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SÉMINAIRE

Spin torque in tunnel junctions and electronic structure of materials for spintronics

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The field of spin electronics is very broad and includes the investigation of spin dependent processes in various systems ranging from metallic multilayers to oxide magnets to semiconductor and tunnel junctions. In recent years, interest in spintronics has been accentuated by the discoveries of current induced magnetization switching (spin transfer torque) [1] and prediction and discovery of extremely high tunneling magnetoresistance in epitaxial magnetic tunnel junctions [2]. The latter are objects of increasing interest because of their high sensitivity to magnetic fields, which makes them good candidates for hard drive read heads and magnetic random access memories (MRAM).

In the first part of my talk I will present studies of non-equilibrium spin currents and the corresponding spin torques in simple cubic epitaxial magnetic tunnel junctions with non-collinear moments. Calculations are based on the Keldysh formalism in which the non-equilibrium Green functions are calculated within a tight-binding model. The properties of spin torque and spin currents as a function of applied bias, barrier thickness and distance from the interface in the free layer for simple cubic structures are discussed. The exchange coupling between ferromagnetic layers in magnetic tunnel junctions is presented via its relation to the spin torque.

The second part of the talk will be devoted to ab-initio studies of electronic and magnetic properties of epitaxial structures based on different type of materials. I will start from first-principles investigations of symmetry based spin dependent tunnelling in Fe|MgO|Fe, Fe|GaAs|Fe and Fe|ZnSe|Fe structures using electronic structure calculations. Next, systematic ab-initio studies of magnetic properties of CoFe|Pd alloys and multilayers will be presented. This work was motivated by search of materials with high saturation magnetization for write heads. After that I will present studies of interfacial magnetism in rutile-based magnetic tunnel junctions with half-metallic electrodes. Finally, I will conclude with results of electronic structure calculations of spinels considered to be a possible new class of materials for spintronics.

[1] J. C. Slonczewski, *J. Magn. Magn. Mater.*, **159**, L1 (1996); L. Berger, *Phys. Rev. B*, **54**, 9353 (1996)

[2] W. H. Butler et al, *Phys. Rev. B*, **63**, 054416 (2001); J. Mathon and A. Umerski, *Phys. Rev. B*, **63**, 220403(R) (2001)