Ultrafast uncoupled magnetism in atoms

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Future computers will require a magnetic material which can be manipulated ultra-rapidly by breaking the strong magnetic coupling. A study has been published in *Nature Communications* today in which Swedish and German scientists demonstrate that even the strongest magnetic coupling may be broken within picoseconds (10^{-12} s). This will open up an exciting new area of research.

The element gadolinium is named after the Uppsala chemist Johan Gadolin who discovered the first rare-earth metal yttrium in the late 1700s. Gadolinium is in the same class of elements and it has unique magnetic properties which make it especially interesting for magnetic data storage. Its most useful property is that it has the greatest spin magnetic moment of any element since there are two different magnetic moments on every atom. These spin moments are coupled in parallel so strongly that no existing magnetic field on earth could break the coupling.

An international collaboration between Karel Carva and Peter Oppeneer, two physicists from Uppsala University, and researchers from the Free University Berlin and Konstanz University in Germany has shown that it is possible to break the coupling between the spin moments. Researchers in Berlin used light pulses shorter than picoseconds to excite metallic gadolinium and then monitored the spin dynamics of both spin moments with ultra-short, high-energy x-ray flashes. The spin dynamics they revealed showed that the strong coupling was broken within picoseconds (10-12 s) and it remained uncoupled for almost 100 picoseconds. The theoretical calculations of the Uppsala researchers provided a detailed explanation of how this fundamental magnetic interaction can be overcome.

"Not too long ago it became clear that the weaker coupling between spin moments on different atoms of a material can be broken. We've now shown that even the stronger spin magnetic coupling within an individual atom can be overpowered. This provides new opportunities to manipulate magnetic materials and opens new paths to the data storage of the future," says professor Peter Oppeneer.

More information: Disparate ultrafast dynamics of itinerant and localized magnetic moments in gadolinium metal, B. Frietsch, J. Bowlan, R. Carley, M. Teichmann, S. Wienholdt, D. Hinzke, U. Nowak, K. Carva, P.M. Oppeneer & M. Weinelt, dx.doi.org/10.1038/ncomms9262

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