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Spontaneous Quantum Hall Liquids

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Driven by electron-electron interactions, bilayer graphene and its thicker cousins, chirally (ABC) stacked multilayers, exhibit a variety of distinct broken symmetry states in which each spin-valley flavor spontaneously transfers charge between layers, because of their flat touching bands and large pseudospin chiralities. These gapped states are accompanied by large momentum space Berry curvatures and different types of topological orders. These competing ground states are distinguished by their flavor Hall conductivities, orbital magnetizations, edge state properties, and response to external fields. These spontaneous quantum Hall (SQH) states at zero field smoothly evolve into quantum Hall ferromagnet states at finite field. Various phase transitions occur by tuning carrier densities, temperature, and external fields. Recently, SQH states have started to be observed and explored in transport and Hall experiments on suspended devices with dual gates.