Quantum Scaling for the Metal-Insulator Transition in a Two-Dimensional Electron System

V. Kagalovsky[1], S. V. Kravchenko[2], D. Nemirovsky[1]

[1] *Shamoon College of Engineering, Beer-Sheva 84105, Israel*
[2] *Physics Department, Northeastern University, Boston, Massachusetts 02115, USA*
e-mail: victork@sce.ac.il

We suggest Gaussian approximation to describe the quantum phase transition observed experimentally in seminal studies of two-dimensional (2D) electron systems [1-3]. Our approach explains self-consistently the universal value of the critical exponent 3/2 (found after scaling measured resistivities on both sides of the transition as a function of temperature) as the result of the divergence of the correlation length when the electron density approaches the critical one. We also provide numerical evidence for the exponential temperature dependence of the metallic phase's resistivities (never suggested before) and show that it leads to correct qualitative results. Finally, we interpret the phase diagram on the density-temperature plane exhibiting the quantum phase transition and two crossover lines (see Fig. 1 below).

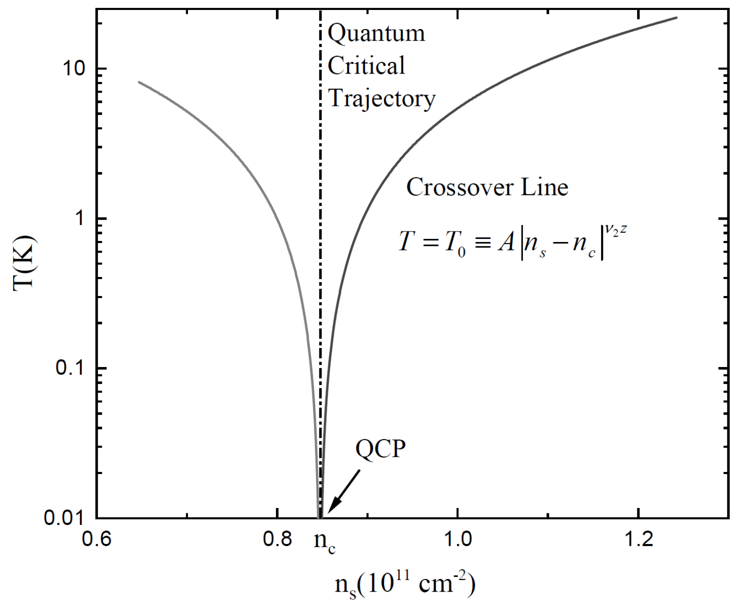

Fig. 1. Phase diagram of the system. The quantum critical point (QCP) is on the horizontal axis $T = 0$ $n_c \approx 0.85$. Quantum critical trajectory is a vertical dash-dotted line starting at QCP. Solid lines represent crossover lines ($n < n_c$ for an insulator and $n > n_c$ for a metal).

[1] T. N. Zavaritskaya and E. I. Zavaritskaya, JETP Lett. 45, 609 (1987).
[2] S. V. Kravchenko, G. V. Kravchenko, J. E. Furneaux, V. M. Pudalov, and M. D’Iorio, Phys. Rev. B 50, 8039 (1994).
[3] S. V. Kravchenko, W. E. Mason, G. E. Bowker, J. E. Furneaux, V. M. Pudalov, and M. D'Iorio, Phys. Rev. B 51, 7038 (1995).