LNCMI-Grenoble

Using NMR to understand high temperature superconductivity

Stage Master (M1/M2)

Summary *(400 caractères maxi)*

Superconductivity enables an electric current to flow without dissipating heat. This quantum phenomenon was understood in 1957, which led to a Nobel prize in 1972. In 1986, however, "high temperature" superconductivity was discovered in copper-oxides below ~130 K (-143 C). Since then, understanding the mechanism of this new type of superconductivity has been one of the greatest challenges of condensed-matter physics. The reason why this problem is not solved yet is that copper oxides have extremely unusual and complex electronic properties. This is what we are trying to understand.

Detailed subject *(1200 caractères maxi dont une figure possible)*

Our research group is specialized in the NMR technique that provides rich information about electronic properties at the microscopic (atomic) scale. In order to understand the origin of high temperature superconductivity, we use NMR to study how the material's properties change as a function of temperature, doping or pressure. Perhaps paradoxically, a particularly fruitful strategy we have been using extensively in recent years is to "destroy" superconductivity with intense magnetic fields. This has led us to discover that electrons in these materials actually experience a very unusual balance between forming a superconductor and forming a wavy pattern in which their density varies in space. Understanding this interplay between superconductivity and "charge-density waves" is currently our main motivation (and the motivation of many other groups across the world).

There are diverse opportunities for a Master student to get involved in this research program:

- Performing NMR measurements
- Developing new experimental setups (for example, integrating a unixial-pressure device into the NMR probe)
- Performing data analysis and computer simulations

While this research is clearly labeled as fundamental, tremendous technological applications are expected if cracking this mystery ultimately helps to fabricate materials that superconduct at room temperature.

Please, visit us to learn more about the internship and our research, and to tell us about what you like!

Publications linked to the theme

- Nuclear magnetic resonance in high magnetic field: Application to condensed matter physics.
C.R. Physique 18, 331 (2017). https://doi.org/10.1016/j.crhy.2017.09.009

Background and skills expected : Motivation for experimental work. Teamwork spirit. Background in solid state physics, quantum mechanics and statistical physics (even better if including magnetism and superconductivity).

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