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# Non-collinear long-range coupling in manganates superlattices

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Transition metal oxides display versatile magnetic phenomena that are mediated by various exchange mechanisms thanks to the localized d-electrons Perovskite manganese oxides (manganates) are archetypal examples of such magnetic transition metal oxides. In manganates, the super-exchange and double-exchange interactions play a major role in determining the magnetic phase. The relative strength between the two interactions is tuned by the average number of electrons at Mn sites, which leads to a phase diagram crowded with numerous magnetic phases. In addition, their ideal half-metallicity makes manganates as prominent candidate materials for near future magnetic devices such as magnetic random-access memory (MRAM), and other spin-current applications.
Another property that is invaluable for magnetic devices is the long-range magnetic interaction such as RKKY, which is currently used to generate antiparallel spin configurations in MRAM. Yet, exhaustive investigation of long-range interaction in transition metal oxides have been lacking. There are only few examples where non-collinear magnetic ordering was observed in superlattices composed of different perovskites. Here, we demonstrate that superlattices made of only manganates can exhibit non-collinear magnetic superstructures and present their temperature- and field-dependence using polarized neutron reflectometry. The long-range exchange interaction was tuned by the modulation of dopants using oxide layer-by-layer molecular beam epitaxy, which minimized the detrimental lattice-mismatch between layers. Considering extremely versatile phase diagram of manganates, discovery of non-collinear ordering in our only-manganate superlattices calls for further investigation of manganates superlattices.

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