Laboratory CRISMAT

Ph. D thesis

Title : **Single-Ion and Single-Chain Magnetism in Oxides**

Start : **September/October 2017**

Profile : **Master of Science in Condensed Matter Physics**
Basic knowledge in magnetism (mandatory)

Context

Magnetism was revealed this last decade to play a primordial role for the discovery of new devices, as exemplified by the giant magnetoresistance (GMR) phenomena (Albert Fert Physics Nobel Prize 2007), or more recently by the numerous studies on multiferroics in view of applications for the realization of memory materials. Low dimensional systems which exhibit spin dynamics slow enough to behave as "magnets", even in the absence of long-range ordering (LRO), are attracting a lot of interest nowadays, both from viewpoints of fundamental (e.g., quantum tunneling of magnetization) and applied (e.g., nanometric memory units) research. This behavior results from high-energy barriers to spin reversals, yielding relaxation times that can reach long durations (e.g. months or years) below a certain blocking temperature. In 0D systems, these barriers come from on-site anisotropy, leading to a behavior of Single-Molecule Magnet (SMM) for clusters [first report in 1993] or Single-Ion Magnet (SIM) for individual spin centers [first report in 2003]. In the 1D counterpart, called Single-Chain Magnet (SCM), the barriers combine local anisotropy with exchange coupling along the chains [first report in 2001]. It turns out that present investigations are almost exclusively carried out on molecular compounds.

Recently, we have demonstrated that these phenomena can also take place in oxides, more specifically in spin-chains organized on a triangular lattice.

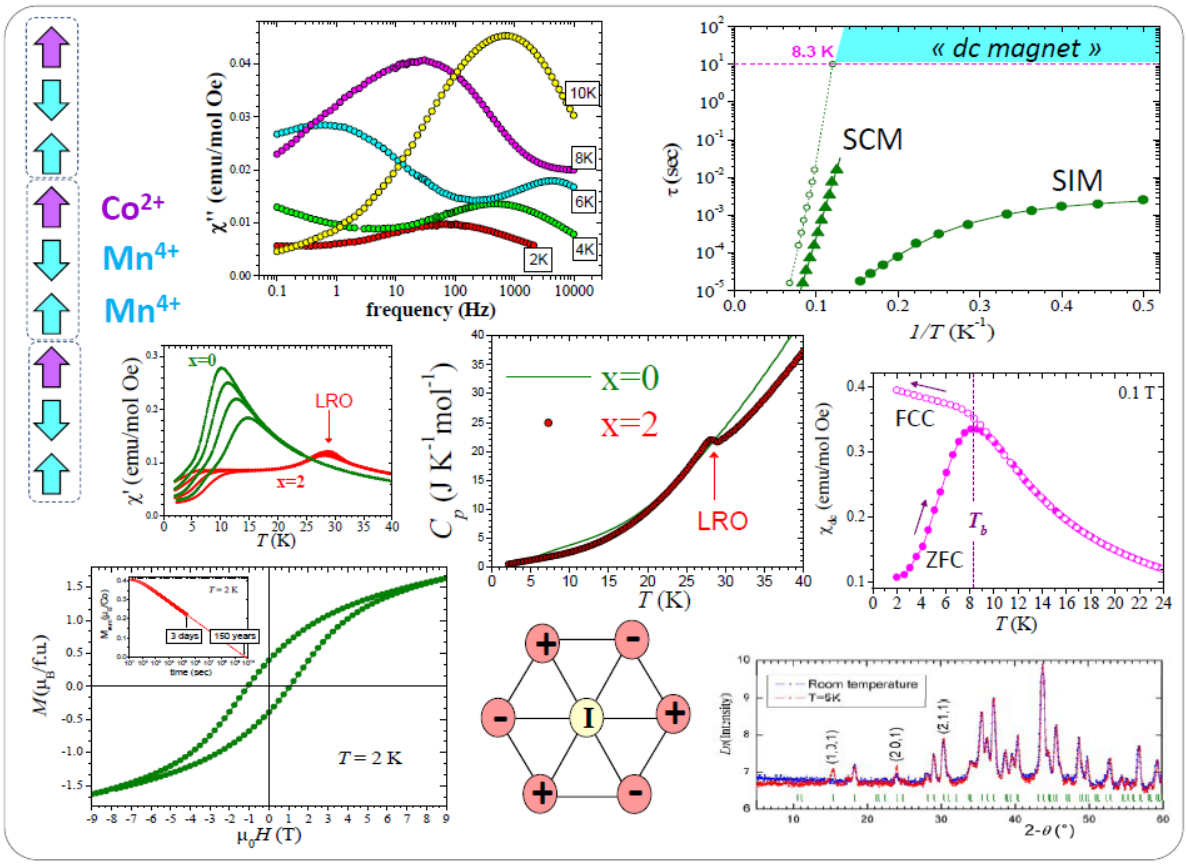
This extension of the topic towards inorganic compounds offers new potentialities for an experimental investigation the 0D and 1D nanomagnets based on blocking effects.

Project

The thesis will consist in an experimental investigation of the magnetism within the series $Sr_{4-x}Ca_xMn_2CoO_9$, addressing the complex issue of the interplay between SIM, SCM and LRO. This study will be mainly based on magnetization, ac susceptibility and heat capacity measurements, for which all the necessary equipment is available in the CRISMAT (see below a patchwork of preliminary results).

These investigations will be complemented by experiments on large-scale facilities, in particular for neutron diffraction and very high-field exploration. The measurements will be initially carried out on polycrystalline materials synthesized in the laboratory. To address the anisotropy of the magnetic response, the investigations will be extended to single crystals or at least to aligned-powder materials. Further developments towards other compositions with

the same structure or to other members of the same structural family will be envisaged if time permits.



The PhD student will be integrated into the CRISMAT team working on this topic, which comprises chemists, crystallographers and physicists.

The goal of the thesis will be to propose a global interpretation of the magnetic properties of these compounds, on the basis of precise physical characterizations combined with a detailed knowledge of the structural features.

The PhD student will benefit from a dual supervision, addressing both the physical and structural aspects of the project.

Supervisors

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Details

-CRISMAT is a lab. located in Caen/ Normandy / France (*http://www-crismat.ensicaen.fr/)*

-The PhD is expected to start on Sept./Oct. 2017, for a duration of 3 years.

-The scholarship is about 1350 euros net /month.

Applications (to be sent to both supervisors)

- CV containing details of courses taken in the Master, transcript of records, and rankings.
- Motivation letter
- Recommendation letters (if any)