Giant magnetoresistance in metallic magnetic nanostructures: a unified view on granular and multilayer systems

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A description of spin-dependent scattering processes leading to giant magnetoresistance (GMR) will be given for various magnetic nanostructures. The two limiting cases are (i) granular metals in which nanoscale ferromagnetic (FM) particles with superparamagnetic (SPM) characteristics are embedded in a non-magnetic matrix and (ii) perfect nanoscale ferromagnetic(FM)/non-magnetic multilayers. In the first case, the field dependence of the magnetoresistance is proportional to the square of the Langevin function L(x) describing the field dependence of the magnetization where x is proportional to the magnetic field and the average SPM magnetic moment. In perfect multilayers (i.e., without SPM entities), the field dependence of the GMR is governed by the interplay between the FM layer coupling and the magnetic anisotropy. In non-perfect magnetic nanostructures, both FM and SPM magnetic entities can be present and in this case the GMR field dependence is proportional to L(x). We will show how to separate the SPM contribution from the measured GMR in multilayers [for details, see: I. Bakonyi and L. Péter, Progr. Mater. Sci. 55, 107 (2010)].