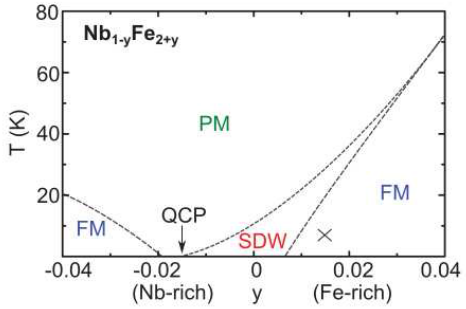
NÉEL INSTITUTE Grenoble

Topic for Master 2 internship – Academic year 2021-2022

Remarkable magnetic behavior of itinerant electrons

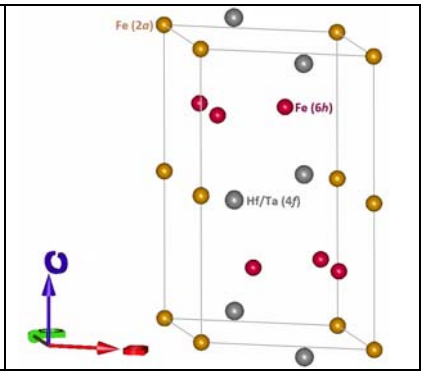
General Scope : The itinerant electron magnetism of 3d electrons of transition elements is a matter of intensive research nowadays [1-4]. When alloying transition metal (Fe, Co..) with rare-earth elements (R) various interesting physical properties can be obtained such as high performance magnetostriction of RFe_2 compounds usefull in actuators and sensors (sonars etc..) or large magnetocaloric properties of RCo_2 materials promising for magnetic refrigeration. Another surprising feature is the magnetically driven negative thermal expansion of materials which do not exhibit the expected contraction but on the contrary expand upon cooling [2]. In addition to the great importance of such remarkable properties for both scientific research and modern technological applications, fundamental research is needed to go deeper in the understanding of the 3d itinerant electron magnetism which can exhibit a wide range of behavior from localized magnetism to pure itinerant electron magnetism. Recent reports showed the complex magnetic phase diagram including quantum critical points (QCP) in $NbFe_2$ [3,4] attracting a large interest from the scientific community from both theoreticians and experimentalists

Research topic and facilities available : The internship is aimed to investigate the magnetic phase diagram of selected R-Fe compounds and analyze their unusual behavior at the crossover between competing interactions of ferro and antiferromagnetic type. In order to modify and probe the magnetic properties, we will use different approaches including insertion of light element and application of presure. This fundamental research will be performed aiming to determine the physical properties ranging from crystal structure to magnetic, thermal and transport properties. The research will involve experimental investigations at Néel laboratory as well as study of data from large scale facilities like neutron diffraction (to determine the arrangement of the magnetic moments) and/or synchrotron radiation. Most of the experiments will be performed at cryogenic temperatures down to 2K. The internship will include preparation of samples, measurements of their interesting physical properties and analysis of the observed behavior. This will be done in a research team using equipments already available. **This internship is aimed to be followed by a PhD Thesis**



Left : Magnetic phase diagram of $Nb_{1-y}Fe_{2+y}$ compound Paramagnetic : PM, Ferromagnetic :FM, Quantum critical point QCP

Right : Typical crystal structure of RFe_2 compounds



Possible collaboration and networking : We currently have several national and international collaborations on this research topic. collaboration in France with the CNRS, the Institute Laue Langevin and synchrotron SOLEIL, and with foreign laboratories in Germany, Czech republic (collaborators specialists of magnetic measurements at high pressure) and Brazilian colleagues.

Required skills: sciences Interest for experiments and wish to broaden its knowledge in fundamental sciences. Master 2 in Condensed Matter Physics or Engineer in Materials wanted.

Starting date : February or march 2021

Contact : Olivier ISNARD Institut Néel - CNRS
Phone : 04 76 88 11 46 e-mail : olivier.isnard@neel.cnrs.fr