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Oscillatory Non-collinear Magnetism Induced by Interfacial Charge Transfer in Metallic Oxide Superlattices

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Non-collinear magnetic textures give rise to interesting charge and spin transport properties, and allow for control of magnetism using small electric currents. While these textures have been observed in a number of bulk materials and in thin films, realizing non-collinear magnetism in heterostructures presents new avenues to control their properties using tailored interfaces and gate electric fields. We have discovered a non-collinear magnetic coupling in superlattices comprised of two metallic perovskites, $La_{2/3}Sr_{1/3}MnO_3$ (LSMO) and $LaNiO_3$ (LNO). The superlattices are synthesized using oxide molecular beam epitaxy, and characterized with a variety of means, including x-ray and neutron scattering. We find that the angle between the magnetization of the LSMO layers varies in an oscillatory manner with the thickness of the intervening LNO. The magnetic field and temperature dependence of this coupling angle cannot be explained using models that incorporate bilinear and biquadratic coupling, which are commonly used to describe non-collinear magnetism in conventional metallic heterostructures. Furthermore, we observe substantial electron transfer from the LSMO into the LNO layer, causing the Ni sites in the vicinity of interfaces to be in approximately a 2+ oxidation state. We propose a model where these localized Ni^{2+} spins in the LNO couple to a momentum dependent spin susceptibility, giving rise to a spiral magnetic structure within the LNO.