PRESS RELEASE

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Demagnetization by rapid spin transport

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The fact that an ultrashort laser pulse is capable of demagnetizing a ferromagnetic layer in a jiffy has been well-known since approximately 1996. What we don't yet understand, however, is how exactly this demagnetization works. Now, physicist Dr. Andrea Eschenlohr and her colleagues at the Helmholtz Centre Berlin and Uppsala University in Sweden have shown that it turns out not to be the light pulse itself that prompts demagnetization.

For purposes of their research, the scientists irradiated two separate layered systems with ultrashort laser pulses on the order of just one hundred femtoseconds (10^{-15} s). One sample consisted essentially of a single thin layer of ferromagnetic nickel. By contrast, a second sample of this same nickel material was coated with a non-magnetic layer of gold. Only a mere 30 nanometers (10^{-9} m) thick, the gold layer swallowed up the lion's share of the laser light so that barely any light ended up reaching the nickel layer. In spite of this, the nickel layer's magnetization rapidly dissipated shortly after the laser pulse entered each sample. However, in the case of the gold-coated sample, the researchers recorded a split-second delay. The observations were based on measurements obtained using circularly polarized femtosecond x-ray pulses at BESSY II, Berlin's own electron storage ring, with the help of the femtoslicing beamline.

"This allowed us to demonstrate experimentally that during this process, it isn't the light itself that is responsible for the ultrafast demagnetization but rather hot electrons, which are generated by the laser pulse," explains Andrea Eschenlohr. Excited electrons are able to rapidly move across short distances - like the ultra-thin gold layer. In the process, they also deliver their magnetic moment (their "spin") to the ferromagnetic nickel layer, prompting the breakdown of the latter's magnetic order. "Actually, what we had hoped to see is how we might be able to influence the spin using the laser pulse," explains Dr. Christian Stamm, who heads the experiment. "The fact that we ended up being able to directly observe how these spins migrate was a complete surprise to everyone."

Laser pulses are thus one possibility to generate "spin currents" where the spin is transferred in place of an electric charge. This observation is relevant for spintronics research where scientists design new devices from magnetic layered systems, which perform calculations based on spins rather than electrons, enabling them to very quickly process and store information while at the same time saving energy.

Dr. Eschenlohr concluded her doctoral work at HZB, in the context of which she generated the results described above, in late 2012. As of January of this year, Dr. Eschenlohr is a scientific associate at University of Duisburg-Essen.

The paper “Ultrafast spin transport as key to femtosecond demagnetization” will be published on 27. January 2013, 18:00 London time (GMT), in Nature Materials with doi: 10.1038/nmat3546.

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