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Probing Local Magnetic Order in the Frustrated Bow-tie Lattice of Layered Oxide $Ca_2Mn_3O_8$

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Frustrated magnetism continues to be a vibrant area of research in chemistry and condensed matter physics. Geometric frustration arises when the magnetic degrees of freedom are incompatible with the underlying lattice geometry, and contrasts conventional magnetism because the system exhibits numerous degenerate ground states. Hence, rich exotic phenomena are observed as a function of pressure and (or) temperature. A plethora of frustrated layered oxide materials exist, including the delafossite family which is similar to the well-known Kagomé system and is based on a triangular antiferromagnet. One variant of this family with interesting bow-tie connectivity is $Ca_2Mn_3O_8$, which contains two unique manganese sites. It exhibits two magnetic phase transitions, one at T^* = 130 K that is associated with short-range spin correlations and a second at T_N = 58 K that is associated with three-dimensional long-range order. From neutron diffraction studies, the former transition is exclusively linked to the crystallographic *b*-direction but fully ordered one-dimensional chains are not realised. To further investigate this interesting local magnetic behaviour, temperature studies using inelastic neutron scattering, X-ray absorption spectroscopy and muon spin spectroscopy were carried out. Measurements reveal the intriguing correlation between the unique manganese sites such that static-dynamic behaviour between both persists below T^* in an attempt to relieve frustration.

Primary author: Ms MCPHILLIPS, Holly L. (University of Kent)

Co-authors: Dr VERA STIMPSON, Laura J. (Canterbury Christ Church University); Prof. DREW, Alan J. (Queen Mary University of London); Dr EWINGS, Russell A. (ISIS Neutron and Muon Source); Dr DIXEY, Richard J. C. (Queen Mary University of London); Dr ARNOLD, Donna C. (University of Kent); Dr RAMOS, Silvia (University of Kent)

Presenter: Ms MCPHILLIPS, Holly L. (University of Kent)

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