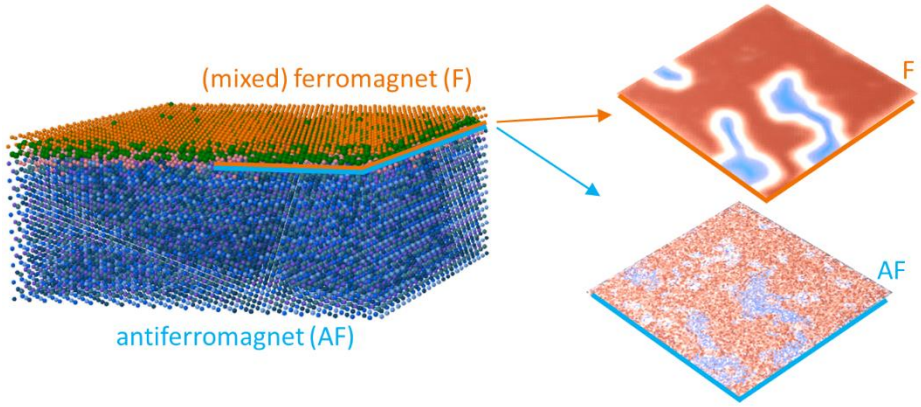
Atomistic simulations of antiferromagnetic skyrmions

Context

Skyrmions (Sk) are local topological magnetic textures. They are attracting a lot of attention due to their rich spin physics and high potential for storage and logic computing. **Antiferromagnetic (AF) Sk** encompass various advantageous properties over their ferromagnetic (F) counterparts, including a vanishing net magnetization which provides robustness against perturbations by external magnetic fields and a vanishing net topological charge, which prohibits the Sk from acquiring an unwanted transversal velocity [1]. However, since they lack net magnetization, the nucleation of AF Sk is challenging. A way we used to manipulate the order parameter of an AF is to take advantage of the exchange bias interaction between the AF and an adjacent F in order to imprint F configurations into the AF [2]. **Our objective for the present project is to investigate theoretically which parameters actually drive the Sk imprint, and how AF Sk influence the field- and current-driven magnetic reversal of the interacting adjacent F and vice versa.** In order to model the dynamics of AFs it is necessary to use atomistic models [3] which accurately represent the atomic scale magnetic structure. It makes it possible to model the formation and evolution of exchange bias and the resulting dynamics of coupled spin textures, as well as their fundamental thermodynamic properties [4]. This project builds on preliminary results obtained between **SPINTEC and YORK** in the UK [5].

[1] V. Baltz et al, Rev. Mod. Phys. 90, 015005 (2018) - [2] K. G. Rana, R. L. Seeger et al, Appl. Phys. Lett. 119, 192407 (2021) - [3] R. F. L. Evans et al, J. Phys.: Condens. Matter 26, 103202 (2014) - [4] S. Jenkins et al, Phys. Rev. B 100, 220405 (2019) - [5] M. Leiviskä, S. Jenkins et al, in preparation (2022).



(Left) Atomic structure used for the simulations. (Right) Magnetic textures in the F and AF, at the interface - 100 x 100 nm^2.

Work program & Skills acquired during internship

The work will include :

1/ modelling of Sk in single thin films of Fs and AFs and evaluation of the influence of several key parameters like grains sizes, finite size, anisotropy, interfacial DMI, and exchange stiffness on the size, dynamics and thermal stability of the Sk following an exchange bias imprint procedure;

2/ modelling of the influence of AF Sk (single and arrays) **on the dynamic properties of the F in F/AF bilayers, and vice-versa.**

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Requested background: Master 2, solid state physics, numerical simulation, good level of English
Duration: 6 months
Start period: Feb/ March 2023
Possibility of PhD thesis : YES
Proposal number : do not fill in