PhD position (3 years) – AI-assisted discovery of skyrmion materials for next-generation spintronics

Joint supervision: IJL (Nancy, France) and TOM group, University of Liège (Belgium)

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Scientific context

Skyrmions are nanoscale chiral magnetic textures with strong potential for information technologies such as logic-in-memory and other beyond-CMOS concepts. A central challenge is to identify ultrathin multilayer stacks that reliably host skyrmions with target properties (size, stability, mobility, dynamical response) and to enable low-power control. This PhD project contributes to a consortium effort to accelerate the discovery and optimization of skyrmion-hosting materials by combining high-throughput thin-film experiments with predictive Artificial Intelligence.

PhD project (Liège-based, strong IJL interaction)

The PhD candidate will be hosted by the Topological Orders in Matter (TOM) group at the University of Liège or/and by the Institut Jean Lamour (IJL). The candidate will work in close collaboration between these partners and actively collaborate with other partners involved in thin-film growth, imaging, and characterization. The core of the project is to develop and validate an end-to-end AI workflow that links experimental observables to materials/process parameters, and that can propose new candidate stacks to guide subsequent experiments.

Main objectives:

- Develop a predictive Machine Learning (ML) workflow connecting experimental observables (e.g., skyrmion density/size/stability under field, strain or acoustic excitation) to materials and process parameters (composition, thickness gradients, interfaces, substrates).
- Implement data-driven strategies to propose new candidate stacks and guide experimental exploration (active learning or Bayesian optimization are welcome).
- Interface ML outputs with physics-based modelling (e.g., micromagnetics/spin dynamics and/or descriptor-based approaches) to ensure physical consistency and interpretability.

Typical tasks:

- Data engineering: harmonize, curate, and quality-control multi-source datasets with consistent metadata and uncertainty estimates.

- Model development: build regression/classification models with uncertainty quantification; emphasize interpretability to extract design rules.
- Closed-loop discovery: propose “next experiments” for growth/characterization partners and evaluate predictions against new measurements.
- Dissemination: publish results in peer-reviewed journals and present at international conferences.

Environment & collaboration

- Host lab: TOM group, University of Liège (ULiège), within an active condensed-matter and magnetism ecosystem.
- Key partner: IJL (CNRS / Université de Lorraine) with expertise in thin-film growth and advanced magnetic characterization.
- Computing: access to local and institutional CPU resources; GPU resources may be used depending on the modelling needs.

Candidate profile

Applicants should hold a Master’s degree (or equivalent) in physics, materials science, computer science, applied mathematics, or a related field.

Required:

- Strong programming skills (Python, FORTRAN or C) and hands-on experience with ML libraries (e.g., PyTorch, TensorFlow, scikit-learn).
- Solid analytical skills and interest in interdisciplinary research connecting experiments, modelling and data science.
- Good written and spoken English.

Highly appreciated:

- Background in magnetism/spintronics (skyrmions, thin films, DMI, anisotropy, micromagnetics).
- Experience with uncertainty quantification, Bayesian methods, active learning, or scientific ML.
- Familiarity with materials modelling or simulation workflows and handling large experimental datasets.

We offer

- A 3-year funded PhD position at the interface of spintronics, materials science and AI in an international collaboration.
- Training opportunities in scientific ML and advanced magnetism, plus support for conference travel and partner visits.

How to apply

Please prepare the following documents:

1. Curriculum vitae (including projects and software/ML experience).
2. Motivation letter describing your interests in AI and skyrmion materials discovery.
3. Academic transcript(s).
4. Contact details of two referees (or recommendation letters, if available).
5. Optional: link to code repositories or a short portfolio.

Applications will be reviewed on a rolling basis until the position is filled.