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Observation of Mermin-Wagner Behavior in $LaFeO_3/SrTiO_3$ and $LaFeO_3/LaAlO_3$ Superlattices

We report on the magnetic properties of two sets of superlattices composed of antiferromagnetic $LaFeO_3$, separated by either $SrTiO_3$ or $LaAlO_3$. The superlattices consist of 1, 2, or 3 unit cells of $LaFeO_3$, separated by 5 unit cells of $SrTiO_3$ in one set, and 5 unit cells of $LaAlO_3$ in the other, each repeated 10 times. The magnetic behavior was investigated using low-energy muon spin spectroscopy at the Paul Scherrer Institute. Our results reveal that superlattices containing 2 or 3 unit cells of $LaFeO_3$ exhibit static magnetic order for both separation materials, with comparable transition temperatures. In contrast, superlattices with a single unit cell of $LaFeO_3$ display dynamic behavior down to the lowest measured temperature of 4 K. Moreover, the behavior of electronic moments differs from that in superlattices with 2 and 3 unit cells of $LaFeO_3$ even above transition temperature and indicates slow fluctuation. Zero-field measurements suggest a temperature-dependent slowing down of electronic fluctuations. In line with the Mermin-Wagner theorem, no long-range magnetic order is observed in the one unit cell $LaFeO_3$ superlattices.

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