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Electron-Electron Correlations and Metallic Conduction in Two Dimensions

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One of the most puzzling phenomena which remained challenging for the last decade is the apparent "metallic" state and "metal-insulator transition" (MIT) in two-dimensional electron systems (2DES). In the experiments with high-mobility 2DES in semiconductors, a strong increase of the conductivity with cooling has been observed in the vicinity of a critical density n_c. At lower and higher densities, the conventional localizing behavior was restored. According to the existing theories, a true metallic phase, if exists in 2D, must be a non-Fermi liquid. A considerable progress has been achieved in understanding of the $e-e$ interaction in 2D electron system: the interactions have been quantified in terms of the Fermi-liquid coupling parameters. In particular, for high-mobility samples it has been shown that the drop of conductivity with cooling at intermediate temperature range $T \gg \hbar/\tau$ is due to the interaction effects. However, the new knowledge on the role of $e-e$ interactions at intermediate temperatures does not provide a clue to the quantum-mechanical ground state of the 2DES. There is a puzzling disagreement between the theory and experimental data in this low-temperature limit. It is believed that the effective $e-e$ interactions, by itself, should be renormalized as T decreases (i.e. the length scale increases), which may drive the 2D system to new electronic phases. The talks briefly overviews the experimental data on the electron transport, magnetotransport, and spin-magnetization in 2D and on the electron-electron interaction effects.

Keywords : strongly correlated electrons