Nanoscale Anisotropic Structural Correlations in the Paramagnetic and Ferromagnetic Phases of $Nd_{0.5}Sr_{0.5}MnO_3$

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$Nd_{0.5}Sr_{0.5}MnO_3$ belongs to the family of "Colossal Magnetoresistance" (CMR) materials. These compounds exhibit very large changes in their electric resistivity in applied magnetic fields and therefore hold promise of applications in magnetic recording. To understand the mechanism of the CMR phenomenon, it is necessary to explain the anomalously high resistivity exhibited by the high-temperature paramagnetic insulating (PI) phase of these materials. Recently, it has been shown[1] that nanoscale-size domains possessing orbital and charge order are present in the PI phase in some manganites. The presence of these domains, and the associate polaron-polaron correlations, were linked to the high electrical resisitivity of these compounds. However, the microscopic nature of the correlated domains, as well as whether this mechanism of the resisitvity enhancement is universal to the CMR manganites, has yet to be established.

In this work, we report x-ray scattering studies of short-range structural correlations and diffuse scattering in $Nd_{0.5}Sr_{0.5}MnO_3$. Highly anisotropic structural correlations were found in both the PI and ferromagnetic metallic (FM) states of this compound. The corresponding correlation length grows with decreasing temperature and reaches its maximum at the charge ordering transition temperature; below this temperature, these structural correlations abruptly collapse. Single polaron scattering, while reduced, is clearly present in the ferromagnetic state suggesting that substantial lattice distortions are present in this phase. We argue that our measurements indicate that nanoscale regions exhibiting layered orbital and magnetic order exist in the paramagnetic and ferromagnetic phases of $Nd_{0.5}Sr_{0.5}MnO_3$. Together with previous measurements[1], our results show that nanoscale lattice correlations play an important role in magneto resistive manganites.

References: [1]P. Dai, et al., Phys. Rev. Lett. **85**, 2553 (2000); C. P. Adams, et al., preprint cond-mat/0009132 (2000)