High-Temperature Quantum Valley Hall Effect and Valleytronics

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One-dimensional edge states arising from a system of non-trivial bulk topology are potential quantum information carriers and platforms to explore the physics of topology and interactions. In this talk, I will discuss our effort in realizing the quantum valley Hall effect and the properties of its edge state, the kink states. Using van der Waals stacking and precision lithography, we create valley-momentum locked kink states in bilayer graphene and demonstrate its precise resistance quantization, a hallmark of ballistic edge state transport. The resistance quantization remains very robust against temperature, only changing 3% at ~ 50 K. The all-electrical construction of the kink states gives us the ability to realize a number of valleytronics operations. I will show the workings of a witch drive by topological phase transitions, reconfigurable ballistic waveguides, a topological valley valve, and a continuously tunable electron beam splitter. The cleanness and maneuverability of this platform enables future experiments of edge state physics and bolds well for its potential application as quantum information highways.

References

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