Researchers discover chromium's hidden magnetic talents

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Two Dartmouth researchers have determined that the element chromium displays electrical properties of magnets in surprising ways. This finding can be used in the emerging field of “spintronics,” which might someday contribute to new and more energy efficient ways of processing and storing data.

The study, titled “Electrical effects of spin density wave quantization and magnetic domain walls in chromium,” will be published in the April 17 issue of the journal *Nature*.

Electrons have an intrinsic angular momentum, called spin, in addition to their electrical charge. In electronics work, it is the charge of the electron that is used for calculations and transmitting information. In spintronics, it is the electron spin that is exploited.

“The phenomena that we have discovered are likely to lead to new applications of chromium,” says Yeong-Ah Soh, the lead researcher on the paper and an associate professor of physics and astronomy at Dartmouth. She worked on the study with Ravi Kummamuru, a former post-doctoral research associate at Dartmouth now at the University of Illinois at Urbana-Champagne.

She goes on to explain that in essence, this indicates that a simple and well-known element, chromium, displays different electrical properties on heating and cooling. These differences reflect subtle internal rearrangements of the electrons and their spins.

In ferromagnets, the kind of common magnet you might see on a refrigerator, the spins of electrons interact with each other leading to alignment. In antiferromagnets, however, the interactions between neighboring electron spins are such that they are opposed. Researchers have long studied the electrical properties of ferromagnets and the influence of electron spin. Less attention has been paid, according to Soh and Kummamuru, to the influence of spin on the electrical properties in antiferromagnets, where it is more difficult to manipulate, and chromium is special since it is the only simple element that is an antiferromagnet.

“Antiferromagnets are used in numerous fields: physics, materials science, and chemistry, and they are increasingly used in technology, where they are found in the tiny heads that read the data on computer disc drives,” says Soh. “Our research opens the entire new field of controlled electrical effects at a slightly-larger-than-quantum scale in antiferromagnets. The findings show that not only ferromagnets can be used in spintronics; there is a possibility that antiferromagnets can also be employed to manipulate and store information.”

Source: Dartmouth College