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Edge states in twisted bilayer graphene: quantum spin Hall and electron-hole bilayers JAVIER D. SANCHEZ-YAMAGISHI, JASON LUO, Massachusetts Institute of Technology, KENJI WATANABE, TAKASHI TANIGUCHI, National Institute of Materials Science, Japan, PABLO JARILLO-HERRERO, Massachusetts Institute of Technology — Twisted bilayer graphene offers a unique platform for studying 1d edge states in a bilayer 2-dimensional electron gas. Despite being spaced by only 0.34 nm, a large interlayer twist decouples the layers in the bulk, while opening the door for interesting interactions at the edges. To probe this physics, we study the electronic transport through quantum Hall edge modes in twisted bilayer graphene devices. Using dual electrostatic gates, we independently control the filling factor of each layer to form different combinations of bilayer edge states while measuring their conductance. The most dramatic transport effects are observed when the layers are doped to have edge states of opposite chiralities, resulting in coexisting electron- and hole-like states. We will present evidence that, in this regime, the twisted bilayer graphene can form a quantum spin Hall state where edge states in each layer counter-propagate in opposite directions with opposite spin polarizations. This bilayer realization offers a flexible system to study quantum spin Hall edge transport as well as to build more complex 1d circuits. We will also discuss the possibility for fractional generalizations of this edge physics and our measurements of the fractional QHE in twisted bilayer graphene.

Javier Sanchez
Massachusetts Inst of Tech-MIT

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