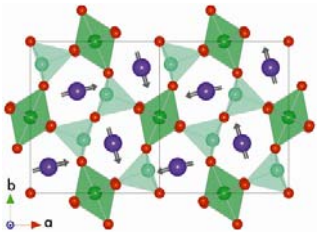
STUDY OF THE INTERPLAY BETWEEN SPIN/CHARGE AND LATTICE IN MULTIFERROIC OXIDES RMn_2O_5 (R=La, Nd, Pr)



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Strongly correlated electronic systems continue to attract great attention in condensed matter physics because of their fascinating properties. Among them, oxides have a central position, including cuprates and high Tc superconductivity, manganites and colossal magneto-resistance, and more recently multiferroics. In all of these systems, there is a strong coupling between different degrees of freedom, including charge, spin, lattice and orbitals. In multiferroic compounds, the ground state is characterized by strong coupling of the magnetic and ferroelectric order parameters. These materials, due to the magnetoelectric effect in these materials may open the route to promising novel electronic devices, allowing tune the electric polarisation by an applied magnetic field and vice-versa.

In multiferroics, ferroelectricity is associated with a lattice distortion closely related to the complex magnetic orders which appear in the system. In the particular case of RMn_2O_5 (R is a rare earth) multiferoics, the lattice distortion is accompanied by a charge order, located either on the Mn sites or on the Mn-Mn bonds. In this series, the coupling between spin, charge and lattice degrees of freedom is thus particularly complex and call for a deep investigation. In particular, a detailed study of the different order parameters is necessary in the ordered phases as well as in the pretransitionnal fluctuation regime. The influence of the applied pressure is also an important issue as it is expected to strongly impact the atomic distances and thus the magnetic interactions along with the magnetic orders. Such studies require the use of coupled techniques such as X-ray diffuse scattering, anomalous scattering at the Mn and R edges and neutron diffraction, all under extreme conditions.

The subject of the proposed PHD work consists in two important components. The first part concerns the synthesis and detailed characterization (powder X-ray diffraction, susceptibility, transport, EXAFS) of single crystals of the RMn_2O_5 (R=La, Nd, Pr) compounds. The study of these compounds largely unexplored, will help to explain the dramatic changes of the electrical polarization upon R in RMn_2O_5 systems. This synthesis work will be performed in the group of Prof. M. Greenblatt (Rütgers Univ., USA), specialist of the oxide synthesis and will be supported by a NFS/CNRS grant (2008/2011). The second part of the PHD deals with the X-ray and neutron scattering study of the interplay between spin, charge and lattice orders and couplings. The measurements will be performed in the P. Foury's group at the LPS and in collaboration with the large facilities of the Saclay Plateau : LLB (S. Petit) and SOLEIL (S. Ravy), supported by the RTRA network.

References :

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