# Coupling of magnetic phases at nickelate interfaces

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Perovskite rare earth nickelates (with chemical formula $RENiO_3$, RE = Rare Earth, RE $\neq$ La) are fascinating materials, well-known, for their metal to insulator transition (MIT) and unique antiferromagnetic ground state [1–3]. Due to the lack of sizeable single crystals, heterostructures constitute the best system to study the fascinating properties of these materials. Pursuant to this, we have grown superlattices made of $SmNiO_3$ and $NdNiO_3$ layers. When these two compounds are brought together at an interface the stability of a metal-insulator phase separation can be controlled by the thickness of the individual layers, giving a critical length scale below which, a single metal-to-insulator transition occurs. We have demonstrated that this behavior is set by the balance between the energy of the interfacial phase-boundary and the bulk phase energies [4]. As the ground state of this materials is not only insulating but also antiferromagnetic, by combining a probe of long-range magnetic order—resonant x-ray magnetic scattering—and a highly sensitive probe of local magnetism—muon spin relaxation—we study how the magnetic order evolves in this complex multicomponent system. We find that similar to what is observed in the resistivity measurements, these superlattices display either two magnetic transitions or one depending on the superlattice wavelength. The critical length scale over which antiferromagnetic-paramagnetic phase coexistence can occur is found to be greater than the critical length scale for insulating-metallic phase coexistence, indicating that, relative to the bulk phase energies, the magnetic phase boundary is more costly. The results of this study offer a complete picture of how distinct phases couple at interfaces and may carry implications for ultrathin oxide devices.

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