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JOHANNES GUTENBERG UNIVERSITÄT MAINZ

Theory of Condensed Matter: Hard Condensed Matter

June 17, 2014 at 10 a.m.
Seminar Room K, Building 2/413

Prof. Dr. H. C. Schneider
TU Kaiserslautern

Demagnetization dynamics and spin-dependent lifetimes in ferromagnets

I will present some theoretical results on spin-dependent carrier dynamics/ magnetizatin dynamics in ferromagnets after excitation by ultrashort optical pulses.

Ultrafast demagnetization has been well established experimentally for more than 10 years, but there is still no agreement on the microscopic mechanism behind it. I will give a brief review of the experimental facts and the different theoretical approaches, and then focus on the contribution of Elliott-Yafet spin-flip scattering. Although this concept from semiconductor physics has long been the most promising candidate to explain ultrafast demagnetization, there have always been problems with it and its importance has recently been challenged.[1]

We have done the first dynamical calculations of Elliott-Yafet scatterin in ferromagnets based on an ab-initio description of the optical exciation and electron-phonon scattering. [2] Recently, we have also included a time-dependent exchange splitting in the dynamics [3]. Our results indicate that Elliott-Yafet type spin-flip scattering does play an important role in the demagnetization dynamics of ferromagnets, but only if it is "amplified" by a time-dependent exchange splitting.

I will also briefly present our recent ab-initio based calculation of spin-dependent lifetimes in ferromagnets including spin-orbit coupling
[4], which agrees, for the first time, with 2-photon photoemission data. These results cast some doubt on the importance of superdiffusive spin transport, which has, so far, been based on computed spin-dependent lifetimes that are in contradiction with experiments.

[1] See, e.g., Eschenlohr et al., Nature Materials 12, 332 (2013), Battiato et al., Phys. Rev. B 86, 024404 (2012)
[2] Essert & Schneider, Phys. Rev. B 84, 224405 (2011), J. Appl. Phys. 111, 07C514 (2012).
[3] Mueller et al., Phys. Rev. Lett. 111, 167204 (2013).
[4] Kaltenborn & Schneider, arXiv:1403.4728 (2014).

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