

## **Complementarity Gone Mad: Magnetostructural Correlations in Rare Earth Strontium-Doped Cobaltates**

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Substantial interest has recently been generated by rare earth cobaltate compounds as cathode materials for solid oxide fuel cells. We have synthesised a wide range of single phase perovskite-based rare earth cobaltates ( $Ln_{1-x}Sr_xCoO_{3-d}$ ) ( $Ln = La^{3+} - Yb^{3+}$ ). A combination of electron and high-resolution synchrotron X-ray powder diffraction of these phases reveals a complex family of tetragonal and orthorhombic superstructures. The nature of structural and magnetic ordering relies on both cation and oxygen vacancy distribution, which has been further investigated using powder neutron diffraction. Phase boundaries exist between compounds containing large, medium and small rare earths (between  $Nd^{3+}$  and  $Sm^{3+}$ , and also between  $Gd^{3+}$  and  $Dy^{3+}$ ) and also at different Sr-doping levels. These phases show mixed valence (3+/4+) cobalt oxidation states that increases with Sr content. A range of magnetic and electrical behaviours have been observed including ordered antiferromagnetism at elevated temperatures (>300 K) and metallic conductivity.