Understanding the Origin of Ferromagnetism in LaNiO$_3$/CaMnO$_3$ Superlattices

CHARLES FLINT, Stanford University, ALPHA N’DIAYE, PADRAIC SHAFER, ELKE ARENHOLZ, Advanced Light Source, YURI SUZUKI, Stanford University — Interfacial ferromagnetism (FM) in transition metal oxide heterostructures is a promising route for engineering new low-dimensional devices. In 2001, FM was discovered in CaRuO$_3$/CaMnO$_3$ superlattices (SLs), which is attributed to an itinerant electron-mediated Mn-Mn double-exchange (DE). Since then we have discovered interfacial FM in (LaNiO$_3$)$_N$/ (CaMnO$_3$)$_8$ SLs that is consistent with this DE interaction$^1$. Now we have explored even further reduced dimensionality by fabricating [(LNO)$_{n=2-7}$/(CMO)$_{10}$] SLs. Transport measurements confirmed a thickness dependent metal-insulator transition, with insulating films for N<4. Bulk magnetometry measurements reveal interfacial FM in insulating and conducting SLs. Since there are no itinerant electrons in the insulating SLs, this FM must arise from a different source. Using x-ray absorption spectroscopy and magnetic circular dichroism, we have identified the coexistence of Ni$^{2+}$ and Ni$^{3+}$ and Ni magnetism. We therefore speculate that the FM in insulating SLs originates from a Mn-Ni superexchange interaction. We discuss the role of these interactions in interfacial FM and methods for controlling them.