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High temperature superconductors probed by NMR

Master 1 / Master 2

Summary

In this Master project, we propose to perform nuclear magnetic resonance measurements in a high T_c cuprate superconductor in order to understand the competition between superconductivity and magnetic or charge ordering.

The internship will take place in a team of several researchers and will offer a wide range of opportunities: handling of cryogenic fluids and magnetic fields, NMR measurements, data analysis.

Detailed subject

Superconductivity, that allows an electric current to flow without dissipating heat, is a fascinating quantum phenomenon that has been explained long ago (https://www.nobelprize.org/prizes/physics/1972/summary/). Since 1986, however, one of the greatest challenges of condensed-matter physics is to understand a new type of superconductivity observed at high temperature in copper-oxides. This is a hard problem because these cuprates have particularly complex and unusual electronic properties. Our research precisely aims at understanding these puzzling properties and thus superconductivity.

Our research group is specialized in nuclear magnetic resonance (NMR), a technique that provides powerful information about the material's electronic and magnetic properties at the microscopic (atomic) scale. In recent years, we have discovered that key properties of high T_c superconductors were in fact "hidden" by the presence of superconductivity [1-3] and that they can be revealed by applying very intense magnetic fields (available in our lab and in a few other facilities worldwide) that destroy the superconducting state. The internship precisely aims at studying these hidden states.

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

Publications linked to the theme

[1] Hidden magnetism at the pseudogap critical point of a high temperature superconductor, Nature Phys. 16, 1604 (2020) https://doi.org/10.1038/s41567-020-0950-5 (open access version https://arxiv.org/abs/1909.10258)

[2] Magnetic fields make waves in cuprates, Science 350, 914 (2015). https://doi.org/10.1126/science.aad3279

[3] Magnetic-field-induced charge-stripe order in the high temperature superconductor YBa2Cu3Oy, Nature 477, 191 (2011). https://doi.org/10.1038/nature10345 (open access version https://arxiv.org/abs/1109.2011)

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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https://nmr-lncmi.wixsite.com/nmrgroup/people