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Demagnetization dynamics in ferromagnets and spin-polarized transport in metals

Prof. Hans Christian Schneider

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Abstract We will present some theoretical results on the magnetization dynamics in ferromagnets after excitation by ultrashort optical pulses. The ultrafast demagnetization has been well established experimentally for more than 10 years, but there is still no agreement on the microscopic mechanism behind it. A somewhat self-contained review of the experimental facts and an introduction to the different theoretical approaches will be given. The main part of the talk is focused on the so-called Elliott-Yafet depolarization mechanism, which is perhaps the most widely accepted proposal behind the demagnetization. This mechanism yields spin dynamics due to the interplay of spin-diagonal scattering mechanism and the spin-orbit interaction. We have done the first dynamical calculations of this mechanism in ferromagnets based on an ab-initio description of the optical excitation and electron-phonon scattering. We find that the Elliott-Yafet mechanism cannot explain the observed demagnetization behavior. Also, a macroscopic approach will be briefly presented to describe spin transport in metals (and ferromagnets) that incorporates both diffusive and ballistic transport, as well as the regime between these two "extremes". We will illustrate this by calculations that apply to the spin transport in metals after pulsed excitation.

Prof.Hans Christian Schneider Hans Christian Schneider received his Master's (1996) and Ph.D. (2000) degrees from the University of Marburg (Germany). He was a postdoc at Sandia National Laboratories (2000-2002), and joined the University of Kaiserslautern as an Assistant Professor in 2002. Since 2007 he has been a Professor at Kaiserslautern. His work has ranged from the optical and electronic properties of semiconductors over spin-dependent dynamics in semiconductors and metals to spin transport in layered metal-ferromagnet structures.

jjshi@pku.edu.cn

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