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Quantum Spin Hall Effect in Twisted Bilayer Graphene FRANCESCA FINOCCHIARO, FRANCISCO GUINEA, IMDEA Nanoscience, PABLO SAN-JOSE, Instituto de Ciencia de Materiales de Madrid — Motivated by a recent experiment (Sanchez-Yamagishi et.al, arXiv:1602.06815) reporting evidence of helical spin-polarized edge states in layer-biased twisted bilayer graphene under a magnetic flux, we study the possibility of stabilising a Quantum Spin Hall (QSH) phase in such a system, without Zeeman or spin-orbit couplings, and with a QSH gap induced instead by electronic interactions. We analyse how magnetic flux, electric field, interlayer rotation angle, and interactions (treated at a mean field level) combine to produce a pseudo-QSH with broken time-reversal symmetry, and spin-polarized helical edge states. The effect is a consequence of a robust interaction-induced ferrimagnetic ordering of the Quantum Hall ground state under an interlayer bias, provided the two rotated layers are effectively decoupled at low energies. We discuss in detail the electronic structure and the constraints on system parameters, such as the angle, interactions and magnetic flux, required to reach the pseudo-QSH phase. We find, in particular, that purely local electronic interactions are not sufficient to account for the experimental observations, which demand at least nearest-neighbour interactions to be included.

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