

## Collective spin states in lightly doped $\text{LaCoO}_3$

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We present results of electron spin- (ESR), nuclear magnetic resonance (NMR) and inelastic neutron scattering (INS) studies of single crystals of the lightly doped  $\text{LaCoO}_3$ . In contrast to undoped system, which is nonmagnetic at  $T \leq 30$  K, a very small  $\text{Sr}^{2+}$  doping ( $x \sim 0.002$ ) yields a strong magnetization already at low  $T$ .  $^{59}\text{Co}$  NMR measurements indicate the formation of extended magnetic clusters in this temperature regime. ESR spectroscopy reveals multiple gapped resonance excitations with different g-factor values suggesting that magnetic clusters have a large spin multiplicity and substantial spin-orbital coupling. These results and INS data [see, A. Podlesnyak, *et al.*, Phys. Rev. Lett. **101**, 247603 (2008)]. gives evidence that the cluster comprises 7 magnetic Co ions. We argue that the doped hole couples these ions ferromagnetically yielding a spin-state polaron with a huge local magnetic moment. Influence of different sorts of dopants on the polaron formation was studied.