UNIVERSITÄT DUISBURG ESSEN | PHYSIK

Physikalisches Kolloquium

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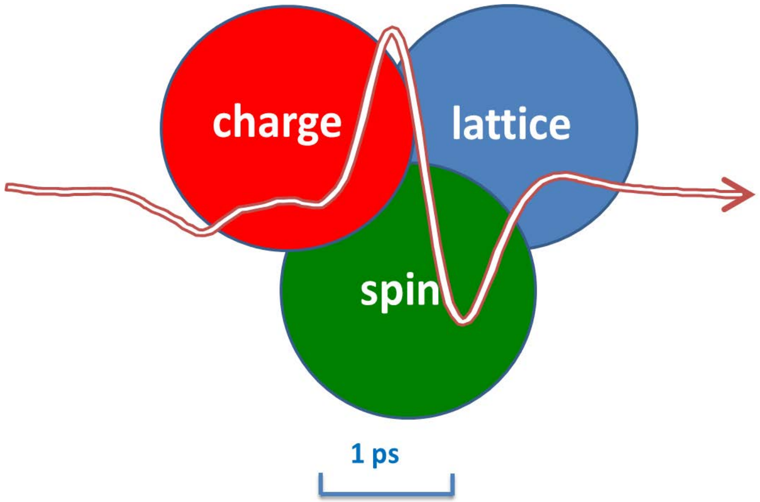
Direct look at charge, lattice and spin dynamics in solids with ultrafast terahertz spectroscopy

Prof. Dr. Dmitry Turchinovich
Universität Duisburg Essen



Many elementary processes in electron, phonon and spin subsystems of a solid: e.g. momentum relaxation times of conduction electrons, lattice oscillation periods, spin dynamics etc, occur on the ultrafast timescale of 10s of femtoseconds up to a few picoseconds. This timescale τ matches the terahertz (THz) frequency range, broadly defined as $\omega/2\pi \sim 0.1 - 30$ THz, and corresponding to the period of oscillation of electromagnetic fields in the range ~ 10 ps - 30 fs, or to the photon energies of ~ 0.4 – 120 meV. This facilitates the use of THz radiation for spectroscopy in a unique regime of $\omega\tau \sim 1$, where the elementary ultrafast dynamics in condensed matter can be directly resolved. Based on modern femtosecond laser technology, ultrafast THz spectroscopy allows one to directly probe equilibrium and non-equilibrium dynamics of charge, lattice and spins with temporal resolution down to 10s of femtoseconds, in a contact-free and non-destructive fashion. In this presentation, after a brief introduction to the method, we will review some of our recent case studies on ultrafast electron conduction in graphene, spin-controlled conduction in ferromagnetic metals, and polar lattice dynamics in polymers and methylammonium lead halide perovskites.t