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Fast 3D magnetization recovery of 2D magnetic structures

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In the actual paradigm, where it is possible to grow magnetic nanostructures with 3D magnetization configuration, more complex structures appear, such as vortexes, skyrmions or hopfions. In order to visualize these new configurations, new magnetic imaging techniques different from the conventional 2D approach are mandatory. With X-ray Magnetic Circular Dichroism (XMCD) in X-ray transmission microscopes, it is possible to access the vector magnetization field within arbitrary magnetic systems down to tens of nm resolution [1-2]. To obtain the full magnetization field, different projections where the sample is rotated with respect to the X-ray beam are needed since we are only sensitive to the magnetization component along the X-ray beam. However, recording all the projections needed for an accurate reconstruction consumes a lot of time (usually a vector tomography experiment with 240 different projections requires 24 –28 hours of beamtime). Here we present a fast method to reduce dramatically the acquisition time needed for accurate magnetization vector reconstruction specific for quasi two-dimensional magnetic structures, heterostructures and continuous films which are of interest for spintronics. The algorithm combines the transmission images to obtain first the electronic charge and, then, the magnetic configuration fitting the Bourguer-Lambert-Beer equation particularized for XMCD [3].
To validate our method, we performed measurements of 40 nm thick Py microstructures at the MISTRAL beamline of the ALBA Synchrotron. Even though 30 projections were taken, we have proven that with only 6 projections it is possible to reconstruct the magnetization thus greatly reducing the acquisition time.
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