20 March 2026

PhD contract offer

Subject: Synthesis and physical properties of a new family of double kagome material

General information

Workplace: Nancy, France
Type of contract: PhD contract
Contract period: 36 months
Expected date of employment: October 2026
Proportion of work: Full time
Remuneration: 2.300€ gross monthly
Desired level of education: Master's degree in chemistry or material science.
Experience required: -

Missions / Activities

In condensed matter physics, quantum materials gather all materials whose essential properties cannot be described in terms of semiclassical particles and basic quantum mechanics. At the microscopic level, four fundamental degrees of freedom intertwine (charge, spin, orbital and lattice), resulting in complex electronic states. Currently, the interplay between geometry, topology, and correlation is emerging as a promising avenue for exploring new quantum materials. The latter will probably show crucial features for developing the next-generation quantum technologies that will meet the urgent technological demands for achieving a sustainable and safe society. From material science point of view, the rise of quantum materials is a direct result of crystal growers effectively navigating toward materials that enable the study of these phenomena. Perfection in materials synthesis has been important for discovering exciting physics in this domain, but disorder has also often unexpectedly played a key role. As crystal growers keep advancing the state of their art, interesting new physics will undoubtedly be discovered.
Among quantum materials, the transition-metal-based kagome magnets have been found to be a fertile ground for the search of exotic quantum states. With its two-dimensional network of corner-sharing triangles, the kagome lattice was first extensively studied for its potential to host magnetic frustration and (quantum) spin liquids. Then, it was noted that the peculiar electronic band structure of kagome metals presented characteristics of both electronic correlations as well as non-trivial topology. It gives rise to various phenomena including Weyl states, Dirac points, flat bands, van Hove singularities while large anomalous intrinsic Hall effects have been observed in most of these materials. In addition to a large and fascinating variety of topological and/or quantum states reported in Kagome metals, the capability to switch topological transport properties (intrinsic anomalous Hall effect), by controlling the direction of the spins in Kagome magnets, could be of technological interest.
In this context, the thesis focuses on a new double-kagome magnet, $Zr_3Mn_3Sn_4Ga$, recently discovered by our group. It crystallizes in a hexagonal structure ($P6_3/mmc$), deriving from the Ti_6Sn_5-type structure, featuring two distinct kagome layers: a non-magnetic breathing Zr_3Sn_4 layer (at z = 0.25 and 0.75) and a magnetic intact Mn_3Ga layer (at z = 0 and 0.5). In this compound, the Mn sublattice orders antiferromagnetically at T_N = 87 K. Meanwhile, an isostructural phase based on non-magnetic elements has been reported, pointing out the potential chemical adaptability of this structure. This system must support numerous substitutions on the Mn-site, the Zr-site or even on the metalloid sites (Sn, Ga), which should allow one to obtain tunable magnetic and electronic structures. The co-existence of magnetic and non-magnetic kagome layers makes these materials a promising platform to exploit the interplay between magnetism and topological electronic states.
The thesis student will grow high quality single crystals using flux method. He/she will further characterize the sample using X-ray/neutron diffraction techniques, magnetization measurements and thermodynamic measurements. He/she will measure the longitudinal and transverse electronic transport properties to get access the anomalous intrinsic Hall effect highlighting topological matter. The thesis student will try to control topological properties (if any) as a function of the temperature or magnetic field dependence of the easy magnetization direction. Meanwhile, the chemical composition

will be used as a control parameter to tailor the physical properties, by modifying the system dimension and/or the valence electron concentration. In our group, the thesis student will benefit from a longstanding expertise in the synthesis and structural/magnetic characterization of kagome materials. Through established collaborations with other IJL groups, the thesis student will get access to electron transport properties and electronic spectroscopy. In addition to in-house measurements, complementary studies will involve large scale facilities, such as neutron sources and synchrotron.
The thesis deals with a hot topic at the forefront of modern condensed matter physics and material chemistry. The original results that will be obtained may help to understand and tailor other kagome materials with exotic quantum properties that has not been explored to date.

References

B. Keimer & J.Moore, Nat. Phys. 2017, 13, 1045–1055
D. Sante et al., arXiv :2511.12731
T. Clausse et al., Acta Cryst B 2022, 78, 817-822
B. Ortiz et al., J. Am. Chem. Soc. 2025, 147, 5279−5292

Keywords:
synthesis, kagomé, intermetallics, magnetism.

Work context

The PhD student will work under the supervision of Yvan Sidis and Thomas Mazet within the Intermetallic Compounds research group whose topics focus on the synthesis, crystal-chemistry and physical properties of intermetallic compounds.

Skills

Knowledge of Solid State Chemistry, including synthesis, crystal-chemistry and magnetism is essential. Knowledge of French (oral and written) is important and knowledge of English would be an advantage. As an enthusiastic researcher you like team work, and have a flexible approach to collaborating between different laboratories.

Constraints and risks

The position you are applying for is located in a sector relating to the protection of scientific and technical potential. It therefore requires, in accordance with the regulations, that your arrival be authorized by the competent authority of the Ministry of Higher Education, Research and Innovation.

About Institut Jean Lamour

The Institute Jean Lamour (IJL) is a joint research unit of CNRS and Université de Lorraine.
Focused on materials and processes science and engineering, it covers: materials, metallurgy, plasmas, surfaces, nanomaterials and electronics.
By 2026, IJL has 258 permanent staff (33 researchers, 133 teacher-researchers, 92 IT-BIATSS) and 389 non-permanent staff (146 doctoral students, 43 post-doctoral students / contractual researchers and more than 200 trainees), from some seventy different nationalities.
Partnerships exist with 150 companies and our research groups collaborate with more than XX countries throughout the world.
Its exceptional instrumental platforms are spread over 4 sites ; the main one is located on Artem campus in Nancy.

Application

Applicants are invited to send a CV and cover letter together with diploma copies to:
Yvan Sidis (CNRS Researcher): yvan.sidis@univ-lorraine.fr
Thomas Mazet (Professor at Lorraine U.): thomas.mazet@univ-lorraine.fr