New method enables high-resolution measurements of magnetism

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In a new article, published in *Nature Materials*, researchers from Beijing, Uppsala and Jülich have made significant progress allowing very high resolution magnetic measurements. With their method it is possible to measure magnetism of individual atomic planes.

Magnetic nanostructures are used in a wide range of applications. Most notably, to store bits of data in hard drives. These structures are becoming so small that the usual magnetic measurement methods fail to provide data with sufficient resolution.

Due to the ever-growing demand for more powerful electronic devices, the next generation spintronic components must have functional units that are only a few nanometers large. It is easier to build a new spintronic device, if we can see it in sufficient detail. This is becoming increasingly difficult with the rapid advance of nano-technologies. One instrument capable of such detailed imaging is the transmission electron microscope.

An electron microscope is a unique experimental tool offering scientists and engineers a wealth of information about all kinds of materials. As opposed to optical microscopes, it uses electrons to study the materials. This enables enormous magnifications. For example, in crystals one can routinely observe individual columns of atoms. Electron microscopes provide information about structure, composition and chemistry of materials. Recently, researchers also found ways to use electron microscopes to measure magnetic properties. However, atomic

resolution has not yet been reached in this application.

Ján Rusz and Dmitry Tyutyunnikov at Uppsala University, together with colleagues from Tsinghua University, China, and Forschungszentrum Jülich in Germany have developed and experimentally proven a new method that allows magnetic measurements of individual atomic planes. The method uses a unique transmission electron microscope PICO that can correct both geometrical and chromatic aberrations, allowing a detailed look at individual atomic planes over a wide spectral range.

"The idea came from Dr. Xiaoyan Zhong, with whom we have a growing fruitful collaboration. We have contributed simulations, which have confirmed the validity of the experimental design and demonstrated that the experiment really offers a very detailed look at magnetism of materials," says Ján Rusz.

More information: Zechao Wang et al. Atomic scale imaging of magnetic circular dichroism by achromatic electron microscopy, *Nature Materials* (2018). DOI: 10.1038/s41563-017-0010-4

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