Understanding the insulating phase in colossal magnetoresistance $La_{1-x}Ca_xMnO_3$ manganites - the total scattering approach

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The strength of the total scattering analysis is that it provides important insight into the local structure of a material, the structure beyond crystallography. This method is now successfully applied for studying a wide class of materials, from glasses, nanoparticles, and other crystallographically challenged materials, to crystalline samples that exhibit novel nanoscale physics. Results will be presented of the most comprehensive total scattering study to date of the local Jahn-Teller (JT) distortion across the phase diagram of the high-Tc colossal magnetoresistive (CMR) $La_{1-x}Ca_xMnO_3$ ($0 < x < 0.5$). The local structure has been obtained using the neutron powder diffraction based atomic pair distribution function (PDF) approach, over the wide temperature and Ca-doping range. These results are compared to the conventional crystallographic results obtained by Rietveld analysis. The results will be compared with both homogeneous and inhomogeneous models of the electronic structure. Local structural aspects of the orthorhombic to pseudocubic phase transition (JT-transition) in this system will be presented. I will show how the local structure can be used to probe the electronic state of the manganese ions across the metal to insulator boundary. The completely unexpected result throws into doubt the importance of nano-phase separation in the CMR phenomenon.