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Emergent Magnetic Phenomena at Manganite Interfaces

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Emergent phenomena at transition metal oxide interfaces have been the focus of recent intense study since the discovery of metallicity at the interface of $LaAlO_3$ and $SrTiO_3$ a decade ago. Emergent magnetic phenomena at transition metal oxide interfaces had been studied even earlier. However there have been surprisingly few systems demonstrating interfacial ferromagnetism especially combined with metallicity. Recently, we have developed a general picture describing the origin of interfacial ferromagnetism in $CaMnO_3$ based systems. Density functional theory attributed the interfacial ferromagnetism to a double exchange interaction among interfacial Mn ions (just in the first single unit cell of $CaMnO_3$) mediated by conduction electrons from the neighboring itinerant layer. We have demonstrated interfacial ferromagnetism in superlattices composed of the antiferromagnetic insulator $CaMnO_3$ and an itinerant metal ($CaRuO_3$ or $LaNiO_3$). Through polarized neutron spectrometry, x-ray magnetic circular dichroism and bulk magmetometry, we have shown that the ferromagnetism originates from Mn ions in a single unit cell of the $CaMnO_3$ at the interfaces as theoretically predicted. The modulation of interfacial ferromagnetic moment as a function of constituent layer thicknesses as well as long-range antiferromagnetic correlations in the $CaMnO_3$, observed by neutron diffraction, are indicative of the competing magnetic interactions at play.