Magnetic texture revealed by soft x-ray coherent scattering: current status and opportunities with next generations light sources

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Nowadays, magnetic chirality has become a topic of utmost importance considering the ever-growing interest in static and dynamic properties of topological magnetic structures such as magnetic skyrmions and domain walls and their possible implications in future high-density data storage devices [1]. One effective way of inducing chiral magnetic structures is to consider magnetic systems showing a dominant Dzyaloshinskii-Moriya interaction (DMI) [2]. To master the stabilization of such magnetic objects, it is crucial to access the magnetic chirality, which still remains a challenge. Recently analyzing the amplitude of magnetic satellites of a crystal Bragg peak, Zhang *et al.* [3] showed that x-ray resonant magnetic scattering (XRMS) is a powerful tool to access to the relevant topological parameters (chirality, winding number, ...).

First, we will report that small angle XRMS is a straightforward tool to reveal directly the properties of chiral magnetic systems. In our approach using dichroism in reflectivity, the existence of a Bragg peak is not required and thus it can be used for any type of materials (ultra thin films, amorphous,…). We show that it can straightforwardly and unambiguously determine the main characteristics of chiral magnetic distributions in perpendicularly magnetized multilayers [4,5]: its chiral nature, the quantitative winding sense (clockwise or counterclockwise), and its type, *i.e.*, Néel (cycloidal) or Bloch (helical). We will also show that this approach can be used for antiferromagnetic multilayers [6] or in multiferroic material to access both magnetic and electric chiralities [7,8].

Second, I will then present that using the same approach one can also probe chirality at ultra-fast time scale [9] using free electron laser.

In the last part I will introduce the opportunities offered with the next generation of synchrotron light sources to reveal magnetic or ferroelectrical textures.

References

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