Interaction-driven Effects in Strongly Correlated Two-dimensional Systems

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Most experiments of measuring dilute electron systems demonstrate activated conduction such as the variable range hopping observed in the insulating side of the 2D metal-to-insulator transition (MIT). This is consistent with disorder-dominated Anderson Insulator developed for non-interacting particles. Important questions on whether electron-electron interaction can fundamentally alter the electron states, e.g. Wigner crystallization in a low disordered environment, remain unanswered. Recently, results from measurements of higher purity, strongly interacting 2D electron systems at low T demonstrate certain nonactivated behaviors that are absent in more disordered systems. Measuring high quality 2D holes in undoped GaAs field-effect-transistors with variable charge densities down to 7×10^8 cm^{-2}, we found a power-law like T-dependence of the conductivity for the lowest charge concentrations. The scaling of the exponent, varying between 1.3 and 1.8, with the change of charge density points to an interaction-driven nature. This non-activated characteristic may well be an universal interaction-driven signature for an electron state of strongly correlated (semiquantum) liquid. Moreover, a conductivity kink, indicated via a discontinuous step in the temperature derivative, is also observed for carrier densities below 4×10^9 cm^{-2} which is the critical density of MIT. A possible phase transition will also be discussed.[1]

[1]Jian Huang, L.N. Pfeiffer, K.W. West, Phys. Rev. B. (Rapid Communications) **83**, 081310 (2011).