Interplay Between Topological and Defect States: Periodic One-Dimensional Patterns in Bilayer Graphene

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Gating Bernal bilayer graphene breaks the inversion symmetry so that the stacking AB/BA boundaries reveal topologically protected states within the gap [1]. Here, we theoretically investigate arrays where the AB and BA domains are periodically patterned with experimentally identified defect lines [2,3]. In the calculations we consider electron-electron interaction effects using density functional theory. Our findings reveal the existence of topological states within a gap induced by the patterning even without an applied gate voltage. Furthermore, with an applied gate potential, the defect lines introduce spin-polarized states pinned within the gap and exhibit ferromagnetically coupled states. Importantly, we observe a hybridization of magnetic and topological states near the valleys that form conducting channels characterized by spin-momentum locking. The effect persists even with slight n-doping and gate voltage; however, the progressively pinned n-doped defect states induce spin polarization in the topological and valley states. Additionally, the two-dimensional bands under doping conditions exhibit nesting across the Fermi surface, allowing for modulation of charge densities along the lines which are nearly commensurate with the underlying graphene-defect lines. These quasi-one-dimensional patterns in bilayer graphene show a new kind of spin conducting channels with novel characteristics common to both spintronics and valleytronics [4].

References

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Figures

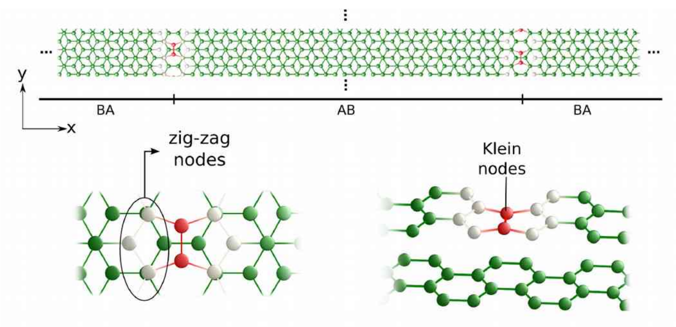

Figure 1: (Upper panel) Schematic view of an array of defect lines in bilayer graphene separating AB and BA stacking domains. (Lower panels) Zoom views of defect nodes. Gray and red carbon atoms correspond to zigzag- and Klein-like nodes, respectively.

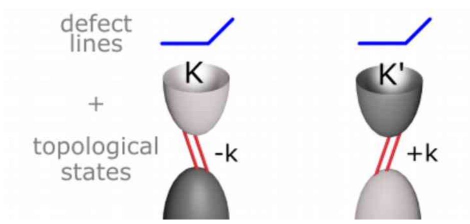

Figure 2: Interplay of defect states and topological states around valleys, to be discussed for domain walls in bilayer graphene, as shown in Fig 1.