Fractional quantum Hall effect and Wigner crystallization in suspended Corbino graphene disk

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Competition between kinetic and electrical energy in two-dimensional electron system leads to a multitude of different ordered phases. At high magnetic fields, the kinetic energy of electrons is suppressed, which favors Wigner crystallization of electrons to a lattice. However, electrons commonly favor an incompressible liquid state, the fractional quantum Hall (FQH) liquid, instead of the Wigner crystal solid phase. We have investigated competing Wigner crystal and FQH liquid phases in atomically thin suspended graphene devices in Corbino geometry [1]. Low-temperature magneto- and transconductance measurements along with IV characteristics all indicate unconventional sequence of FQH phases with lowering electron density n, where the conventional sequence of FQH states is interrupted by Wigner crystal order. At small n, with the filling factor $\nu \sim 0.15 - 0.19$, electrons crystallize into ordered Wigner solid, while an incompressible Hall liquid is obtained with lowering density down to $\nu \leq 0.14$. The Wigner crystal state was experimentally confirmed by a microwave absorption resonance near 3 GHz which agrees with pinned, submicron-sized crystallites.

[1] M. Kumar, A. Laitinen, and P. J. Hakonen, Fractional quantum Hall effect and Wigner crystallization in suspended Corbino graphene disk, arXiv:1611.02742