# Electron-electron interaction correction and magnetoresistance of 2DE system in the parallel field.

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Various low density 2D systems demonstrate strong positive magnetoresistance (MR) in the field parallel to the 2D plane [1-3]. This effect is believed to be due to the influence of the Zeeman splitting on electron-electron interactions and is often used to determine the renormalized spin susceptibility [4,5]. The parallel field MR was explained in two different manners, in terms of: (i) diffusive electron-electron interaction correction (EEC) [6,7], and (ii) renormalization of the density of states and single impurity scattering time [8].

Analysis of the resistivity tensor components $\rho_{xx}$ and $\rho_{xy}$ in perpendicular magnetic field was demonstrated earlier [9] to enable extraction of the EEC. Following this ideology, in the present study we use tilting the magnetic field as a powerful tool to distinguish between spin and orbital effects and to explore mechanisms of the parallel field magnetoresistance. We use several Si-MOS disordered 2D electron systems (mobilities $\mu$=1500–5000 $cm^2$/Vs) with isotropic *g*-factor and thin 2DE layer (<4 nm). EEC is extracted from the simultaneous analysis of both $\rho_{xx}$ and $\rho_{xy}$ components measured in tilted magnetic field up to 15 Tesla, for electron densities (8-30)$\cdot 10^{11} cm^{-2}$, and at temperatures 0.3-30K.

By changing the tilt angle we show that EEC depends on the modulus of magnetic field rather than on its direction, in agreement with theory of the EEC for an isotropic g-factor case. However, the extracted EEC value appears to be an order of magnitude smaller than that required to explain the large MR. This anomalously strong parallel field MR is sharply suppressed by an insignificant, non-quantizing perpendicular field component. The above suppression points to a non-purely Zeeman origin of the parallel field MR.

We also observe a nonlinearity of the Hall resistance (~10%) in low-fields that finds so far no explanation. In total, our findings point at the incompleteness of the existing theory of magnetotransport in interacting and disordered 2D systems: too strong parallel field magnetoresistance, its suppression by perpendicular magnetic field, and the low-field Hall anomaly require an explanation. We believe that these three phenomena are interrelated and originate from a destructive action of the perpendicular field on the localized states coexisting with the 2D electron liquid.

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