HL 18: Quantum Hall Effect

Time: Monday 14:30–15:30 Location: POT 151

HL 18.1 Mon 14:30 POT 151

Huge Magnetoresistance in a High Mobility Two-Dimensional Electron Gas — •Lina Bockhorn[1], Patrick Barthold[1], Dieter Schuh[2], Werner Wegscheider[3], and Rolf J. Haug[1] — [1]Institut für Festkörperphysik, Leibniz Universität Hannover — [2]Institut für Experimentelle und Angewandte Physik, Universität Regensburg — [3]ETH Zürich, Switzerland

We study the fractional Quantum-Hall effect in high mobility two-dimensional electron gas (2DEG). Hall geometries are created by photolithography on a GaAs/GaAlAs quantum well containing a 2DEG. The 2DEG have an electron density of n_e=3.1*10^{11}cm^{-2} and a mobility of μ_e=11.9*10^6cm^2/Vs at a temperature of 1.5 K.
We observe a strong negative magnetoresistance at zero magnetic field. In lowering the electron density the magnetoresistance gets more pronounced and reaches values of more than 300%. We observe that the huge magnetoresistance vanishes for increasing the temperature. An additional density dependent factor is introduced to be able to fit the parabolic magnetoresistance to the electron-electron interaction correction.
A discrepancy between theory and experiment is observed. A possible origin could be that the influence of the density fluctuation for high mobility 2DEG is not correctly described by theory. In our high mobility samples a very small, but finite density variation across the sample induces an additional long range potential, up to now not treated in theory.
arXiv:1012.0168

HL 18.2 Mon 14:45 POT 151

THz photoresponse of quantum Hall edge channels — •Christian Notthoff[1,2], Kevin Rachor[3], Detlfe Heitmann[3], Dirk Reuter[4], Andreas Wieck[4], and Axel Lorke[2] — [1]Nanoparticle Process Technology, Universität Duisburg-Essen, Lotharstr.1, D-47048 Duisburg — [2]Fachbereich Physik, Universität Duisburg-Essen, Lotharstr.1, D-47048 Duisburg — [3]Institut für Angewandte Physik, Universität Hamburg, Jungiusstr. 11,D-20355 Hamburg — [4]Lehrstuhl für Angewandte Festkörperphysik, Ruhr-Universität Bochum, Universitätsstraße 150, D-44780 Bochum

We present THz photoresponse measurements on quasi-Corbino-shaped GaAs/AlGaAs heterostructures in the quantum Hall regime. A Fourier spectrometer is used as a broad band, black-body source with a very low spectral intensity compared to THz-Lasers used in other experiments. At filling factors $\nu > 2$, we find two independent contributions to the photoresponse-signal. One contribution clearly results from bolometric heating inside the bulk and the other one is caused by a non-bolometric mechanism. Furthermore, combining the quasi-Corbino shape with a cross-gate technique allows us to directly investigate the THz-induced transport between adjacent edge states, thus avoiding bulk effects. In the absence of bulk effects a pronounced photo voltage at zero applied bias is revealed. The photo voltage and its dependence on the bias current can be described using the model of an illuminated photodiode, resulting from the reconstruction of the Landau bands of the sample edge. Moreover, the photodiode model is also applicable to the samples where the bulk effects are present.

HL 18.3 Mon 15:00 POT 151

Probing electron-electron interactions in quantum Hall systems by scanning tunneling spectroscopy — •Marcus Liebmann[1], Stefan Becker[1], Christoph Karrasch[2], Torge Mashoff[1], Marco Pratzer[1], Volker Meden[2], and Markus Morgenstern[1] — [1]II. Physikalisches Institut B and JARA-FIT, RWTH Aachen University, 52074 Aachen — [2]Institut für Theorie der Statistischen Physik and JARA-FIT, RWTH Aachen University, 52074 Aachen

Some of the most intriguing quantum Hall phases, e.g., the fractional quantum Hall phase, are driven by electron-electron (e-e) interaction. A central challenge towards a microscopic investigation of quantum Hall physics dominated by e-e interaction is to provide a sufficiently clean and electrically decoupled system, which can be probed down to the relevant length scales, most notably the magnetic length $l_{\mathrm{B}} = \sqrt{\hbar/(eB)} \approx 10$ nm (6 T). Using low-temperature scanning tunneling spectroscopy applied to the Cs-induced two dimensional electron system (2DES) on p-type InSb(110), we probe e-e interaction effects in the quantum Hall regime. The 2DES is decoupled from the p-doped bulk of the sample exhibiting spreading resistance within the insulating quantum Hall phases. In quantitative agreement with calculations we find an exchange enhancement of the spin splitting at odd fillings. We observe that both the spatially averaged as well as the local density of states feature a characteristic Coulomb gap at the Fermi level. These results show that e-e interaction effects can be probed down to a resolution below all relevant length scales.

HL 18.4 Mon 15:15 POT 151

Theory of the microwave induced zero resistance states in two-dimensional electron systems — •Sergey Mikhailov — Institute of Physics, University of Augsburg, D-86135 Augsburg, Germany

The microwave induced zero resistance states [1] and microwave induced resistance oscillations [2] were discovered in the very-high-electron-mobility GaAs/AlGaAs quantum-well systems about ten years ago but have not been understood so far. We show [3] that this phenomenon is explained by the influence of the nonlinear ponderomotive forces which arise in the near-contact regions of the two-dimensional electron gas under the action of microwaves. The theory [3] agrees with all accumulated experimental facts and provides a simple and natural explanation of the frequency, polarization, magnetic field, mobility, power and temperature dependencies of the observed effects.

[1] R. G. Mani et al., Nature 420, 646 (2002); M. A. Zudov et al., Phys. Rev. Lett. 90, 046807 (2003)
[2] M. A. Zudov et al., Phys. Rev. B. 64, 201311 (2001); P. D. Ye et al., Appl. Phys. Lett. 79, 2193 (2001)
[3] S. A. Mikhailov, arXiv:1011.1094v1 (4 Nov 2010)