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Magnetic x-ray scattering, transport and MFM study of strongly correlated $La_{1-x}Sr_xMnO_3$ nanowires[1]

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Artificial patterning is a promising new approach to studying strongly correlated materials, since a boundary acts as a perturbation that can tip the balance among various competing ground states. We have fabricated large, periodic arrays of 80 nm wide nanowires from epitaxially grown $La_{0.67}Sr_{0.33}MnO_3$ (LSMO) thin films. Their electronic and magnetic properties were studied with resonant soft x-ray scattering (RSXS), transport measurements and magnetic force microscopy (MFM). RSXS measurements revealed a series of structural diffraction peaks that arise from the periodic wire structure. Below the Curie temperature we also observed a series of magnetic superlattice reflections, indicating collective ordering of the magnetic moments into a pattern with a spatial period of five wires. Transport measurements also showed anomalous "telegraph" switching noise at temperatures below 15K, and MFM revealed unusual domain formation. We interpret these results as arising from unusual, boundary-induced magnetic domains interacting via long-ranged, classical magnetic dipole coupling.

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