PhD Subject: Low-dimensional MagnetoCalorics for Efficient Refrigeration (Low-MACER).

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Context: The Magneto-Caloric Effect (MCE) is an important phenomenon that can lead to a strong cooling effect if a magnetic field applied to a magnetic material is removed under adiabatic conditions, see Figure 1. The largest magnitude of the MCE is reached near the Curie temperature for a paramagnet-ferromagnet phase transition. Adiabatic magnetic cooling has recently attracted much attention for ambient-temperature refrigeration processes due to its high energy efficiency, approaching 60% of the Carnot limit. However, there remains a significant need for MC materials for low-temperature applications, especially near 20 K, for an efficient liquefaction of hydrogen. This becomes progressively more important as hydrogen receives an increased industrial interest within an energy framework, where the production of liquid hydrogen will be critical for its storage and transportation.

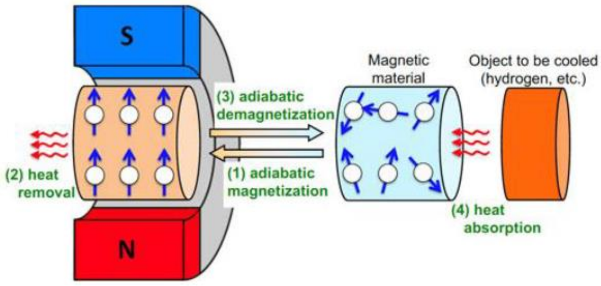

Fig. 1. Operation principle of magnetic refrigeration.

Research topic: This PhD project will explore low-dimensional magnetic materials as new magnetocalorics at low temperature. The materials will be based on the presence of ferromagnetic units with weak or frustrated magnetic coupling. This prevents magnetic order in the absence of applied fields, but leads to a rapid increase of the magnetization under a small applied field (metamagnetism).

Scientific skills: The project will involve solid-state and high-pressure/high-temperature synthesis of mainly oxides containing transition metals. The prepared materials will be characterized using powder and single-crystal X-ray diffraction (XRD), along with Scanning and Transmission Electron Microscopy (SEM and TEM) for detailed chemical composition and symmetry studies through electron diffraction. There will also be extensive use of Neutron and Synchrotron radiation facilities (ILL and ESRF @ Grenoble, Diamond and ISIS @ Abingdon, ALBA @ Barcelona) for a deeper knowledge of the crystal and magnetic structures of the materials. The PhD candidate will also develop significant expertise in measuring physical properties using a PPMS. The candidate will also enhance his/her scientific communication skills through the preparation and presentation of results in scientific journals and at international conferences.

Keywords: Crystallography, Magnetocaloric Materials, High-Pressure Synthesis.

Starting: October 2024 (3 years).

Funding: The funding is through the LOW-MACER M.ERA-NET European project. In collaboration with UCM (Madrid) and U. Leipzig (Germany).

Application: We are looking for a highly motivated candidate with a degree in physics, chemistry or materials science. The candidate must hold an MSc degree in an affine field and meet the requirements to be enrolled in the Doctoral School of the University of Lille.

Email to Angel Arevalo-Lopez (angel.arevalo-lopez@univ-lille.fr) and Olivier Mentré (olivier.mentre@univ-lille.fr) with the subject "Thesis-LowMACER-2024-your name". Attach a CV, a brief motivation letter and the contact person for a reference.