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Spin-lattice coupled anomalies and magneto-crystalline transition in Pr0.50Sr0.50CoO3 investigated by x-ray absoprtion spectroscopies

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The spin state of Co ions is a key degree of freedom in many *Ln*_{1-x}*A*_xCoO₃ (*Ln*: lanthanide, *A*:alkaline-earth) oxides with remarkable physical properties. In (Pr,*Ln*_{1-x})Ca_xCoO<sub>3</su cobaltites near half-doped (x≈0.5), Co³⁺ spin-state sharp changes induce a first-order Pr³⁺ to Pr⁴⁺ valence shift and an exotic MIT. The insulating state is extraordinarily unleashed by electron transfer from Pr to Co sites, producing a volume contraction and stabilizing the diamagnetic Co³⁺ in LS state. Pr_{0.50}Sr_{0.50}CoO₃ (PSCO) notably differs from Pr_{0.50}Ca_{0.50} (PCCO). In contrast with the absence of long-range magnetic order in PCCO, metallic PSCO is FM below *T_C*≈230 K. Here, an unexpected step in magnetization at *T_{S1}*≈120 K was ascribed to changes in the magnetocrystalline anisotropy. This step may be positive or negative as a function of the applied field. The crystal symmetry reduction from orthorhombic to tetragonal at *T_{S1}*, with a significant local deformation of Co-O octahedra could be related to changes in the orbital moment *m_l*.However, the CoL_{2,3} XMCD-derived *m_l* shows a monotonous behavior with temperature and no anomaly across *T_{S1}* . This contrasts with *m_s*, which presents an upward (downward) step on cooling at 100 (10) mT. This result thus points to a leading role of the spin-lattice coupling in this anomalous transition shown by PSCO. XAS and XES spectra also suggest Co³⁺ ions to be in a mixed spin state coexisting with predominantly low spin Co⁴⁺ ions, with an average spin state slightly larger than the one recently determined for PCCO.

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Primary author: Ms PADILLA-PANTOJA, Jessica (Institut de Ciència de Materials de Barcelona, ICMAB-CSIC, Campus Universitari de Bellaterra, E-08193, Bellaterra, Barcelona, Spain)

Co-authors: Dr BARLA, Alessandro (3Istituto di Struttura della Materia, ISM CNR, Area Science Park Basovizza (Ts), Trieste I-34149, Italy); Dr HERRERO-MARTÍN, Javier (ALBA Synchrotron Light Facility, 08290 Cerdanyola del Vallès, Barcelona, Spain); Prof. GARCÍA-MUÑOZ, José Luis (Institut de Ciència de Materials de Barcelona, ICMAB-CSIC, Campus Universitari de Bellaterra, E-08193, Bellaterra, Barcelona, Spain); Dr VALVIDARES, Manuel (ALBA Synchrotron Light Facility, 08290 Cerdanyola del Vallès, Barcelona, Spain); Dr GARGIANI, Pierluigi (ALBA Synchrotron Light Facility, 08290 Cerdanyola del Vallès, Barcelona, Spain)

Presenter: Ms PADILLA-PANTOJA, Jessica (Institut de Ciència de Materials de Barcelona, ICMAB-CSIC, Campus Universitari de Bellaterra, E-08193, Bellaterra, Barcelona, Spain)

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