PRESS RELEASE

X-rays shed light on magnets

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A new test method developed in Berlin could soon find its way into textbooks. It makes thick, compact magnetic materials accessible, as well as materials used in spintronics and semiconductor technology.

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When Sergio Valencia of Helmholtz-Zentrum Berlin (HZB) ever so slightly rotates soft X-rays using a magnetic field, this captures the interest of not only physicists, but also IT hardware developers. After all, this can be used to study those tiny magnetic structures that almost no modern computer can do without. Yet, pure researchers will be the first to use the method that Sergio Valencia and Andreas Gaupp, together with colleagues from Germany, Switzerland and Sweden, will present in Physical Review Letters: *DOI:* 10.1103/PhysRevLett.104.187401

The method is based on a known effect that occurs when polarized light encounters a magnetic field inside a solid. The plane of the light rotates slightly. And since X-rays are nothing other than very short-wavelength light, they too are rotated by a magnetic material under certain conditions.

Using the right measuring technique, one can learn about a magnetic material from the way the polarization plane of X-ray light is rotated. The shorter the light wavelength used, the smaller the structures one can observe. Accordingly, soft X-rays – that is very short-wavelength light– can be used to study very small structures. Physicists have been using similar microscopy methods for quite some time. In the 1990s, a special effect of visible light was discovered, named the Schäfer-Hubert effect after its discoverers. Sergio Valencia has now extrapolated this effect to X-rays, and has observed a rotation of the polarization plane of the light of just under 0.1 degrees.

This minimal rotation offers physicists a new analytical method. Unlike other methods employing X-rays, the one reported by Sergio Valencia and coworkers do not need the light to penetrate and go through the test material – they are reflected instead. That means that even thick layers that are impenetrable to X-rays can be investigated.

Furthermore, most of the existing methods are only suitable for ferromagnetic materials, iron being the most familiar of these. Yet, there are also antiferromagnetic substances such as nickel oxide, which are of great interest for information technology, but have so far only been investigable by one method, XMLD, or “X-ray magnetic linear dichroism”. This works well with constant intensity X-ray light. It is not so easy, however, with lasers that emit X-ray pulses of varying intensity, which are increasingly in use these days.

The new method from HZB with applications in microscopy provides a valuable complement for anti-ferromagnetic substances especially, since it is less sensitive to such intensity fluctuations due to the fact that it measures the rotation of the light and not its intensity. Furthermore, selecting the appropriate energy of the X-rays it can be used to “visualize” and measure separately magnetic elements such as iron, nickel, cobalt and many others from complex compounds with mixed materials. “Such a method did not exist before,” Sergio Valencia says with delight. It will soon be used by many colleagues.

2,500 guest researchers from universities and other research organisations worldwide. Above all, HZB is known for the unique sample environments that can be created (high magnetic fields, low temperatures). HZB conducts materials research on themes that especially benefit from and are suited to large scale facilities. Research topics include magnetic materials and functional materials. In the research focus area of solar energy, the development of thin film solar cells is a priority, whilst chemical fuels from sunlight are also a vital research theme. HZB has approx.1,100 employees of whom some 800 work on the Lise-Meitner Campus in Wannsee and 300 on the Wilhelm-Conrad-Röntgen Campus in Adlershof.
HZB is a member of the Helmholtz Association of German Research Centres, the largest scientific organisation in Germany.