Storing data on atomic roundabouts

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There are right-handed and left-handed yoghurts, right-handed and left-handed snail shells, and right-handed and (occasionally) left-handed screws. Scientists at the University of Bonn have now demonstrated the existence of right-handed and left-handed "magnetic vortices". Through their research, in collaboration with colleagues from Berlin and Geneva, they believe that this physical phenomenon could eventually lead to the construction of faster and more reliable hard disks. The physicists have reported their discovery in the latest issue of the journal *Nature*.

The magnetic vortex can be pictured like a traffic roundabout. But instead of cars circulating, it consists of an arrangement of magnetised atoms. They form a pattern rather like a ring of tiny bar magnets, so nothing actually moves around the atomic roundabout, but the direction can change: when the "north poles" are all pointing clockwise the magnetic vortex is "right-handed", otherwise the vortex is "left-handed".

"The existence of a circular atomic traffic system of this sort has been presumed for several years," explains the Bonn physics professor Dr. Manfred Fiebig. "In the Nature study we have actually discovered this kind of vortex field in a substance called lithium cobalt phosphate and employed laser-optics to determine its direction." Borrowing from the term "ferromagnetism", the authors -- who include, alongside Manfred Fiebig, the Dutch scientist Bas Van Aken and the Geneva-based physicists Hans Schmid and Jean-Pierre Rivera -- have called the phenomenon "ferrotoroidicity".

This finding is extremely interesting from a fundamental research standpoint. But there could also be very practical consequences in terms of technological applications. This is because magnetic vortices could be used to store information: when the atomic roundabout "traffic" goes right, it could be made to stand for the binary number "0"; going left, it could designate the "1" -- a physical principle that might be introduced one day into the design of computer hard disks.

Slow magnetic fields

"We now store data by magnetically poling the surface coating of a hard disk," explains Manfred Fiebig. "Today's data storage device contains many billions of polable zones, ordered in rows. To write information onto them or read from them you have to have magnetic fields." The current technology has two problems: on the one hand, to produce the necessary fields there must be a flow of electricity for which electrical charge carriers are actuated, and this is a relatively slow process. On the other hand, with ever greater densities of data the danger is that the magnetic fields to be read can destroy the stored information.

The atomic roundabouts do not have these drawbacks. Here, information is also "magnetically" stored but, as Manfred Fiebig points out, the "direction of rotation of the vortices can be changed by electrical fields." Moreover, "The reading process does not require a magnet field that might overwrite the stored data by mistake." Another advantage is that no electricity has to flow to generate the electrical fields so, in principle, storage can run much faster.

Next goal: learning to write

Professor Fiebig came to Bonn University from the Max Born Institute in Berlin over a year ago. The measurements made in Berlin were then analysed in Bonn, and this analysis of the data has produced the proof of the vortices. "We haven't yet succeeded in reading the direction of rotation of the magnetic vortex," the physicist adds. One of the next steps for him and his team is to find out how to write information reliably. They are also looking for other material that may prove suitable for future mass storage media.

However, Fiebig and his team certainly won't be building the hard disk drives of the future as he himself makes clear: "Our primary interest centres on the principles at work behind this phenomenon and what they reveal about the nature of magnetism. But if this research does result one day in a technological application, that'll obviously be quite a bonus."

Source: University of Bonn

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