New discovery opens for 3-D measurements of magnetism

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A team of researchers from Uppsala University, China and Germany have substantially extended the possibilities of an experimental technique called EMCD, that is used for measuring magnetism in materials. The results were published in *Nature Communications* on May 15 2017.

The EMCD (electron magnetic circular/chiral dichroism) method uses a transmission electron microscope to analyse, how electrons scatter on magnetic materials. Physical processes involved in EMCD are very similar as in XMCD, (x-ray magnetic circular dichroism), which is a well-established experimental method for precise measurements of magnetism. XMCD measures absorption of x-rays in magnetic materials, generated in synchrotrons, such as the unique instrument in MAX Lab IV in Lund.

According to previous theoretical research at Uppsala University from 2011 it was shown that EMCD should be sensitive not only to magnitude of the magnetisation, but also to all three components of the magnetisation vector. Now the research team have detected signals from the EMCD method originating from magnetisation of cobalt in a direction perpendicular to the electron beam, not just a projection of magnetisation vector to the beam direction, which is a limitation of the XMCD method that can only detect magnetisation parallel to the x-ray beam. Another advantage of the EMCD method is its capability to provide magnetic information from very small areas, reaching sub-nanometer level.

The new results open paths for development of efficient high-spatial resolution magnetic measurement methods, capable of measuring all three components of the magnetisation vector, to obtain the complete magnetisation vector field.

More information: Dongsheng Song et al. An in-plane magnetic chiral dichroism approach for measurement of intrinsic magnetic signals using transmitted electrons, *Nature Communications* (2017). DOI: 10.1038/ncomms15348

Ján Rusz et al. Local electronic structure information contained in energy-filtered diffraction patterns, *Physical Review B* (2011). DOI: 10.1103/PhysRevB.84.064444

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