Long range versus short range spin correlations in $A_{0.8}La_{1.2}MnO_{4.1}$ (A = Sr, Ba)

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Interesting magnetic phenomena can arise in compounds with the K_2NiF_4-type structure containing paramagnetic ions such as Mn^{3+} (1,2). In such materials, frustration results due to the interlayer magnetic coupling in the Mn^{3+} sublattice which consists of square planar layers stacked in an *I*-centred sequence. Here the strikingly distinct magnetic properties of two such isostructural compounds, $Sr_{0.8}La_{1.2}MnO_{4.1}$ and $Ba_{0.8}La_{1.2}MnO_{4.1}$ are discussed. Neither of these compounds have been reported so far, with only oxygen deficient and oxygen excess forms of $Sr_{0.8}La_{1.2}MnO_4$ being studied before (3,4). Both $Sr_{0.8}La_{1.2}MnO_{4.1}$ and $Ba_{0.8}La_{1.2}MnO_{4.1}$ have been recently synthesised in our laboratory, the latter as a single crystal, and their magnetic properties have been investigated and compared. $Ba_{0.8}La_{1.2}MnO_{4.1}$ is a rare example of an anisotropic spin glass, showing spin freezing for the field direction parallel to the *c*-axis only, with no evident freezing with the field in the *ab* plane as indicated in the D.C. and A.C. magnetic susceptibility. The heat capacity data showed no evidence for long range magnetic order and a T^1 power law at low temperature, consistent with the spin glass behaviour in the magnetic susceptibility. Furthermore, the neutron diffraction data for $Ba_{0.8}La_{1.2}MnO_{4.1}$ at 35 K (above T_g) and 3.5 K (below T_g) indicated the absence of magnetic Bragg peaks. On the other hand, $La_{1.2}Sr_{0.8}MnO_{4.1}$ shows a broad maximum in the D.C. magnetic susceptibility data, characteristic of strong intra planar 2D antiferromagnetic spin correlations above T_N = 95 K. The magnetic structure is the $\boldsymbol{k}$ = (1/2 1/2 0) type typical for such materials with the Mn^{3+} moment along the c-axis. Neutron diffraction on $Sr_{0.8}La_{1.2}MnO_{4.1}$ performed at temperatures above 95 K confirmed the Warren type line shape indicative of strong 2D spin correlations. Additionally, Mn K-edge XANES analysis revealed that Mn is in the +3 oxidation state in both compounds. The observed differences in properties are explained based on structural arguments.

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