Tuneable moiré bands in high angle twisted trilayer graphene

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Since the pioneering studies on magic angle twisted bilayer graphene, the field of twistronics has rapidly expanded to encompass more complex structures in the pursuit of new quantum phases of matter and exotic physical properties [1]. To date, a wide family of twisted multilayer graphene configurations where neighbouring layers are misaligned at small angles has been investigated [2]. In our research, we introduce a high-angle helically twisted trilayer graphene, where the top and bottom layers are twisted by 0.2 degrees, while the middle layer is misaligned with both outer layers. We conducted electron transport measurements revealing the formation of Brown-Zak oscillations, which are indicative of a moiré superlattice with a wavelength of 72 nm, along with integer Chern numbers observed in the moiré minibands. Furthermore, we identified a crossover dependent on displacement field and magnetic field between the coupled trilayer graphene regime and the fully decoupled regime. This study represents the first instance of moiré physics being observed in high-angle twisted multilayer graphene. Our system exhibits significant advantages over conventional twist configurations. Firstly, it facilitates the exploration of quantum moiré materials with exceptional device quality and tunability, enabled by high-angle twists. Secondly, it provides access to hexagonal moiré patterns at low twist angles, avoiding typical moiré lattice relaxation into triangular domains [3], thereby stimulating the study of higher-order magic angles [4]. Finally, this work lays the groundwork for the design of more intricate artificial materials featuring cross-layer hybridization.

References

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