Incipient Fractional Chern Insulator in Monolayer Graphene

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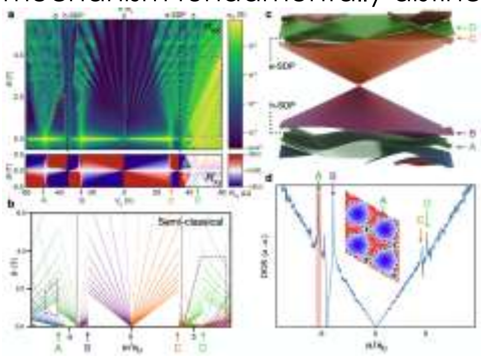
The realization of fractional Chern insulators (FCIs) has predominantly relied on the engineering of isolated flat bands in complex multilayer moiré systems. Whether such strongly correlated topological phases can emerge in theoretically more tractable systems with genuinely dispersive energy bands, and if so, *by what mechanism*, remains a fundamental open question. Here, we elucidate a mechanism for magnetic-field-induced strong correlations in the highly dispersive bands of a monolayer graphene–hexagonal boron nitride superlattice. Operating in the low-field classical-to-quantum crossover regime of the second moiré miniband, we demonstrate that the interplay between the moiré potential and weak magnetic fields (B<1.5T) profoundly alters electron dynamics. Specifically, we reveal that saddle-point van Hove singularities give rise to extended open orbits that effectively quench the kinetic energy of charge carriers in magnetic fields, facilitating a regime where Coulomb interactions dominate, while the weak magnetic field simultaneously lifts valley degeneracy and redistributes Berry curvature. Through high-resolution magnetotransport and temperature-dependent measurements, we observe the opening of an incipient topological energy gap at fractional filling factors, providing direct evidence for interaction-driven incompressibility in this dispersive-band system. Our results establish a fermiology-driven route to correlated topological phases operating in the classical-to-quantum crossover regime, revealing that dispersive-band systems can host interaction-driven topological states through a mechanism fundamentally distinct from flat-band platforms.



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