MASTER DE PHYSIQUE ET APPLICATIONS - 2ème année
Spécialité Sciences des Matériaux et Nano-objets
International Nanomat Master Program

Internship proposal 2009-2010

Laboratory : Laboratoire Léon Brillouin (UMR12, CNRS-CEA)

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Quantification and confinement of spin excitations in magnetic nanowires

Scientific project: Magnetism plays an important part in shaping key new technologies like "spintronics" or in the development of new materials based on nano-particles. Many strategies are being developed to understand them and a large variety of nano-objects are now available using techniques like epitaxial growth, lithography, electro-deposition or self-assembling at the molecular scale. Magnetic nanowires either made up through "top-down' or "bottom-up" approaches, are of prime interest regarding both fundamental issues and technological applications like magnetic recording and sensor devices. More specifically, we are interested in the spin dynamics of these materials as a function of size, shape, organisation and composition. There is now a wide range of structures but an attractive route to build well-organised nanowires uses porous membranes, made of aluminium oxide for instance, into which magnetic metals (Co, Ni) can be inserted.
In this project, we propose to use neutron scattering techniques to probe the magnetic properties of such nanowires. These techniques involve structural investigations using Small Angle Neutron Scattering (SANS), Grazing Incidence Sans Angle Neutron Scattering (GISANS) and dynamical investigations using Inelastic Neutron Scattering (INS). In nanowires, a better knowledge of spin excitations is important to the magnetization dynamics (switching processes, time scale) and thus their potential functionalities. Quantized Magnetic excitations in highly-ordered Ferromagnetic Ni nanowires embedded in porous membranes have been recently observed using Brillouin Light Scattering (BLS) under magnetic field. The observed modes around 0.1 meV correspond to radial quantization of bulk spin-waves modes. To go beyond BLS, both in terms of energy and wave-vector, INS is a well adapted technique as it allows a complete mapping of the spin excitations. SANS and GISANS techniques will be used to obtain a clear picture of the magnetization profile and to understand structural and magnetic static disorder in the nanowires.

Techniques in use: Magnetic characterisation (SQUID); Neutron Scattering (Saclay, Grenoble), cryogenics at low temperature (1.5K), magnetic fields, numerical work.

Applicant skills: Depending on the candidate profile and interest, the training project will be more experimental (sample preparation, characterisation, neutron experiments) or theoretical (modelling spin excitations). Some solid knowledge in condensed matter physics, a strong taste for experimental physics and a substantial autonomy in both experimental and theoretical work are required. Good knowledge in English is compulsory; some basic knowledge in French will be an asset.

Granted internship: yes (300 – 800 € / month depending on curriculum)
C'nano IdF laboratory (France only): yes
Possibility for a thesis: yes (type of grant: CFR (CEA grant) upon curriculum)