Quantum Hall Edge States in Twisted Bilayer Graphene Nanoribbons

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Abstract

Twisted graphene-based nanostructures have been extensively studied in recent years due to their unique electronic properties that induce new outstanding quantum phenomena [1]. The quantum Hall effect is a fascinating phenomenon that occurs in two-dimensional electron systems subjected to a strong magnetic field, with significant practical applications in metrology, topological quantum computing and spintronics [2]. In finite systems, the quantum Hall effect gives rise to the formation of chiral edge states that propagate unidirectionally along the boundary of the material. In this work, the electronic properties of twisted bilayer graphene nanoribbons are investigated for scrutinizing the quantum Hall edge states, which are critical for the complete understanding of the electron behaviors under the influence of a sufficiently strong magnetic field. The recursive Green's function method allows for computing of both global and local electronic quantities [3-4], and is therefore a very efficient tool for modelling the quantum Hall edge states in twisted graphene-based nanoribbons (see Fig. 1). By using this approach, the interplay between the magnetic field and the moiré superlattice interaction on the formation of quantum Hall edge states is investigated. These quantum Hall edge states are also found to be strongly influenced by the atomic nature of the edges.

References

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[2] K. von Klitzing, T. Chakraborty, P. Kim, et al., Nat. Rev. Phys. **2** (2020), 397–401
[3] V. H. Nguyen et al., 2D Mater. **8** (2021), 035046
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Figures

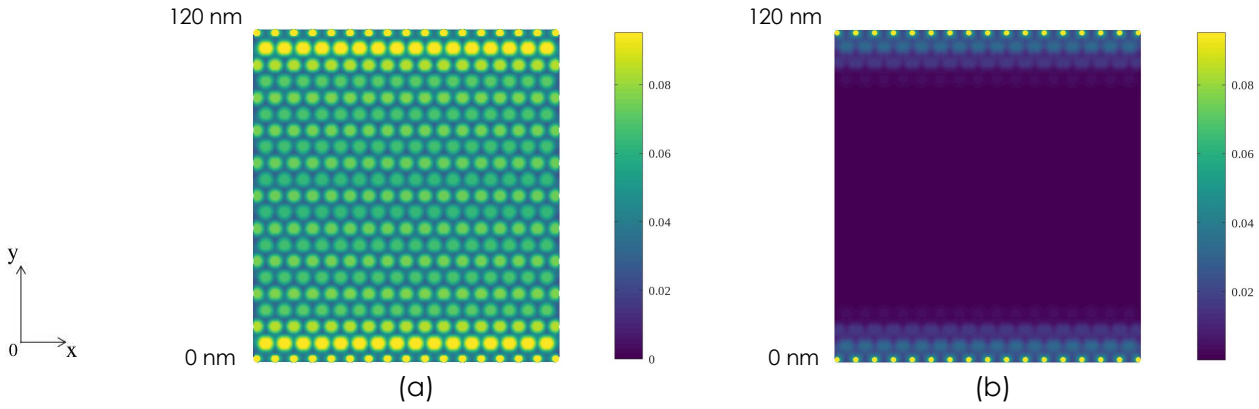

Figure 1: Local density of states (in arbitrary units) in twisted bilayer graphene nanoribbon (twist angle ~ 2°) calculated at the energy of 30 meV in the absence/presence of a magnetic field: (a) B = 0 T and (b) B = 40 T.