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

Internship proposal 2011-2012

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Title for the scientific project

Spin dynamics and magneto-elastic coupling in $AgCrS_2$

Recently, intensive research has been devoted to the study of materials exhibiting a coupling between spin ordering and electric polarization, the so-called multiferroics. Amongst the different families of magnetoelectric materials newly discovered, one of the most puzzling is characterized by stackings of triangular planes, on which geometrically induced frustration leads to complex non-collinear magnetic structures : $RbFe(MoO_4)_2$ or $ACrO_2$ are amongst the most studied representatives of this family. New candidates have been discovered lately, also based on a stacking of magnetic triangular arrays, the layered sulfides $CuCrS_2$ and $AgCrS_2$.

$AgCrS_2$ orders antiferromagnetically at T_N = 42K ; magnetic ordering occurs simultaneously with a first-order structural transition ; below T_N polarization measurements shows that $AgCrS_2$ is ferroelectric, with a remnant polarization value at 10K of 20µC/m^2. A recent study performed at LLB has evidenced that in $AgCrS_2$, the antiferromagnetic arrangement is an unconventional collinear one, which can be described as doubled magnetic stripes coupled antiferromagnetically : the mechanism behind the emergence of ferroelectricity is thus very different from the one commonly acknowledged for $AgCrO_2$ and requires further understanding, in particular on the role of the ligand anion in mediating the magnetic exchange.

The first part of this work will consist in a mean-field analysis of the magnetic structure, to determine the relevant magnetic exchanges stabilizing this unusual configuration; an analysis of the inelastic scattering data recorded on the Time of Flight spectrometer IN4 above and below T_N will then follow, to understand the different features of the spin excitation spectra. The second part of this work will be more experimental, and devoted to the study of a compound with a different ligand anion, $AgCrSe_2$: it will involve neutron techniques such as powder diffraction and inelastic neutron scattering experiments, and determination of crystal and magnetic structures via Rietveld refinements.

This work can be followed by a PhD on the role of the ligand ion on the magnetic structures and spin dynamics in the series $AgCrS_2$, $AgCrSe_2$ and $AgCrTe_2$.

Techniques in use : neutron scattering (elastic, inelastic)

Applicant skills : Good knowledge in condensed matter physics, magnetism in particular

Granted internship : yes (450€/month)
C'nano IdF laboratory (France only) : yes
Possibility for a thesis : yes (type of grant : CFR/CEA)