MIRO origin. We exploit the specific advantages of THz laser radiation not present in the MW regime, i.e., the possibility to focus it onto a spot smaller than the sample's size and easy control of the radiation's polarization. The most important features clearly detected on a large variety of samples are (i) a very weak dependence of the oscillations' amplitude on the photon helicity and (ii) the "bulk" nature of the effect. Moreover, our

study shows that the MIRO oscillations can be excited at THz frequencies even in the samples with low mobility whereas in the MW range ultra-high mobility samples are needed for this type of experiments.