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Emergent Phenomena in Spatially Confined Manganites

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There is evidence that chemically disordered single crystal manganites exhibit electronic inhomogeneity in which areas with vastly different electronic and magnetic properties form and coexist in phase separated domains ranging in size from a few nanometers to micrometers. This phase separation is of particular interest, as it has been suggested that it is the central feature that leads to colossal magnetoresistance in manganites, the Mott transition in VO2 and may play a part in high-TC superconductivity in cuprates. We will discuss our ongoing efforts to answer fundamental questions about the specific role of PS in complex oxides using a novel spatial confinement technique. Unlike transport measurements on bulk or thin films where the electrons follow only the metallic path of least resistance, spatially confining a phase separated material to the scale of its inherent domains forces electrons to travel through both the metallic and insulating regions that lie along the conduction path. This has led to observations of several new phenomena such as a reemergent metal-insulator transition, ultra-sharp jumps in resistivity at the metal-insulator transition, and the first high resolution observation of stable single domain electronic phase transitions in time. La(5/8-x)Pr(x)Ca(3/8)MnO(3) (LPCMO) is used as a model system due to its large scale electronic phase separation into ferromagnetic metal (FMM) and charge ordered insulator (COI) electronic phase domains and well documented spin-charge-lattice interactions. These properties allow us to isolate domains through conventional wet etch techniques and offer a wide range of tunability through doping and substrate strain. This ability to control key elements of the underlying complexity and observe the resulting changes in the emergent behavior help answer questions about the fundamental physics that rule complex materials.