Competing phases of correlated Chern insulators in
Superconducting Twisted Bilayer Graphene

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Flat-bands in magic angle twisted bilayer graphene (MATBG) have recently emerged as a rich platform to explore strong correlations, superconductivity and magnetism. Here we use magneto-transport and Hall measurements to reveal a rich sequence of wedge-like regions of quantized Hall conductance with Chern numbers C = ±1, ±2, ±3, ±4 which nucleate from integer fillings of the moiré unit cell ν = ±3, ±2, ±1, 0 correspondingly. We interpret these phases as spin and valley polarized many-body Chern insulators. The exact sequence and correspondence of Chern numbers and filling factors suggest that these states are driven directly by electronic interactions, which specifically break time-reversal symmetry in the system. In addition we observe correlated Chern insulator in zero magnetic field in hBN non-aligned MATBG, which manifests itself in an anomalous Hall effect around a filling of one electron per moiré unit cell n = +1 with a Chern number of C = 1 and has a relatively high Curie temperature of Tc ≈ 4.5 K. Slight gate tuning away from this state exposes strong superconducting phases with critical temperatures of up to Tc ≈ 3.5 K. In a perpendicular magnetic field above B > 0.5 T we observe a transition of the n = +1 Chern insulator from a Chern number C = -1 to a higher C = 3, which is characterized by a quantized Hall plateau with Ryx = h/3e2. These observations show that interaction-induced time-reversal symmetry breaking in MATBG leads to a zero-field ground state which consists of almost degenerate and closely competing Chern insulators, where the B-field always couples strongest to states with higher Chern numbers. Our study is also the first demonstration of a system which allows gate-induced transitions between magnetic and superconducting phases, and hence marks a major milestone in the creation of a new generation of quantum electronics.