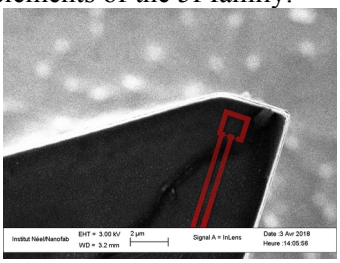
NÉEL INSTITUTE Grenoble

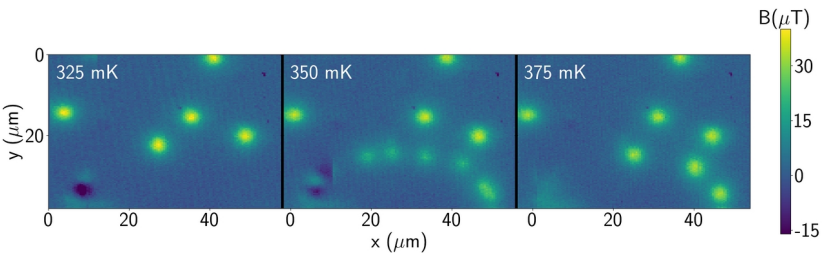
Topological superconductivity imaged by scanning SQUID microscopy

General Scope :
The aim is to discover manifestations of topological superconductivity using vortex matter as indicator. Topological superconductivity is a phenomenon in which surface (2D/1D) effects are different from bulk properties. Our approach is to study superconductors with 5f electrons (Uranium compounds UPt_3, UCoGe UTe_2) being natural candidates for topological superconductivity as suggested by their complex superconducting phase diagrams.
Finding topological superconductivity will allow us to manipulate novel quantum states and to further the theoretical understanding of these states.

Research topic and facilities available :
We have developed a magnetic scanning microscope operating at very low temperatures (0.2 kelvin). It is a well suited tool to study these superconductors as they transit below 2 K into the superconducting state. We use a Superconducting Quantum interference Device (SQUID) as magnetic sensor in our microscope: Flying at a height of a few nanometers above the surface of the superconductor the SQUID probe intersects magnetic flux lines acquiring thus magnetic images. During the M2 internship the student will be familiarized with the cryogenic environment and the scanning probe techniques before acquiring and interpreting magnetic images of superconductors with elements of the 5f family.



Al NanoSQUID probe (Neel Nanofab)



Half Quantum vortex formation and fusion in UPt_3 (thèse P. Garcia Campos thesis link).

Possible collaboration and networking :
This subject is part of a collaboration between teams at ESPCI in Paris and Pheliqs Grenoble and teams in Germany and Japan.

Possible extension as a PhD :
After familiarization with the subject and the instrument, improvements of the SQUID detector are to be achieved using techniques of nanofabrication and characterization with highly sensitive amplifiers. This work will be done with the support of the technical services and scientists of the collaboration. Funding may be obtained via the Quantum PhD calls or:by the doctoral school.
Required skills:
Curiosity for technological aspects of Science, programming, dexterity
Starting date :spring 2023

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