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Quantum Spin Hall Effects and Interactions in Twisted Bilayer Graphene

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Twisted bilayer graphene is the ultimate limit of a bilayer 2DEG, where two graphene layers are stacked directly on top of each other with an interlayer distance of only 0.34nm. This system owes its rich electronic structure to an interlayer tunnel coupling which can be continuously tuned by twisting the two layers. At large twist angles, the system behaves as two decoupled monolayer graphene sheets, where inter-layer and intra-layer Coulomb interactions compete to form new ground states. We investigate the possibility of realizing a quantum spin Hall state in twisted bilayer graphene when it is doped to form an electron-hole bilayer at moderate magnetic fields. In this regime, counter-propagating edge modes exist on different layers and the occupation of each mode can be independently controlled. We discuss the electronic properties of this twisted bilayer graphene quantum spin Hall state and the role of electron-electron interactions in its realization.