



**Les Séminaires de la Fondation
“Nanosciences aux limites de la Nanoélectronique”**

**Judi 26 février 2009
à 16h00**

Mairbek Chshiev

SPINTEC, Grenoble (France)
Chair of Excellence of the Foundation Nanosciences



présentera un séminaire intitulé :

**“Recent Advances in Theory of
Spintronic Phenomena”**

Vous êtes tous cordialement invités au pot qui suivra la présentation.

**Amphithéâtre 15 de l'école PHELMA Polygone
(anciennement ENSERG)
23 rue des Martyrs – 38000 Grenoble**

Recent Advances in Theory of Spintronic Phenomena

The discoveries of giant magnetoresistance¹ (GMR) in magnetic multilayers and of tunnel magnetoresistance² (TMR) in magnetic tunnel junctions generated a new field of research called spin electronics³ (spintronics). It combines two traditional fields of physics: magnetism and electronics. In this field, it is not only the electron charge but also the electron spin that is used to operate a device. The field of spintronics 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 switching⁴ (spin transfer torque) leading to prediction and discovery of extremely high tunneling magnetoresistance in epitaxial magnetic tunnel junctions⁵. Because of their high sensitivity to magnetic fields, the latter are good candidates for hard drive read heads and magnetic random access memories (MRAM).

The first part of the seminar will be devoted to a brand new concept of spin-dependent tunneling based on spin filtering effect arising from the symmetry of the wave functions. Ab-initio studies of electronic and magnetic properties of epitaxial structures based on different type of materials will be presented to provide an insight into the origin of symmetry based spin filtering.

In the second part of the presentation studies of non-equilibrium spin currents and the corresponding spin torques in simple cubic epitaxial magnetic tunnel junctions with non-collinear moments will be presented. 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 will be discussed.

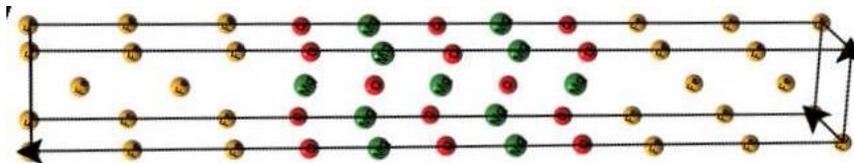
[1] M. Baibich, J. M. Broto, A. Fert et al, *Phys. Rev. Lett.* 61, 2472 (1988); G. Binasch, P. Grunberg, F. Saurenbach, W. Zinn, *Phys. Rev. B* 39, 4828 (1989); Albert Fert and Peter Grunberg were awarded the Nobel Prize in Physics for the discovery of GMR

[2] J. S. Moodera, Lisa R. Kinder, Terrilyn et al, *Phys. Rev. Lett.* 74, 3273 (1995); T. Miazaki and N. Tezuka, *Journ. Magn. Magn. Mat*, 139, L231 (1995)

[3] A. Fert et al, *Mat. Sci. Eng. B*, 84, 1 (2001); S. A. Wolf, *Science*, 294, 1488 (2001)

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

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



Supercell representing Fe|MgO(001) magnetic tunnel junction used in first-principles calculations

Biography

The research of Mairbek Chshiev is focused on the theory of spin-dependent electronic transport phenomena in nanostructures with giant and tunnel magnetoresistance. He also works mainly in the field of electronic band structure of materials for spin electronics (spintronics).

He received his Ph.D. degree from Moscow State University (Russia) in 1997 and his Habilitation Degree from Joseph Fourier University (Grenoble, France) in 2008. After several postdoctoral stays in France and in the USA between 1998 and 2004, he joined the Center for Materials for Information Technology at the University of Alabama where he stayed as a Research Scientist.

He has been involved in two emerging directions of spintronics:

- Investigation of transport phenomena in epitaxial nanostructures and
- Electronic structure of materials for spintronics from first principles.

In 2008, Dr. M. Chshiev joined Spintec Laboratory in Grenoble (France) holding one of the Chairs of Excellence supported by the Foundation "Nanosciences at the frontier of nanoelectronics".

He carries on his research in order to understand fundamental transport mechanisms required for the developments of future spintronic devices in close collaboration with other scientists involved within the Foundation's network (over 32 laboratories including : CEA/INAC, Institut Neel/CNRS, Joseph Fourier University, Groupe INP, and further more)