Tunable quantum Hall states and electron interactions in few-layer graphene

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Few-layer graphene have emerged as fascinating platforms for investigating electronic interactions as well as quantum Hall (QH) physics. In addition to their high mobility, the presence of spin and valley degrees of freedom leads to SU(4) symmetries that do not have counterparts in traditional two-dimensional electron gas based on GaAs heterostructures. The addition of layers and multiple bands with non-trivial Berry curvatures provide additional degrees of freedom, resulting in an incredibly rich display of symmetries that can be broken either spontaneously or by external scalar or gauge fields. Here we will discuss gapped states induced by interactions and external fields, the tunable symmetries of integer and fractional quantum Hall states and the rich phase diagrams at the charge neutrality point in few-layer graphene.