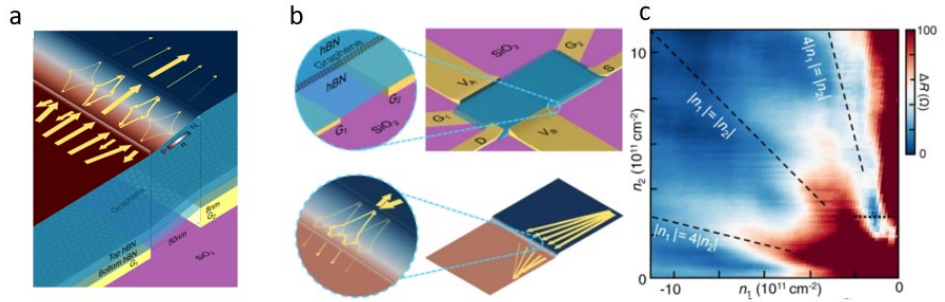
CAREER: Mesoscopic Quantum Opto-Electronics in Gate-Defined Transition Metal Dichacogenide Nanostructures

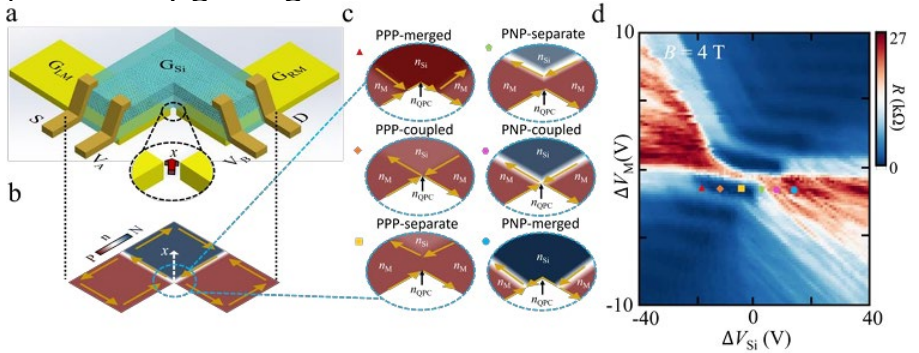
Ke Wang, University of Minnesota-Twin Cities

Guiding Electron Flow though a Strain-defined Microcavity: We developed a novel device architecture of a microcavity defined by carefully engineered local strain and electrostatic fields. We create a controlled interference process for electrons as a consequence of consecutive refractions in the microcavity, which we utilize to guide the electron flow towards desired direction with high efficiency. A manuscript was published in Nature Communication.

Selective Manipulation of Quantum Electronic States via Electrostatically Defined Constriction: Electron flow can be protected from scattering, due to electron orbit quantization under high magnetic field. For such topologically-protected quantum electronic states, we have developed a novel quantum electronic device, that allows unprecedented level of control over its evolution, hybridization, and transmission, and characterize them with high energy resolution. A manuscript was recently accepted for publication in Physical Review B.



(a) A microcavity defined by carefully engineered local strain and electrostatic fields, creates (b) a controlled interference process for (c) effectively guiding electron flow towards desired direction.



(a)(b) A novel quantum electronic device with dual-gated nano-constriction, that allows (b) unprecedented control over quantum electronic states (c) and the resulting quantum phenomena.

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The PI Wang tightly integrate the education and outreach program with research on the frontier of low-dimensional materials systems. The PI have been training graduate and undergraduate students in quantum matter research at the interface of experimental and theoretical science. They also maintain a very tight outreach through the existing network setup via University of Minnesota. Students, postdocs and faculty participate in these events to inform and engage the public through discussions of the advanced nanotechnologies developed by our team and its effect on device technologies.

The PI actively participating in both online and in-person conferences as well as the outreach program. Together with collaborators at UMN Math department, Wang participated in a two-day math camp for junior high and high school students in the University of Minnesota Talented Youth Mathematics Program, followed by a tour of the Wang lab and hands-on demonstration..

The Wang group also actively collaborates with the Science Museum of Minnesota for its annual Outreach Event. The Wang group has hosted a full-day exhibition and hands-on demonstration of graphene and TMDs, and their material properties to K-12 students at the annual Science Fusions event.

(Left) Wang group graduate students Xi Zhang and Wei Ren, explaining how to fabricate and measure 2D nano-electronic devices, to K-12 students visiting Wang lab, as a part of the University of Minnesota Talented Youth Mathematics Program.

(Right) Wang at annual outreach event at Science Museum of Minnesota, with hands-on demonstration of a 2D material, and their material properties to K-12 students.