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Strongly correlated electrons in two-dimensional quantum world

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In two-dimensional (2D) electron system, electrons can move in two dimensions but are confined in the third, pretty much like billiard balls. Low-disorder 2D electron systems are currently the focus of a great deal of attention, particularly for low electron densities, where the interactions between them dominate their behavior, theoretical methods are still poorly developed, and new experimental results are of great interest. Consistent with Fermi liquid theory at high electron densities, these 2D systems are expected to freeze into a Wigner crystal in the dilute, strongly-interacting limit. In the intermediate regime, where interactions are not yet strong enough to cause crystallization, the electrons behave like a strongly-correlated liquid. Our recent data show that the low-temperature (fractions of 1 kelvin) properties of this strongly correlated electron liquid are unusual and very interesting. For example, the spin susceptibility grows and seemingly diverges as the electrons become more dilute, which indicates transition to a new state of matter (Wigner crystal or a precursor). Moreover, I will report the observation of strongly nonlinear voltage-current characteristics that display two distinct thresholds and a dramatic increase in noise at the breakdown of the insulating state. With the roles of voltage and current interchanged, this behavior is strikingly like that observed for the depinning of the vortex lattice in Type-II superconductors. Adapting the model used for vortexes to the case of an electron solid yields good agreement with our experimental results. This strongly favors the formation of the electron solid in the insulating phase as the double threshold behavior cannot be described within existing alternative models.

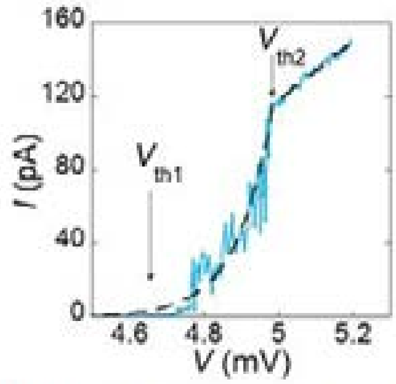

Figure 1: Voltage-current characteristic in the insulating state of a 2D electron system at a temperature of 0.06 K.

Biography

Sergey V Kravchenko has completed his PhD in 1988 from Institute of Solid State Physics, Russia. Since 1998, he is a Professor of Physics at Northeastern University, Boston, USA. His discovery of the metallic state in 2D was listed among 50 main discoveries of the last century in the field of mesoscopic physics.

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