Electrostatic extension of magnetic proximity effect in $La_{0.7}Sr_{0.4}MnO_3$

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Many fascinating magnetic effects emerge at interfaces between layers with different magnetic orders. Interface confinement is intimately related to the magnetic proximity effect, which typically has a spatial extent of only a few atomic layers. This short extent is due to the underlying physical coupling mechanisms, such as the exchange interaction, the Dzyaloshinsky-Moriya interaction, interface states, rehybridization, and reconstruction, all of which are highly localized. We use off-axis electron holography to reveal an exceptionally long-range magnetic proximity effect reaching ~40 nm at a ferromagnetic (FM)/ paramagnetic (PM) interface in $La_{0.7}Sr_{0.3}MnO_3$ (LSMO). This wide extent arises from carrier diffusion and drift across the interface, which changes the Mn^{3+}/Mn^{4+} ratio and thereby the density of magnetic moments and local Curie temperature. We determine the carrier concentration dependence of the Curie temperature and unravel the physical mechanism of the electrostatic extension of magnetic proximity effects, fundamentally reshaping our understanding of micromagnetism in perovskites. [1]

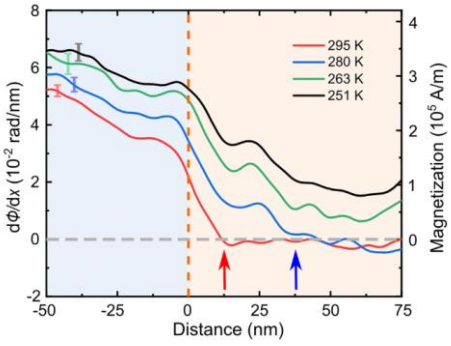

Figure 1: In-plane magnetization (right axis) vs. distance from the PM/FM interface (x=0 nm) along the [001] direction in the LSMO film at different temperatures.

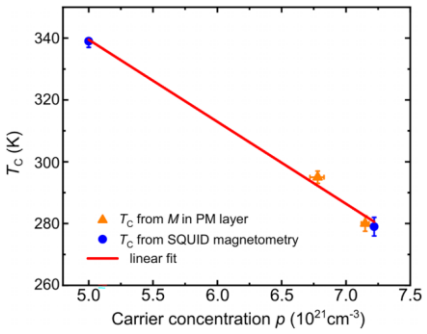

Figure 2: Curie temperature (TC) determined using SQUID magneto-metry (blue dotes) and off-axis electron holography orange tri-angles), as a function of carrier con-centration. A linear relation is found.

[1] Q. Lan *et al.*, Phys. Rev. B **108**, L180410 (2023).

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