

Spatially Resolved Photoemission Spectroscopy to Probe Phase Separation in Manganites and Related Compounds

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Manganese oxides that exhibit colossal magnetoresistance (CMR) are often characterised by a competition of different electronic phases that critically influence their properties and leads to the coexistence of spatially separated competing phases. Despite extensive experimentation, characteristic length-scales associated with phase coexistence remains an important open question. While theoretical work has pointed to a nanometric length-scale, experiments have uncovered multiple length-scales ranging from the atomic to the sub-micron, covering many orders of magnitude. The role of chemical inhomogeneity in driving this phenomenon is not well understood. Moreover, these early experiments were carried out on polycrystalline and thin film specimens. Here we use a spatially resolved, direct spectroscopic probe for electronic structure with an additional unique sensitivity to chemical compositions to investigate high quality single crystal sample of $\text{La}_{1/4}\text{Pr}_{3/8}\text{Ca}_{3/8}\text{MnO}_3$. The formation of distinct electronic domains is observed in absence of any perceptible chemical inhomogeneity, where the relevant length-scale is at least an order of magnitude larger than all previous estimates. The present results, exhibiting memory effects in the domain morphology, suggest that electronic domain formation is intimately connected with long-range strains, often thought to be an important ingredient in the physics of this effect.

Additionally, we have also applied this technique to a variety of related materials, such as $(\text{LuMnO}_3)_{0.79}(\text{La}_{5/8}\text{Sr}_{3/8}\text{MnO}_3)_{0.21}$, and $\text{Sr}_2\text{Fe}_x\text{Mo}_{1-x}\text{O}_6$. Our preliminary results in all these cases suggest that the existence of spatially inhomogeneous electronic phases plays important roles in determining many of the interesting properties of such systems.

This work is carried out in collaboration with M. Bertolo, G. Causero, S-W. Cheong, A. Fujimori, L. Gregerotti, T. Y. Koo, S.R. Krishnakumar, U. Manju, S. Ray, S. La Rosa P. A. Sharma and D. Topwal.