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SFB 1242 Nichtgleichgewichtsdynamik kondensierter Materie in der Zeitdomäne

UNIVERSITÄT DUISBURG ESSEN

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Hot-Electron Transport and All-Optical Switching in Ferromagnets

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Ultrashort optical pulses applied to ferromagnets excite spin polarized electronic distributions far from equilibrium (which are often referred to as ”hot electrons”). Such an ultrashort-pulse excitation can lead to demagnetization [1], but also to a loss of electronic spin polarization due to hot-electron transport in and out of ferromagnetic layers [2]. I will present a Boltzmann transport calculation of optically excited hot-carrier transport in multilayers consisting of normal metals and ferromagnets [3]. The numerical solution is achieved using a Particle-In-Cell approach to treat both transport and scattering effects in a numerically efficient way that is based on ab-initio input and can be easily adapted to different structures. In materials with spin Hall effect, induced spin-currents can be efficiently converted into charge currents that are the source for Tera-Hertz emission [4,5]. By combining the particle-in-cell method for spin-polarized hot-electron transport with a calculation of optical fields for laser absorption and broadband THz emission[3], we analyze optically excited electron spin transport in Fe-Au bilayers, Fe-Au-Fe spin-valve structures and THz emission from Fe/Pt-layers [5].

If time permits, I will briefly discuss a microscopic model of the inverse Faraday effect. In the framework of simple ferromagnetic Rashba system with a band gap, one can compute the complete switching dynamics including spin-orbit coupling, mean-field ferromagnetism and the effect of off-resonant optical fields/pulses. Switching the different contributions on and off, one can separate different mechanisms of all-optical magnetization control. We interpret the results in terms of a ”quantum coherence” between the spin-split electron bands.

[1] N. Bergeard et al., Phys. Rev. Lett. 117, 147203 (2016).
[2] M. Battiato, K. Carva, and P. M. Oppeneer, Phys. Rev. B 86, 024404 (2012).
[3] D. M. Nenno et al., Phys. Rev. B 98, 224416 (2018) & arXiv:1812.06892.
[4] T. Kampfrath et al., Nat. Nanotechnol. 8, 256 (2013).
[5] S. Keller et al., arXiv:1901.10011.

Für diese Zeit steht eine Kinderbetreuung nach vorheriger Anmeldung zur Verfügung.

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