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Impact of Na ordering on the electronic properties of the Co planes in Na_xCoO_2

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In 2003 superconductivity at 4.5K has been discovered in $Na_{0.35}CoO_2$,1.3H_2O, a hydrated cobaltate. These layered cobaltates Na_xCoO_2 have some analogies with the cuprates, as 2D conductivity occurs in the CoO_2 planes, where the Co are arranged on a triangular lattice, and doping can be modified by changing the Na content. But, contrary to the case of most cuprates for which dopant induced disorder is quite influential, the doping achieved in cobaltate samples is associated with the insertion of well ordered 2D Na structures and even 3D ordered stacks of the Na/Co planes. We found that the correlations between magnetic properties and Na structural order are uniquely probed locally through NMR/NQR measurements on both ^{23}Na and ^{59}Co nuclei. The Na ordering appears responsible for very distinct electronic ground state properties of the metallic CoO_2 planes, which do exhibit ferromagnetic in plane correlations for $x > 0.62$ up to the highest Na content (except for x=1 which is a band insulator). These metallic ferromagnetic correlations do not yield any static magnetic order down to T=0[(1)] for x <0.75, beyond which an AF 3D order occurs (in plane ferromagnetic with AF 3D stacking[(2)]). On the contrary for x <2/3, in plane AF correlations appear[(3)], though static 3D AF ordering at low T is only achieved for x=1/2 [(4)]. For x >0.5, the nature of the ground state and the anomalous magnetic properties are found to be linked with a charge segregation which localizes an ordered array of non magnetic Co^{3+} sites in a metallic Co background responsible for the magnetic properties[(5)]. This is contrary to many expectations for which Na order was expected to pin local magnetic moments in a metallic and less magnetic bath. NMR/ NQR experiments have allowed us recently to determine the atomic structure of the x=2/3 phase. We demonstrated that the associated Co charge order is somewhat peculiar as the nearly ferromagnetic metallic state results of hole delocalization on a simple kagome lattice of Co sites[(6)]. Further efforts to determine the actual arrangement of the non magnetic cobalt sites for different Na concentrations is presently undertaken and should give hints to link the ground state properties with the Co charge arrangements.

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