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Experimental Observation of Quantum Hall Effect and Berry's Phase in Graphene

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When electrons are confined in two-dimensional (2D) materials, quantum mechanically enhanced transport phenomena, as exemplified by the quantum Hall effects (QHE), can be observed. Graphene, an isolated single atomic layer of graphite, is an ideal realization of such a 2D system. Its behavior is, however, expected to differ dramatically from the well-studied case of quantum wells in conventional semiconductor interfaces. This difference arises from the unique electronic properties of graphene, which exhibits electron-hole degeneracy and vanishing carrier mass near the point of charge neutrality. In this talk I will present an experimental investigation of magneto transport in a high mobility single layer of graphene. Adjusting the chemical potential using the electric field effect, we discovered an unusual half integer QHE for both electron and hole carriers in graphene, which originates from the quantum mechanical phase associated with the topologically unique graphene Fermi surface. The existence of a non-zero Berry's phase in magneto-oscillations will be discussed in the connection to Dirac Fermion description in graphitic systems. In addition, I will discuss our recent results in transport measurement in strong quantum limit and spin transport in graphene samples.