Valley-Polarized Quantum Anomalous Hall Phase in Bilayer Graphene with Layer-Dependent Proximity Effects

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Realizations of some topological phases in two-dimensional systems rely on the challenge of jointly incorporating spin-orbit and magnetic exchange interactions. Here [1], we predict the formation and control of a fully valley-polarized quantum anomalous Hall effect in bilayer graphene, by separately imprinting spin-orbit and magnetic proximity effects in different layers. This mechanism contrasts with other proposals of this effect where both interactions are needed in both layers and as such poses challenges for experimental realizations. Our model results in varying spin splittings for the conduction and valence bands, which gives rise to a topological gap at a single Dirac cone [see Figure 1(a)]. The topological phase can be controlled by a gate voltage and switched between valleys by reversing the sign of the exchange interaction. By calculating the valley-resolved Hall conductivity [see Figure 1(b)] together with quantum transport simulations in disordered systems, the chirality and resilience of the valley-polarized edge state are demonstrated. Our findings provide a promising route to engineer a topological phase that could enable low-power electronic devices and valleytronic applications as well as putting forward layer-dependent proximity effects as a way to create versatile topological states of matter.

References

[1] Marc Vila, Jose H. Garcia, Stephan Roche, Phys. Rev. B, 104 (2021) L161113

Figures

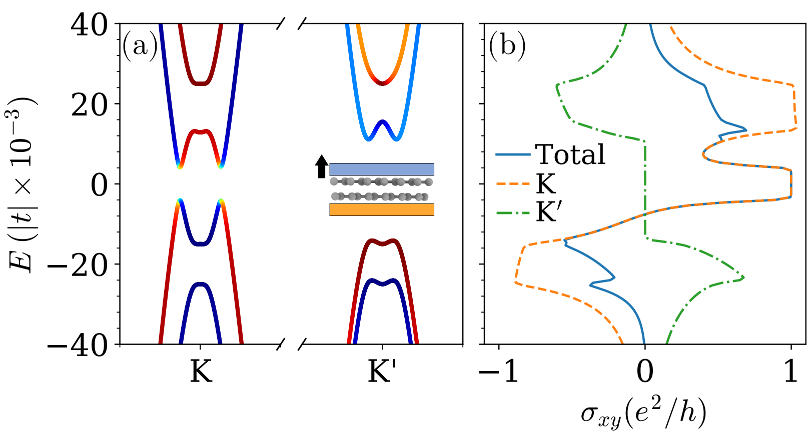

Figure 1: (a) Low-energy band structure of bilayer graphene proximitized with exchange interaction in one layer, and spin-orbit in the other layer. The gap at the K (K') valley is topological (trivial). (b) Valley-resolved Hall conductivity of the system in (a). The plateau of the Hall conductivity in the bulk band gap region demonstrates the presence of a valley-polarized quantum anomalous Hall effect.