Emergence of currentless spin-current edge states in proximitized graphene stabilized by orbital magnetic fields

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Graphene influenced by the valley-Zeeman intrinsic spin-orbit coupling through proximity effects provides signatures of pseudohelical edge states [1,2]. Analyzing the band structure of a zigzag graphene nanoribbon in the presence of proximity induced spin-orbit interaction and an external magnetic field, we have discovered the effect of stabilization of intervalley edge states and removal intravalley edge states by the external magnetic field. Stabilization/removal of states is associated with the closing/reopening of the bulk bandgap between nonzero Landau levels [3]. The magnitude of the external magnetic stabilization/removal field was estimated both numerically and analytically. Finally, we have found that stabilized intervalley edge states in the presence or in the absence of a spin-flip hopping through the armchair edge form pseudohelical states or pure spin current states, respectively. The states of pure spin current are formed in wide graphene flakes and are protected from scattering by defects on the zigzag edges of graphene flakes.
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References

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2. T. Frank, P. Högl, M. Gmitra, D. Kochan and J. Fabian, Physical Review Letters **120**, 156402 (2018).
3. T. Frank and J. Fabian, Physical Review B **102**, 165416 (2020).

Figures

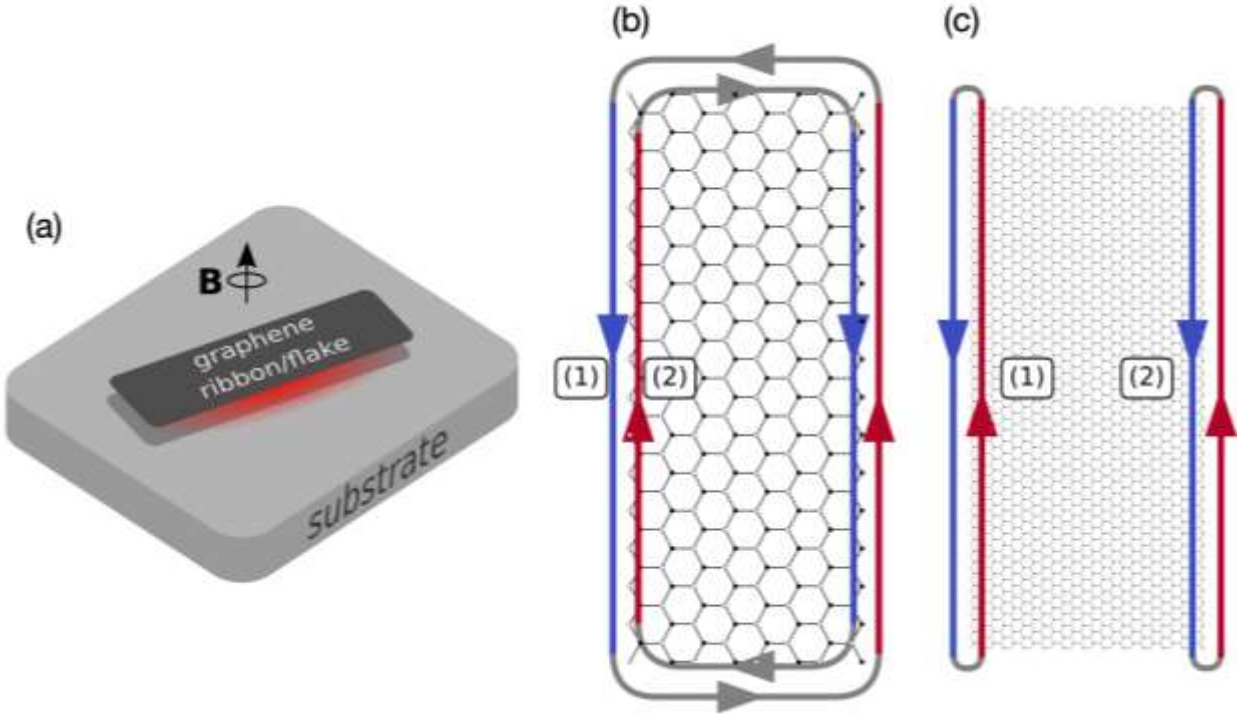

Figure 1: (a) Side view of graphene/TMDC heterostucture with proximity effect in a magnetic field. Schematic representation of pseudohelical states (a) and pure spin current states (b).