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Gate controlled conducting channels in bilayer graphene

The inequivalent valleys K and K' in momentum space in 2D hexagonal lattice offers a new degree of freedom, valley freedom, which can be controlled much like the role played by electron spin. Valleytronics thus become promising for new generation electronics. In 2D systems with broken inversion symmetry, such as an electrically gated bilayer graphene, the Berry curvature Ω have opposite sign in K and K' valleys. A sign reversal of Ω across two oppositely gated regions will give rise to counter-propogating 1D conducting channels with opposite valley indices. These channels are valley-locked and topologically protected from intervalley scattering in clean systems. This approach provides an electrically controlled framework for valleytronics, such as valley valves and valley filter. But it is technically challenging to build such a nanoscale system. Here, we fabricate hBN-BLG-hBN heterostructure with four arrays of dual-split gate. Experiments show conductance contrast for normal E-field state and twisted E-field state, indicating on/off of the channels. And some optimizations are in process to get a highly clean system. Ultimately, if on/off conductance of each gate pairs could be realized to much higher ratio (1/100), the single pair can be a valley polarizer and second pair could detect the valley polarization and serve as a valley analyzer.

References

[1] Martin, I., Blanter, Y. M., & Morpurgo, A. F. (2008). Topological confinement in bilayer graphene. *Physical review letters*, *100*(3), 036804.

[2] Li, J., Wang, K., McFaul, et al. (2016). Gate-controlled topological conducting channels in bilayer graphene. *Nature nanotechnology*.

[3] Wang, L., Meric, I., et al. (2013). One-dimensional electrical contact to a two-dimensional material. *Science*, *342*(6158), 614-617.

Figures

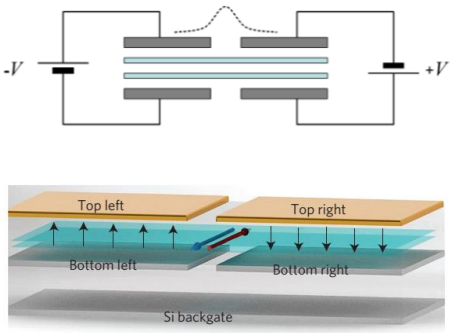

Figure 1. Proposed 1D conducting channels in twisted E-field configuration

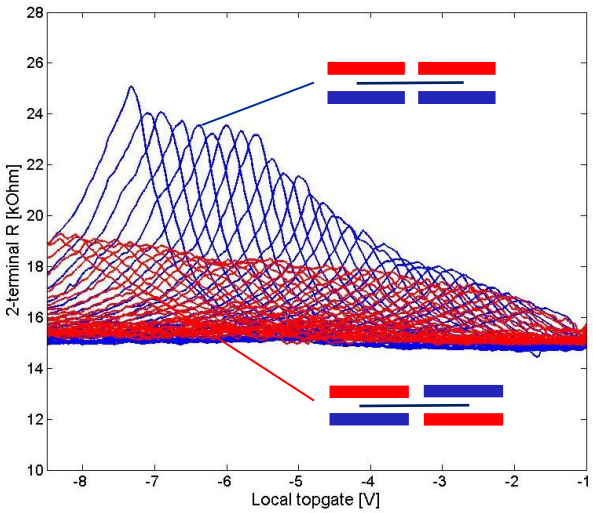

Figure 2. R vs LTG under different LBG for twisted and normal state.

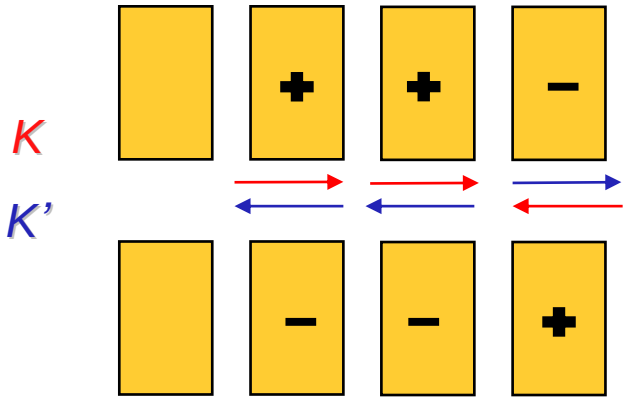

Figure 3. Schematic of valley polarizer and analyzer