Nanoscale Devices to Examine Correlated Materials

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Enormous progress in quantum materials, particularly metals and semiconductors, has been enabled through the development and application of nanofabrication techniques. Nanoscale devices have permitted the study of electronic properties of these systems on physically significant length scales, and confinement and control of individual electrons. Applying these techniques to correlated materials has lagged behind, however, in part because of the complex and stoichiometry-sensitive nature of these systems. I will discuss three sets of experiments that we have performed using micro/nanoscale structures based on strongly correlated materials: magnetotransport in the layered antiferromagnet V_5S_8 down to the nanometer thickness regime (collaboration with Prof. Jun Lou of Rice University); mesoscale transport in a bad metal, hydrogen-doped VO_2, as well as oxide quantum wells (collaborations with Prof. Darrell Schlom of Cornell and Prof. Susanne Stemmer of UCSB, respectively); and preliminary measurements on shot noise in tunnel junctions fabricated in YBCO (collaboration with Dr. Shane Cybart and Prof. R. Dynes at UCSD). These experiments look at the role of reduced dimensionality in magnetic ordering, and the nature of low energy charge-carrying excitations in systems where the existence of well-defined conventional quasiparticles is uncertain.