PAUL SCHERRER INSTITUT

PSD Mini Symposium

Scanning Transmission X-ray Microscope

Tuesday, September 10, 2019

10:00 to 11:20, WBGB 019

10:00: Highlight – 30min
From 2D STXM to 3D Imaging: Soft X-ray Laminography at PolLux

Katharina Witte, Andreas Späth, Simone Finizio, Claire Donnelly, Michal Odstrcil, Manuel Guizar-Sicairos, Mirko Holler, Benjamin Watts, Rainer Fink, and Jörg Raabe

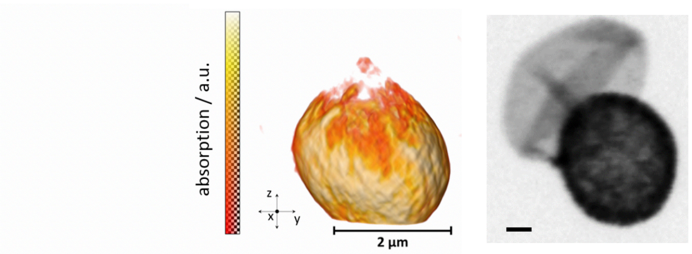

Figure 1. Left: 3D reconstruction of iron oxide functionalized air-filled microsphere. Right: Raw STXM image of microsphere with attached collapsed microsphere (scale bar: 500 nm).

10:40 Coffee break

11:00: PhD Talk – 15min
Directional emission of spin waves from a vortex core

Sina Mayr, Lukáš Flajšman, Simone Finizio, Aleš Hrabec, Markus Weigand, Johannes Förster, Hermann Stoll, Laura J. Heyderman, Michal Urbánek, Sebastian Wintz and Jörg Raabe

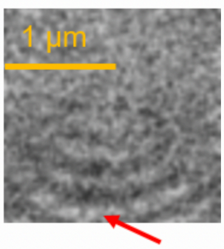

Figure 1. Snapshot of a time-resolved scanning transmission X-ray microscopy measurement illustrating the directional emission of spin waves (f = 8.5 GHz) from a vortex core (indicated by the red arrow), the latter extending to a one-dimensional object upon static field excitation.

From 2D STXM to 3D Imaging: Soft X-ray Laminography at PolLux

Katharina Witte[1], Andreas Späth[2], Simone Finizio[1], Claire Donnelly[1,3], Michal Odstrcil[1,4], Manuel Guizar-Sicairos[1], Mirko Holler[1], Benjamin Watts[1], Rainer Fink[2], and Jörg Raabe[1]

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3D imaging techniques based on computed tomography (CT) are widely used today as standard medical diagnostic tool. By using high-brilliance synchrotron radiation instead of conventional X-ray tubes, CT is also an established method for answering current scientific questions for example in geosciences [1], cultural heritage [2] and condensed matter research [3].

A disadvantage of CT, however, is that the object has to provide a columnar shape or be small enough that the entire sample volume remains in the field of view at all times of the scan to allow artefact-free reconstructions. This places strong restrictions on the sample shape and support, especially in soft X-ray CT measurements [4], where focal distances and attenuation length are typically measured in the few millimeter and sub-micron range.

In the more general geometry of laminography, the sample rotation axis is inclined by the laminography angle $\theta < 90°$ so that it is no longer perpendicular to the incident X-ray beam [5]. This leads to a so-called missing cone in the accessible angular range for the projections, rather than to a missing wedge as in tomography. The advantages for laminography are on the one hand reduced artefacts in the reconstruction and on the other hand the fact that the sample can be rotated without risking collisions.

For the first time, a new setup at the Scanning Transmission X-ray Microscope (STXM) of the PolLux beamline at the Swiss Light Source combines laminography and STXM using soft X-rays. We will present the new setup for Soft X-ray Laminography (SoXL) as well as the first prototype 3D reconstructions of micrometer-sized objects ranging from nanomaterial science, biology, and functional magnetic materials.

This technique is particularly advantageous for the investigation of modern electronic devices based on thin-film technologies and functional materials such as magnetic composites due to the chemically and magnetic contrast sensitive interaction properties of soft X-rays with matter. Furthermore, the implementation into an existing STXM renders future time-resolved investigations feasible.

[1] F. Mees et al., Geol. Soc., London, Spec. Pub. 215, 1 – 6 (2003)
[2] M. P. Morigi et al., Appl. Phys. A 100: 653 – 661 (2010)
[3] M. Holler et al., Nature 543, 402 – 406 (2017)
[4] A. Hitchcock et al., Appl. Phys. A 92: 447 – 452 (2008)
[5] L. Helfen et al., Appl. Phys. Let. 86, 071915 (2005)

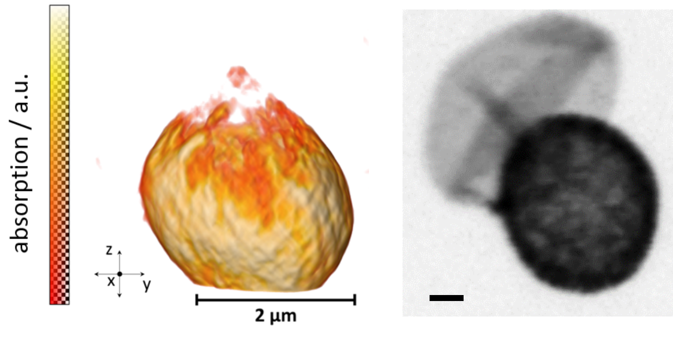

Figure 1. Left: 3D reconstruction of iron oxide functionalized air-filled microsphere. Right: Raw STXM image of microsphere with attached collapsed microsphere (scale bar: 500 nm).

Directional emission of spin waves from a vortex core

Sina Mayr[1,2]*, Lukáš Flajšman[3], Simone Finizio[1], Aleš Hrabec[1,2], Markus Weigand[4], Johannes Förster[5], Hermann Stoll[5,6], Laura J. Heyderman[1,2,], Michal Urbánek[3], Sebastian Wintz[1,5] and Jörg Raabe[1]

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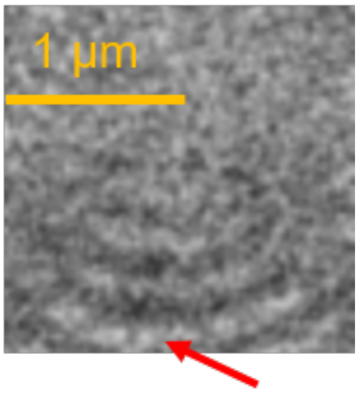
Spin waves could be used as signal carriers in future spintronic logic and memory devices with a potentially lower power consumption and improved miniaturization compared to the present charge-based CMOS technology [1]. Towards the goal of miniaturization, it was shown recently that isotropically propagating spin waves with ultra-short wavelengths can be generated by exploiting the driven dynamics of topological spin textures such as magnetic vortex cores [2,3]. In this contribution, we show that even a directional emission of these waves can be achieved when a static magnetic field is applied to the vortex structure. This deforms the vortex core from a point-like source into a one-dimensional curved object (see Figure 1). In particular, self-focusing effects of spin waves can be observed for certain combinations of magnetic field and driving excitation. This directional emission of spin waves from a vortex core and their self-focusing opens a way for a directional propagation of spin waves without the need for additional patterning or waveguides.

[1] A. Chumak et al., Nat. Phys. 11, 453 (2015)
[2] S. Wintz et al., Nat. Nanotech. 11, 948 (2016)
[3] G. Dieterle et al., Phys. Rev. Lett. 122, 117202 (2019)



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