Imaging non-collinear antiferromagnetic textures via single spin relaxometry

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Antiferromagnets attract a great interest for spintronics owing to the robustness of magnetic textures and their fast dynamics. However, since they exhibit no net magnetization, antiferromagnets are challenging to work with. NV-center magnetometry, which provides a µT sensitivity combined with a nanoscale spatial resolution, has emerged in the last years as a powerful technique to investigate them [1].
Here we introduce a new imaging mode of the NV-center magnetometer which does not rely on the measurement of the static magnetic stray field but on the detection of magnetic noise originating from spin waves inside the non-collinear antiferromagnetic textures of interest. The presence of magnetic noise accelerates the NV spin relaxation. As a consequence, the emitted photoluminescence is reduced, allowing a simple detection of the noise sources [2, 3].

We demonstrate this new technique on synthetic antiferromagnets (SAF) [3] consisting of two ferromagnetic Co layers antiferromagnetically coupled through a Ru/Pt spacer. We first image domain walls and prove that we perform noise-based imaging by measuring a shorter NV spin relaxation time above an antiferromagnetic domain than above a domain wall. Calculations of the spin waves dispersion both in the antiferromagnetic domains and in the domains walls as well as maps of simulated magnetic noise intensity enable us to conclude that the noise which we probe arises from spin waves channelled in the domain walls.
Going further, we tune the composition of the SAF stacks in order to stabilize spin spirals or antiferromagnetic skyrmions. In both cases, our relaxometry-based technique is able to image the non-collinear structures, demonstrating its efficiency and opening new avenues of exploration in the characterization of complex structures in magnetically-compensated materials.

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