Novel approach to magnetic measurements atom-by-atom

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Having the possibility to measure magnetic properties of materials at atomic precision is one of the important goals of today's experimental physics. Such measurement technique would give engineers and physicists an ultimate handle over magnetic properties of nano-structures for future applications. In an article published in *Physical Review Letters* researchers propose a new method, utilizing properties of the quantum world – the phase of the electron beam – to detect magnetism with atom-by-atom precision.

The electron microscope is a fascinating instrument. It uses a highly accelerated electron beam, which passes right through the sample. The way how the beam scatters in that process, gives scientists a whole lot of information about the sample itself. Today it allows us to watch individual atoms and distinguish them by their atomic number. Scientists even learned how to extract a position of every single atom in a nanoparticle. Much of this became possible thanks to the invention of an aberration corrector – a device, which sharpens the image of microscope, the same way as glasses help our eyes.

There is however one domain, where microscopy is still relatively in its beginnings and that is the study of magnetic properties. A team of three scientists, Jan Rusz from Uppsala University, Sweden, Juan-Carlos Idrobo from Oak Ridge National Laboratory, USA, and Somnath Bhowmick from Indian Institute of Technology, India, have proposed a new way, which should bring the resolution in magnetic studies on par with watching individual atoms.

The trick lies in an inovative use of the aberration corrector - "the glasses of the microscope". It is used to correct all errors of the microscope optics, except for one specific distortion, which is tuned to the symmetry of the measured crystal. Imagine your glasses intentionally curved in a specific way, which allows you to see something, that you could not spot before. In the strange world of quantum mechanics this is exactly what happens. The distortion enhances the magnetic signal, which can be then easily measured.

"With this new method, we bring the atomic resolution magnetic measurements to about 400 laboratories world-wide, which are equipped with modern scanning transmission electron microscopes with aberration correctors", says Jan Rusz, and expects that the first experimental confirmations will come very soon.

More information: Ján Rusz, Juan-Carlos Idrobo, Somnath Bhowmick (2014) Achieving atomic resolution magnetic dichroism by controlling the phase symmetry of an electron probe, *Physical Review Letters*, 113, 145501 DOI: 10.1103/PhysRevLett.113.145501

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