Fractional topological phases and unconventional superconductivity in twisted MoTe2

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Two-dimensional moiré systems provide an exceptional platform for exploring novel quantum phenomena arising from the interplay between strong electronic correlations and nontrivial band topology. A notable example is the recent experimental observation of fractional quantum anomalous Hall effects in moiré Chern bands. This discovery opens new avenues for investigating a wide range of many-body quantum phases in lattice systems without external magnetic fields. In this talk, I will present our recent transport studies of high quality twisted MoTe2 devices. In particular, we reveal a subtle competition among fractional quantum anomalous Hall effects, unconventional superconductivity, reentrant quantum anomalous Hall effects, and other interaction-driven quantum states in high-quality twisted bilayer MoTe2 devices with twist angles of ~3.8°-3.9°. We further uncover a unified twist-angle–driven phase evolution that links fractional topology, symmetry breaking, magnetic order, and superconductivity, providing new insights into the emergent quantum phenomena in moiré materials.