INSTITUT NEEL Grenoble

Post-doctoral position: Development of a Continuous Nuclear Demagnetization Refrigerator

Context:

Cryogen-free ("dry") dilution refrigerators have become popular in recent years because of their large experimental space, their automated operation and the cost of helium. The advantages of dry dilution fridges have allowed a large community to reach temperatures as low as ~10 mK. However, several fields of research require still lower temperatures. For example, recent work demonstrated that the energy relaxation time of fluxonium qubits increases as their transition frequency is decreased at least down to 200 MHz. It is desirable to cool such qubits well below 10 mK so as to minimize the excited state populations.

Sub-mK temperatures in condensed matter systems are achieved using adiabatic nuclear demagnetization refrigerators (NDR), which usually include liquid helium baths and have a relatively small experimental space. A few laboratories have realized cryogen-free, single shot NDR, reaching impressive minimum temperatures below 100 μK. However, these dry NDR had relatively high heat leaks of a few nW. This results in a limited autonomy of a few days below 1 mK as well as pre-cooling times that are at least as long making these systems impractical for many applications.

We are developing a continuous nuclear demagnetization refrigerator (CNDR), which would allow ultra-low temperature researchers to take full advantage of cryogen-free technology. According to our numerical calculations [D. Schmoranzer *et al.*, Cryogenics **110**, 103119 (2020)], we can construct a CNDR with a cooling power of tens of nW at 1 mK.

Objectives and means available:

We recently took a major step toward the realization of a CNDR by demonstrating a superconducting heat switch with an extremely low normal state resistance (arXiv 2111.11896). This component is crucial since the thermal resistance of the heat switch can limit the rate at which one can cycle the CNDR and consequently its cooling power.

The candidate will contribute to the development of the nuclear demagnetization refrigerant, integration of the components of the CNDR and automation of its operation. We are exploring two new refrigerant technologies providing high cooling power at relatively low applied magnetic fields.

Candidate profile:

Experience with cryogenics is required. One or more of the following is also desirable: Experience with cryogen-free refrigerators, dilution refrigerators, magnet design, LabView, Python, Ph.D. in low temperature physics.

Foreseen start for the position: Winter/Spring 2022.
Gross Salary: 2664 €/month to 4213 €/month depending on the number of years of experience
Duration : 12-26 months

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