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Observation of helical edge states and fractional quantum Hall effect in a graphene electron-hole bilayer JASON YUANHONG LUO, JAVIER SANCHEZ-YAMAGISHI, Massachusetts Institute of Technology, KENJI WATANABE, TAKASHI TANIGUCHI, National Institute of Materials Science, PABLO JARILLO-HERRERO, Massachusetts Institute of Technology — 1D electronic systems are common theoretical building blocks for constructing quantum circuits, motivating a search for new experimental systems where 1D edge states of different quantum numbers can be coupled to each other by design. Twisted bilayer graphene allows for the stacking of two separate 1D quantum hall edge states, thus providing a natural sandbox for studying different types of edge state interactions. Via doping to form an electron-hole bilayer at moderate magnetic fields, we can induce edge modes of opposite chiralities and spin polarizations on different layers, thereby creating helical edge states reminiscent of a two-dimensional quantum spin Hall system. We report magnetotransport measurements of high-quality twisted bilayer graphene, showing how non-local measurements allow us to elucidate the nature and robustness of the helical edge states, as well as hints of fractional edge state interactions that are observable at higher magnetic fields.

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