



May 2026

Postdoctoral position: 12-month renewable contract (+ 6 months or + 12 months)
Funding for "adiabatic demagnetization cooling".

Title: Development of GdLiF_4 magnetocaloric ceramics and study of new magnetocaloric compounds for integration into ADR space refrigeration systems.

(ADR for Adiabatic Demagnetization Refrigeration)

Host Laboratory:

Direction de la Recherche Fondamentale (DRF)
Institut de Recherche Interdisciplinaire de Grenoble (IRIG)
DEPHY/PHELIQS/IMAPEC - *Laboratoire Matériaux*

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Position available as soon as possible – after completion of the required CEA police investigation.

The postdoctoral research project is part of an internal collaboration within the CEA Grenoble - Fundamental Research Division (DRF) between two laboratories of the IRIG (Grenoble Interdisciplinary Research Institute): the PHELIQS Laboratory and DSBT (Low Temperature Systems Department).

This materials science research is directly motivated by the needs of space cryogenics (cooling bolometers below 0.1 K for astrophysical observation satellites, an area of expertise for the DSBT), which relies on adiabatic demagnetization (ADR) cooling. At the heart of these systems are materials with high magnetocaloric properties. These materials are found in compounds with high magnetic entropy down to very low temperatures, which is rapidly suppressed by weak magnetic fields.

A particularly promising compound for this project is GdLiF_4 . This system exhibits purely dipolar magnetic interactions between gadolinium ions, resulting in very low-order temperatures and high magnetocaloric power, especially between 1 and 4 K. Incorporating it

into an ADR stage requires masses of several hundreds of grams of this system. Therefore, the first part of the study aims to optimize and improve the reliability of the GdLiF₄ sintering conditions. This process has already been studied in the laboratory but requires adjustments to adapt it to fluorinated compounds. It can then be applied to other rare earths of the same composition: RELiF₄ (RE for rare earth). The ultimate goal is to obtain ceramics with maximum density (>95%) to improve mechanical strength, refrigeration efficiency relative to volume, and thermal conductivity - crucial factors for space applications. The synthesis process employs numerous techniques (grinding, sieving, high-temperature heat treatments, cold isostatic pressing, pycnometry, electron microscopy, etc.). Because fluorides are highly chemically reactive, particular care will be taken to maintain their chemical purity during synthesis.

In parallel, a more exploratory study is planned on the development of new magnetocaloric materials, primarily oxides, to expand the possibilities of adiabatic demagnetization cooling at lower temperatures, or to further improve refrigeration efficiency and autonomy. This more fundamental research will focus on obtaining new compounds in powder, ceramic, or single-crystal form, depending on the challenges of the systems under investigation. In direct collaboration with the quantum materials physicists at PHELIQS, the physical properties of these compounds would then be studied: magnetic susceptibility, specific heat and thermal conductivity at low and even very low temperatures, magnetic structures and transitions by neutron diffraction where applicable (depending on the state of the art in published studies on the subject). This research should lead to publications.

The skills required for the Postdoctoral researcher are essentially:

- a materials-oriented approach to the problems encountered (synthesis/characterization loop), with prior experience in materials synthesis.
- knowledge of metallurgy.
- an aptitude for collaboration between different teams or laboratories (within the CEA), adapting to their scientific environments.
- a strong ability to work independently and take initiative.

He / she will have access to the laboratory's extensive synthesis resources:

- Materials processing equipment: 1200°C - 1800°C resistive furnaces, brazing furnace, high-frequency heating, isostatic and uniaxial presses, high-temperature DTA/TGA, glove box, planetary mill, jar turners, polishers, sieve shaker, diamond saw, wire saw...
- Characterization tools: optical microscopes, powder X-ray diffraction, Laue X-ray diffraction, scanning electron microscope, microanalytical equipment, SQUID magnetometer, densitometer...
- Crystal growth equipment: furnaces adapted for flux and vapor-phase transport techniques, image furnace for vertical zone melting, Czochralski, Bridgmann, and Mono Arc techniques.

In addition to these, there are the DSBT/LCCS equipment:

ADR characterization test bench (with thermometry, superconducting coil and dedicated electronics) & Mechanical vibration test equipment for "space" qualification.