Terahertz lightwave-driven control of magnetism

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Harnessing order parameters in solids, as e.g. magnetism, ferroelectricity, superconductivity etc, using ultrashort light pulses is a key science driver in condensed matter research. This is particularly true for the field of magnetism and spintronics [1-3] where besides a fundamental scientific interest there is an exciting potential for technological applications in, e.g., high-speed magnetic logic and magnetic storage devices. A long sought-after and yet to be realized phenomenon is the coherent and deterministic control of a macroscopically ordered spin ensemble on the sub-cycle timescales of the photo-exciting light field [3, 4].

Here, I will showcase the latest developments in our projects on ultrafast magnetism by employing strong-field THz and mid-IR excitations on ferrimagnetic materials to (i) demonstrate an ultrafast and fully deterministic magnetization switching process upon single-shot THz pulse exposure and (ii) photo-drive the generation of a coupled spin-lattice quasiparticle at THz frequencies with ultralong coherence lifetimes.

I will conclude with our future plans on highly brilliant THz light sources to be implemented at the European XFEL.

References

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