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Engineering new atomically thin quantum materials

Two-dimensional electronic systems form a bedrock of quantum condensed matter physics. Quantum Hall effects, Hofstadter's fractal spectrum, topological insulators, the Hubbard model, and the planar building blocks of cuprate superconductors are key examples. Two-dimensional materials, like graphene, have played a central role in advancing the field over the last decade, in part due to the ease with which different layers can be combined to engineer new systems with new electronic properties. My lab specializes in designing and assembling multiple two-dimensional materials into structures for electrical measurements at millikelvin temperatures and in large magnetic fields, where quantum effects dominate.

You will learn how to build layered structures of two-dimensional (2D) crystals and to design microscopic electronic devices for cryogenic measurements. This is hands-on work that requires clever solutions and an ability to learn new experimental methods quickly. You will use high-power optical microscopes, robotic micromanipulators, and atomic force microscopy to assemble and characterize your 2D samples. Along the way, you will learn about engineering electronic properties in 2D materials and in "moiré" materials like twisted bilayer graphene. The goal of this work is to realize superconductivity, strong electronic interactions, and topological states by combining materials that have none of these properties on their own.

You should be comfortable with quantum mechanics, familiar with statistical mechanics, and ready to learn about the latest research in quantum condensed matter physics from a variety of sources.