Tuning magnetic phenomena at the nanoscale by nanostructuring and proximity effects

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Nanoscale magnets show a variety of unusual magnetic behaviors when compared to bulk materials, mostly due to surface/interface effects, including symmetry breaking, modified electronic environment and magnetic interactions. In particular, magnetic nanoparticles based on iron oxides, such as Fe_3O_4 and $CoFe_2O_4$, are widely used in many applications due to the ease of synthesis and functionalization, as well as their high values of both the saturation magnetization and anisotropy. The key challenges are still to understand how nanostructural features (such as topography, composition, crystallinity, and surface chemistry) influence the physical properties of the nanoparticles (magnetic, electronic, and so forth), and how this insight can be used to induce or improve their functionality in different applications [1-3]. Furthermore, nanoscale manipulation of magnetic properties can also be achieved through proximity effects in hybrid heterostructures. For example, the proximity of a ferromagnetic thin film with a vanadium oxide results in a reversible modification of the magnetic properties of the ferromagnet due to the magnetoelastic anisotropy caused by the interfacial stress [4].

In this talk, I will present some examples to illustrate those issues, highlighting the importance of using advanced synthesis methods together with a systematic characterization of the samples using complementary spectroscopy and microscopy tools with sensitivity to local properties, in order to disentangle the key factors behind the functional response of the nanomagnets.

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References
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