Title: Relativistic Theory of Electron Transport in Magnetic Layers
Author: Rudolf Sýkora
Department / Institute: Institude of Theoretical Physics
Supervisor of the doctoral thesis: doc. RNDr. Ilja Turek, DrSc.,
Department of Condensed Matter Physics

Abstract: We review the density-functional theory (DFT) in detail using the Levy−Lieb approach. The Kohn−Sham scheme is discussed, starting from the simplest spinless non-relativistic case, then including spin and considering potential spin magnetism, and finally deriving the full Kohn−Sham−Dirac relativistic scheme. The Linear Muffin-Tin Orbital (LMTO) method for electronic-structure calculation is presented, together with mentioning the necessary changes to include the spin-orbit (SO) interaction effects to an otherwise scalar-relativistic (SR) theory. Derivation of an electronic-conductance formula for a layered system is given, based on the Landauer scattering picture and using simple non-equilibrium Green functions. The formalism is applied to layered metallic systems of light elements Co, Ni, Cu elements, and to layered systems with a tunnelling barrier, Fe/MgO/Ag and Fe/GaAs/Ag. The effects of the SO interaction on the Giant Magnetoresistance (GMR) ratio and/or the Tunnelling Anisotropy Magnetoresistance (TAMR) for these systems are discussed. Both, systems with large and small effects are presented.

Keywords: Density functional theory (DFT), Quantum transport, Magnetic multilayers, Tunnelling anisotropic magnetoresistance (TAMR), Spin−orbit interaction