Quantum valley Hall effect and valleytronics in bilayer graphene

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The advent of two-dimensional materials with hexagonal crystal symmetry offers a new electronic degree of freedom called valley, the manipulation and detection of which could potentially be exploited to form new many-body ground states as well as new paradigms of electronic applications. In this talk, I will describe our effort in creating and understanding valley-momentum locked quantum wires in Bernal stacked bilayer graphene. These quantum wires arise in a topological band structure of bilayer graphene created by state-of-the-art nanolithography and can carry current ballistically with a mean free path of several um's. They are signatures of the quantum valley Hall effect. I will also demonstrate the operations of a topological valley valve and a tunable electron beam splitter, which exploit unique characteristics of the valley Hall kink states [1][2]. Remarkably the operation of the valley valve does not require valley polarized current. The high quality and versatile controls of the system open the door to many exciting possibilities in valleytronics and in pursuing fundamental physics of helical 1D systems.

1. J. Li, R.-X. Zhang, Z. Yin, J. Zhang, K. Watanabe, T. Taniguchi, C. Liu, and J. Zhu, *A valley valve and electron beam splitter in bilayer graphene*, arXiv:1708.02311v1 (2017)
2. Li, J. Wang, K. McFaul, K. J. Zern, Z. Ren Y. F., Watanabe, K, Taniguchi, T, Qiao, Z. H., Zhu, J., *Gate-controlled topological conducting channels in bilayer graphene*, Nature Nanotechnology **11**, 1060 (2016)