Atomically Thin Canvas for Quantum Optoelectronics

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Transition metal dichalcogenide monolayers are atomically thin semiconductors that host tightly bound excitons. Recent advances in materials growth and fabrication have enabled the preparation of high-quality van der Waals heterostructures incorporating these two-dimensional materials. In this presentation, I will describe our efforts to use these heterostructures as a "canvas" to realize new quantum optoelectronic devices for excitons and electrons. I will discuss how we improve exciton's spectral/spatial uniformity and coherence and realize atomically thin mirrors and active "metasurfaces." I will also describe our recent observation of long-sought electron Wigner crystal phases in these heterostructures without a magnetic field or moiré potential and how we study the quantum melting of these crystals. Our studies illustrate that the heterostructures made of atomically thin semiconductors are an attractive solid-state platform for exploring novel excitonic and correlate-electron phenomena.