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Influence of carrier scattering on the magnetization dynamics of ferromagnets

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We present microscopic theoretical results on the demagnetization dynamics in ferromagnets after excitation by ultrashort optical pulses. To this end, we include carrier scattering in the presence of spin-orbit interaction, and calculate the band and momentum resolved electron and hole distributions at low temperatures by combining the band structure including spin-orbit interaction with the scattering dynamics at the level of Boltzmann scattering integrals. We first discuss a model in which carrier-carrier scattering is included using simplified Coulomb and dipole matrix elements that are obtained from fits to experiments. Although this model gives some qualitative insight into the purely electronic contribution to the magnetization dynamics, for quantitative comparisons with experiment it needs to be supported by ab-initio input data. We do such an ab-initio based calculation for the magnetization dynamics due to the electron-phonon interaction, which is sometimes referred to as the Elliott-Yafet demagnetization mechanism. Here we use density-functional theory results for the momentum-resolved band structure as well as for the electron-phonon interaction, and dipole matrix elements. We show that this Elliott-Yafet mechanism cannot quantitatively explain the ultrafast demagnetization in ferromagnets after excitation with an ultrashort optical pulse.

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