The Quantum Twisting Microscope: Visualizing Waves in Quantum Matter

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Some of the most fascinating phenomena in nature arise when electrons behave as quantum mechanical waves that interact with one another. But how can we visualize these electronic waves in action? In this talk, I will introduce the Quantum Twisting Microscope (QTM), an innovative scanning probe microscope designed to directly image electronic wavefunctions and energy bands within quantum materials. At its core lies a unique tip composed of an atomically thin van der Waals material, which functions as a quantum interferometer. Electrons tunnel from this tip into a sample at multiple locations at once, and the quantum interference between these tunneling paths enables the measurement of the phase evolution within electronic wavefunctions. These measurements allow the QTM to probe electrons in momentum space, much as a scanning tunneling microscope probes electrons in real space. I will present new experimental results on one of the most puzzling quantum systems - magic angle twisted bilayer graphene – revealing its interacting electronic bands and the intriguing interactions between its electrons and phonons.