Huge Magnetoresistance in a High Mobility Two-Dimensional Electron Gas

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 $n_e = 3.1 \times 10^{11} \text{cm}^{-2}$ and a mobility of $\mu_e = 11.9 \times 10^6 \text{cm}^2/\text{Vs}$ 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 samples a very small, but finite density variation across the sample.

We find an exchange enhancement of the spin splitting at odd fillings.

In the quantum Hall regime. The 2DES is decoupled from the p-doped 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 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.

Landau bands of the sample edge. Moreover, the photodiode model is also applicable to the samples where the bulk effects are present.

The microwaves oscillations 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 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 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.