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Orbital effects in cobaltites by neutron scattering

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The orbital degree of freedom can play a central role in the physics of transition metal perovskite oxides because of its intricate coupling with other degrees of freedom such as spin, charge and lattice. In this talk the case of $\text{La}_{1-x}\text{Sr}_x\text{CoO}_3$ will be presented. Using elastic and inelastic neutron scattering, we investigated the thermal evolution of the local atomic structure and lattice dynamics in the pure sample and with the addition of charge carriers as the system crosses over from a paramagnetic insulator to a ferromagnetic metal. In LaCoO_3 , the thermal activation of the Co ions from a nonmagnetic ground state to an intermediate spin state gives rise to orbital degeneracy. This leads to Jahn-Teller distortions that are dynamical in nature. Doping stabilizes the intermediate spin configuration of the Co ions in the paramagnetic insulating phase. Evidence for local static Jahn-Teller distortions is observed but without long-range ordering. The size of the JT lattice is proportional to the amount of charge. However, with cooling to the metallic phase, static JT distortions disappear for $x \leq 30\%$, the percolation limit. This coincides with narrowing of two modes at $\hbar\omega = 22$ and 24 meV in the phonon spectrum in which we argue is due to localized dynamical JT fluctuations¹. The implications of the orbital effects to the structural and magnetic properties will be discussed. ¹D. Louca and J. L. Sarrao, Phys. Rev. Lett. **91**, 155501 (2003).