Magnetism under the magnifying glass

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Being able to determine magnetic properties of materials with sub-nanometer precision would greatly simplify development of magnetic nano-structures for future spintronic devices. In an article published in *Nature Communications* Uppsala physicists make a big step towards this goal – they propose and demonstrate a new measurement method capable to detect magnetism from areas as small as 0.5 nm^2.

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 a sufficient detail. This becomes more and more tricky with the rapid advance of nano-technologies, especially when we need not only an overall picture "how the thing looks", but also know its physical properties at nano-scale. One of instruments capable of such detailed look is a transmission electron microscope.

Electron microscope is a unique experimental tool offering to scientists and engineers a wealth of information about all kinds of materials. Differently from optical microscopes, it uses electrons to study the materials, and thanks to that it achieves an enormous magnification. For example, in crystals one can even observe individual columns of atoms. Electron microscopes routinely provide information about structure, composition and chemistry of materials. Recently researchers found ways to use electron microscopes also for measuring magnetic properties . There, however, atomic resolution has not been reached so far.

A team of three physicists from Uppsala University – Ján Rusz, Jakob

Spiegelberg and Peter Oppeneer, together with colleagues from Nagoya University (Japan) and Forschungszentrum Jülich (Germany) have developed and experimentally proven a new method, which allows to detect magnetism from individual atomic planes. The area of the sample, from which a magnetic signal was detected, is about a trillion (10^{12}) times smaller than that of an average grain of sand.

'The discovery of this method came from an unexpected result obtained from computer simulations. It was a surprise, which made us dig deeper into it. Thanks to the international collaboration our curious theoretical observation was soon after followed by an experimental confirmation', says Ján Rusz.

A significant advantage of this new method is its ease of application. Modern transmission electron microscopes can apply the method right away, without any need of modifications or special equipment.

More information: "Magnetic measurements with atomic plane resolution" *Nature Communications*, DOI: 10.1038/NCOMMS12672

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