MAR13-2012-000750

Abstract for an Invited Paper
for the MAR13 Meeting of
the American Physical Society

Critical Behavior of a Strongly-Interacting 2D Electron System[1]

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Two-dimensional (2D) electron systems that obey Fermi liquid theory at high electron densities are expected to undergo one or more transitions to spatially and/or spin-ordered phases as the density is decreased, ultimately forming a Wigner crystal in the dilute, strongly-interacting limit. Interesting, unexpected behavior is observed with decreasing electron density as the electrons' interactions become increasingly important relative to their kinetic energy: the resistivity undergoes a transition from metallic to insulating temperature dependence; the resistance increases sharply and then saturates abruptly with increasing in-plane magnetic field; a number of experiments indicate that the electrons' effective mass exhibits a substantial increase approaching a finite "critical" density. There has been a great deal of debate concerning the underlying physics in these systems, and many have questioned whether the change of the resistivity from metallic to insulating signals a phase transition or a crossover. In this talk, I will report measurements [1] that show that with decreasing density n_s, the thermopower S of a low-disorder 2D electron system in silicon exhibits a sharp increase by more than an order of magnitude, tending to a divergence at a finite, disorder-independent density n_t, consistent with the critical form $(-T/S) \propto (n_s - n_t)^x$ with $x = 1.0 \pm 0.1$ (T is the temperature) [2]. Unlike the resistivity which may not clearly distinguish between a transition and crossover behavior, the thermopower provides clear evidence that a true phase transition occurs with decreasing density to a new low-density phase.

[1] Work done with S. Li and B. Wen (City College of NY), A. Mokashi and S. V. Kravchenko (Northeastern U.), A. A. Shashkin and V. T. Dolgopolov (ISSP, Chernogolovka).

[2] A. Mokashi, S. Li, B. Wen, S. V. Kravchenko, A. A. Shashkin and V. T. Dolgopolov, and M. P. Sarachik, Phys. Rev. Lett. **109**, 096405 (2012).

[1]Work supported by DOE Grant DE-FG02-84ER45153, BSF grant 2006375, RFBR, RAS, and the Russian Ministry of Science.