Quantum valley Hall effect and valleytronics in bilayer graphene

The advent of two-dimensional materials with hexagonal crystal symmetry offers a new electronic degree of freedom, namely 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 work in creating valley-momentum locked quantum wires, namely quantum valley Hall kink states, along artificial domain walls created in Bernal stacked bilayer graphene by gating. The quantum valley Hall kink states exhibit quantized conductance of $4e^2/h$ and are signatures of the quantum valley Hall effect. I will also demonstrate the operations of a valley valve and a tunable electron beam splitter, which exploit unique attributes of the quantum valley Hall kink states. The high quality and versatile controls of this new helical 1D system open the door to many exciting possibilities in low-dimensional and topological systems.