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Nanoscale Structural Correlations in Magnetoresistive Manganites

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The colossal magnetoresistance (CMR) effect in perovskite manganites is a magnetic-field-induced transition form a paramagnetic insulating (PI) to a ferromagnetic metallic state. The large electrical resistivity of the PI state lies at the heart of the CMR effect. This enhanced resistivity stems, in part, from strong electron-lattice coupling and the associated local lattice distortions. Both uncorrelated local distortions (Jahn-Teller polarons) and correlated distortions are present in the PI state. The latter are believed to signal the presence of nanoscale orbital correlations. In this talk, we describe recent x-ray and neutron scattering studies of the orbital correlations in pseudocubic manganites $Ln_{1-x}B_xMnO_3$. Possible microscopic structures giving rise to these correlations are discussed. Dynamical properties of the correlated and uncorrelated distortions are presented. It is found that the correlations are ubiquitous in the orthorhombic PI phase of hole-doped manganites, and that their properties are defined by a single parameter - the doping level x. The correlations, however, are absent in the other paramagnetic phase exhibited by the manganites - the rhombohedral phase. The latter phase is metallic in the doping range in which the CMR effect is observed. Since the uncorrelated lattice distortions are present in the both of these phases, the insulating character of the PI state in CMR manganites results from the presence of the correlated lattice distortions. The orbital correlations, therefore, play the key role in the CMR effect.