Manifest of electron interactions in quantum Hall effect in graphene

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The quantum Hall ferromagnetism (QHFM) and fractional quantum Hall effect (FQHE) in 2-dimensional electron gas with multiple internal degrees of freedom provides a model system to study the interplay between spontaneous symmetry breaking and emergent topological order. In graphene, the structure of the honeycomb lattice endows the electron wavefunctions with an additional quantum number, termed valley isospin, which, combined with the usual electron spin, yields four-fold degenerate Landau levels (LLs). This additional symmetry modifies the QHFM and FQHE with intriguing interplay between two different spin flavours. As a consequence, it is conjectured to produce new incompressible ground states in graphene, reflecting strong electron interactions. In this presentation we report multiterminal measurements of the FQHE in high mobility graphene devices fabricated on hexagonal boron nitride substrates. The measured energy gaps of observed FQHE are large, particularly in the second Landau level where they measure up to times larger than those reported in the cleanest conventional systems. In the lowest Landau level, the hierarchy of FQH states reflects the additional valley degeneracy. We will also discuss the implication of QHFM with spin and valley spin degree of freedoms.