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Temperature dependence of the mixed antiferro-/ferro- magnetic structure of the compositionally complex perovskite L5BO

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Spintronic devices offer fast, non-volatile, and more energy-efficient computing and memory compared to conventional electronic approaches. Compositionally complex oxides (CCOs) are an emerging class of materials for spintronic applications due to their low cost, robust magnetic stability, and high tunability. We are investigating $\text{La}(\text{Cr}_{0.2}\text{Mn}_{0.2}\text{Fe}_{0.2}\text{Co}_{0.2}\text{Ni}_{0.2})\text{O}_3$ (L5BO), a perovskite CCO which exhibits the coexistence of antiferromagnetic (AFM) and ferromagnetic (FM) ordering, due to competition among its 15 different exchange interactions. Bulk magnetic properties are controlled by varying Mn concentration. At a concentration of 40% Mn, exchange biasing behaviour (normally only accessible through intentionally designed heterojunctions) and a gradual transition region in M-T curves, rather than a well-defined transition temperature, has led to the suggestion that AFM and FM ordering can both coexist in relatively equal proportions. Because AFM and FM ordering lead to result in neutrons being scattered at different reflections, using temperature dependent magnetic neutron powder diffraction we have been able to confirm that both AFM and FM ordering coexist within 40% Mn L5BO. We also demonstrate that the AFM and FM fractions of the material have separate transition temperatures, lowering the operational temperature for prospective devices than that given by standard magnetometry. Furthermore, this implies that neutron scattering is an essential tool for future research into similar compositionally complex mixed-magnetic oxides in order to fully understand how different magnetic phases evolve with temperature versus bulk magnetometry.

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