LNCMI

LNCMI-Grenoble

Superconducting nematic phases under stress

Master 1 / Master 2

Summary

The proposed work consists in setting up a uniaxial pressure device, coupled to NMR measurements (a spectroscopic method whose principle is analogous to medical MRI), in order to study novel electronic phenomena in high temperature superconductors.

This Master internship will take place in a team of several researchers and will offer a wide range of opportunities: tests and implementation of the pressure device, handling of cryogenic fluids and magnetic fields, NMR measurements, data analysis.

Detailed subject

In liquid crystals, the molecules may have a preferential orientation while their positions remain disordered: this is called a “nematic” phase. In recent years, physicists have realized that quantum analogs exist in crystalline solids: in such "electron liquid crystals", electronic properties break the rotational symmetry of the crystal (which can, for example, cause anisotropic electrical conduction or orthorhombic deformation of the lattice) but not the translational symmetry.

Electron nematic phases are fascinating novel states of quantum matter but they are also very interesting for the possible relationship (according to some theories) with the phenomenon of high temperature superconductivity. This is particularly true for the iron-based superconductors and for the copper oxide superconductors, the superconducting mechanism of which is one of the greatest mysteries of condensed matter physics.

In order to study such electronic nematic phases, we propose to combine two experimental techniques: on one hand, nuclear magnetic resonance (NMR), an extremely powerful microscopic probe widely used in physics, chemistry and biology, and on the other hand the application of uniaxial pressure.

Feel free to contact us to know more about our research and the internship opportunities not listed here

Publications linked to the theme

Zhou, R., Scherer, D.D., Mayaffre, H. *et al.* Singular magnetic anisotropy in the nematic phase of FeSe. *npj Quantum Mater.* **5,** 93 (2020). https://doi.org/10.1038/s41535-020-00295-1

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

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