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Emergent Interfacial Ferromagnetism in $CaMnO_3$-based Superlattices[1]

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Interfaces of complex oxide materials provide a rich playground not only for the exploration of properties not found in the bulk constituents but also for the development of functional interfaces to be incorporated in spintronic applications. Emergent interfacial magnetic phenomena have been of great interest but surprisingly there have been few examples of emergent interfacial ferromagnetism. In this talk, I will describe our recent work on the stabilization of ferromagnetism in $CaMnO_3$-based superlattices. We have demonstrated ferromagnetism at the interface between the antiferromagnetic insulator $CaMnO_3$ and a paramagnetic metallic layer, including $CaRuO_3$ and $LaNiO_3$. Theoretically the ferromagnetism has been attributed to an interfacial double exchange interaction among the interfacial Mn ions that is mediated by itinerant electrons from the paramagnetic metallic layer. Through polarized neutron reflectivity and observation of exchange bias, we have demonstrated that the ferromagnetism comes from Mn ions in a single unit cell at the interfaces just as theory has predicted. We have also demonstrated that the metallicity of the paramagnetic layer is critical in stabilizing ferromagnetism at the interface and that the interfacial ferromagnetism can be suppressed by suppressing the metallicity of the paramagnetic layer. Despite the agreement with theory, there remain open questions as to the magnetic interactions among the interfacial ferromagnetic layers. For example, the saturated magnetic moment modulates as a function of the thickness of both the $CaMnO_3$ and paramagnetic metal layers. The origins of this oscillation are not well understood and may stem from either structural effects or long-range oscillatory magnetic coupling interactions reminiscent of RKKY interactions. Evidence of the doubling of the unit cell and long range antiferromagnetic correlations support these speculations.

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