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

Internship proposal 2009-2010

Laboratory : Institut de Minéralogie Physique des Milieux Condensés (IMPMC)
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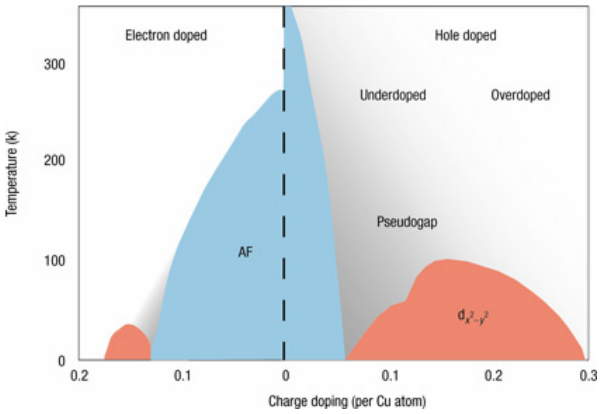
The symmetry of the doping in the phase diagrams of the high-Tc cuprate.

Scientific project: One puzzling feature of high-Tc cuprate superconductors is the hole-electron asymmetry of the electronic phase diagram. (See picture from D. A. Bonn *Nature Physics* **2** (2006) 159). This is unexpected for doped charge transfer Mott-Hubbard insulators and its origin remains highly controversial. While the hole-doped region of the phase diagram has been well established for a number of different systems, the electron-doped region is far less studied, for only one system has been thoroughly investigated (*e.g.* $Nd_{2-x}Ce_xCuO_4$). We argue that $La_{2-x}Ce_xCuO_4$ would be a better playground for studying the phase diagram of electron-doped systems, as it is closer to its hole doped counterpart, $La_{2-x}Sr_xCuO_4$. The difference may arise from the magnetic properties of La and Nd ions, but a detailed study is hampered by the instability of the $La_{2-x}Ce_xCuO_4$ phase. In order to overcome this difficulty, we plan to use high pressure synthetic methods to stabilise new electron-doped compounds, in collaboration with the Ehime University (prof. I. Yamada) and Kyoto University in Japan. Subsequently, we plan to elucidate the properties of the electron-doped region of the phase diagram by studying the magnetic and electronic structure of the new compound by means of SQUID magnetometry.



The PhD program will extend the internship preliminary results to the whole phase diagram, and investigate further the magnetic phase diagram using muon spin rotation and neutron scattering, while the metallic phase will be studied by Hall effect for the charge carrier sign, and the electronic structure measuring the conductivity $\sigma(\omega)$ with ω up to the optical frequencies.

Techniques in use: High pressure solid state synthesis, X-ray powder diffraction, *in-situ* diffraction on synchrotron source, magnetisation (Superconducting Quantum Interference Device).

Applicant skills: Solid state physics and chemistry, crystallography

Granted internship : yes (398.32 €/month)
C'nano IdF laboratory (France only): yes
Possibility for a thesis : yes (type of grant: scholarship by French ministry)