Minicolloque n° OPS33 **x Oral** **☐ Poster**

Helicoidal dichroism of magnetic structures in the extreme ultraviolet

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Studying magnetization configurations of ever more complex magnetic structures has become a major challenge in the past decade, especially at ultrashort timescales. Most of current approaches are based on the analysis of polarization and magnetization-dependent reflectivity. We recently introduced a different concept, centered on the coupling of magnetic structures with light beams carrying orbital angular momentum (OAM) [1].

Beams with OAM, which may have any polarization, show a spiraling wavefront. It is associated with a quantified projection (along the propagation axis) of the OAM of the associated photons, which may take any positive or negative integer value of $\hbar$. The sign of the OAM is determined by the spiraling sense of the phase. Also, the phase singularity at the center of the beam imposes a vanishing intensity, giving an overall donut shape to the beam. In the framework of classical electromagnetic beam propagation based on Maxwell equations, we modelled the reflection of such beams by magnetic structures, showing uneven magneto-optical coefficients. We focused in particular on magnetic vortices, which appear in mesoscopic circular dots much larger than their thickness; and consist of a curling in-plane magnetic configuration and an out-of-plane core. The sense of the curling magnetization can be either clockwise (m=+1) or anticlockwise (m=-1).

Upon reflection by a magnetic vortex, an incoming beam with a unique value ℓ of OAM gets enriched in the neighboring OAM modes ℓ ± 1. It results in anisotropic far-field profiles, which lead to a Magnetic Helicoidal Dichroism (MHD) signal (Figure). The analysis of MHD allows to retrieve the complex magneto- optical constants with excellent precision. This method, which does not require any polarimetric measurement, is a new promising tool for the identification and analysis of magnetic configurations such as vortices, with a possible extension to the femtosecond to attosecond time resolution.

In this talk we will present the main results of our theory and preliminary experimental results.

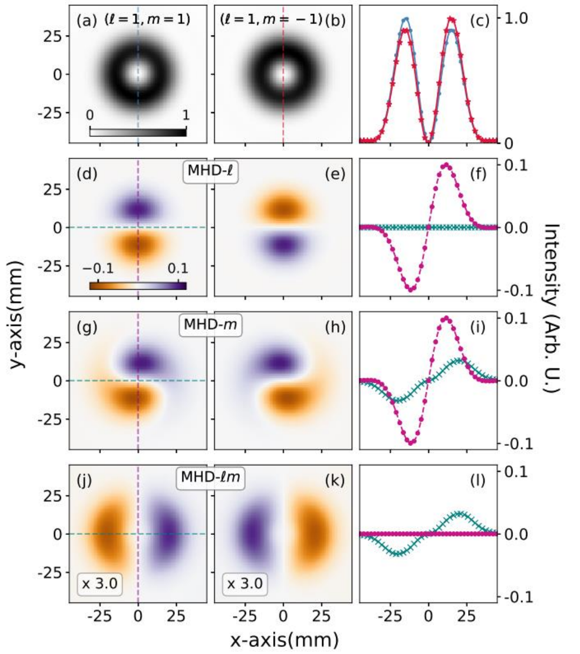

Figure 1: (a- b) Intensity profiles of a LG beam reflected off magnetic vortices of opposite helicities ((a): m=1, (b): m=-1). (d-e) Maps of the normalized differences between the intensity maps with ℓ=1 and ℓ = -1 for the two vortices ((d): m=1 & (e): m=-1). (g, h) Same as (d,e) when changing m for ℓ=1 (g) and ℓ=-1 (h). (j,k) Same as (d,e) when changing both ℓ and m starting from (ℓ, m)=(1,1) (j), (ℓ,m)=(1,-1) for k. (c, f, I, l) lineouts along the dashed lines of the maps on the same line.

[1] M. Fanciulli et al., Phys. Rev.A 103, 013501 (2021)