PhD Subject : Low-dimensional MagnetoCalorics

for Efficient Refrigeration (Low-MACER).

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Context: The Magneto-Caloric Effect (MCE) is a notable physical 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. 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.

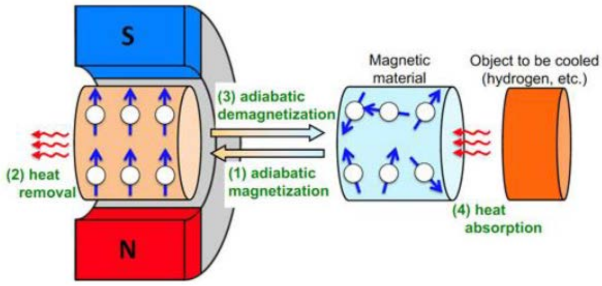

Fig. 1. Operation principle of magnetic refrigeration.

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. They will be characterized using powder X-ray diffraction (XRD), Scanning and Transmission Electron Microscopy (SEM and TEM). The PhD candidate will also perform 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. Physical properties will be determined from bulk magnetization from SQUID and PPMS data, granting the candidate with significant expertise in understanding complex magnetic behaviours. 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: May 2025.

Funding: Full time dedication will be funded through the LOW-MACER (PCI2024-153416) project in the context of the M.ERA-NET European call. In collaboration with CNRS (France) and University of Leipzig (Germany).

Application: CV and motivation letter to Elena Solana Madruga (elsolana@ucm.es) by Friday 7th March.