Interlayer correlations and remote moiré modulation in large-angle twisted graphene multilayers

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In large-angle twisted graphene multilayers, momentum mismatch suppresses interlayer tunneling while adjacent layers remain about 0.3 nm apart, yielding electronically decoupled layers with exceptionally strong interlayer Coulomb coupling. I will present our magnetotransport studies of this platform. In twisted bilayer graphene, interlayer-coherent quantum Hall states appear at odd-integer total filling, and at total filling 1/3 we observe a Halperin (333) state, an exciton condensate of fractional charges, which a displacement field drives into a layer-polarized Laughlin state. In alternating twisted trilayer graphene near 5°, spin-resolved helical edge modes emerge at charge neutrality and an interlayer excitonic state forms at total filling −1. In helical twisted trilayer graphene with the top layer aligned to hBN, the moiré potential modulates the unaligned, decoupled twisted-bilayer subsystem through electrostatic coupling alone. I will also discuss 13-layer rhombohedral graphene, where a moiré on one surface modifies the surface-state physics.