Perturbed angular correlation spectroscopy of complex oxide heterostructures

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Perturbed angular correlation spectroscopy (PAC) measures the local magnetic field and electric field gradient (EFG) in materials by introducing radioactive nuclei and observing their emitted radiation [1]. The sensitivity to the EFG can be a crucial advantage of PAC over other local hyperfine probe techniques such as muon spin rotation and relaxation (μSR). The EFG provides spectroscopic access to lattice distortions (e.g. in ferroelectrics) as well as the local chemical environment (e.g. in heterostructures).

We will study the magnetic phase diagram of $((SmNiO_3)_m$ / $(NdNiO_3)_m)_L$ superlattices grown epitaxially on $[001]_{pc}$-oriented $LaAlO_3$ by $^{111}In/^{111}Cd$-PAC measurements. Using μSR, we have found that two distinct magnetic phase transition occur in this system only if $m > 17$ [2, 3]. Based on DFT simulations, we expect that the difference in EFG between $SmNiO_3$ and $NdNiO_3$ is sufficiently large to be resolved in a PAC measurement. Thus, each spectral line in the paramagnetic state can be assigned to one compound. If the two magnetic transitions correspond to separate transitions of the $SmNiO_3$ and $NdNiO_3$ layers, this will appear in PAC as a splitting of different lines at different temperatures.

We expect that this work will enable future PAC experiments on other complex oxide heterostructures.

This is an ongoing project. We hope to obtain first PAC data by the end of June and to show preliminary experimental results in this presentation.

[1] M. Uhrmacher and K.-P. Lieb, Z. Naturforsch. A 55, 90 (2000).
[2] C. Domínguez et al., Nat. Mater. 19, 1182 (2020).
[3] C. Domínguez et al., in preparation.