Negative Magnetoresistance Induced by an Interplay of Smooth Disorder and Rare Strong Scatterers

L. Bockhorn[1], I. V. Gornyi[2], A. D. Mirlin[2], C. Reichl[3], D. Schuh[4], W. Wegscheider[3], and R. J. Haug[1]

[1] *Institut für Festkörperphysik, Leibniz Universität Hannover*
[2] *Institut für Nanotechnologie, Karlsruhe Institute of Technology*
[3] *Laboratorium für Festkörperphysik, ETH Zürich*
[4] Institut für Experimentelle und Angewandte Physik, Universität Regensburg

In a high mobility two-dimensional electron gas (2DEG) realized in a GaAs/AlGaAs quantum well we observe a strong negative magnetoresistance around zero magnetic field. Figure 1 shows a typical measurement of the strong negative magnetoresistance around zero magnetic field. We divide the strong negative magnetoresistance into two sections because of their different behaviors for different conditions. The huge magnetoresistance at larger magnetic fields depends strongly on the temperature and the electron density, while the peak around zero magnetic field is left unchanged [1, 2, 3, 4] at low temperatures. The crossover between the peak and the huge magnetoresistance is marked by a slight plateau in the longitudinal resistance around B_c=12 mT. The height of the peak is given by $\Delta\rho_{xx} = \rho_0 - \rho_{xx}(B_c)$.

The peak around zero magnetic is a two-dimensional effect, as concluded from tilted magnetic field measurements. In accordance with Mirlin *et al.* [5] we conclude that the peak around zero magnetic field is induced by a combination of smooth disorder and rare strong scatteres. The saturation of the longitudinal resistivity at B_c=12 mT is determined by the smooth disorder, while the height of the peak is dominated by the rare strong scatterers. The density of the strong scatterers n_S is determined by using the curvature of the peak, ρ_0 at zero magnetic field and $\rho_{xx}(B_c)$ at the crossover between the peak and the huge magnetoresistance. However the densities of the strong scatterers of our high mobility samples are much lower than expected from the estimated densities of background doping in our sample.

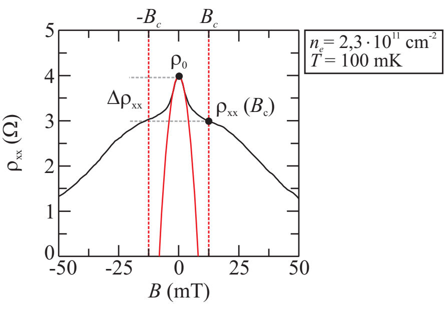

Figure 1: The longitudinal resistivity ρ_{xx} vs. the magnetic field B. The strong negative magnetoresistance is divided into the peak and the huge magnetoresistance.

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