INTERNSHIP PROPOSAL

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Funding: YES
Thesis possibility: YES

Detecting new particles in quantum materials

Project

Quantum computation stands to revolutionize many aspects of society, but the hype might surpass the performance. A central challenge is that materials used at present to build quantum computers do not offer a clear path to scalability. Therefore, a quantum materials revolution is needed to realize the promise of quantum computing. Quantum spin liquids are an exciting family of quantum materials with topological properties that offer novel solutions to quantum computing. In such materials, emergent particles and exotic phenomena arise from the interactions between huge numbers of electrons.

This project will address how to *detect novel particles in these new states of matter*. Topological quasiparticles such as Majorana fermions are predicted to emerge from quantum spin liquid states [1, 2]. However, such particles don't carry an electric charge, so standard measurements do not easily detect them. But they carry entropy and should be detectable by thermal transport experiments such as the "thermal Hall effect" [3, 4]. This effect represents the deflection of heat in a magnetic field and is thought to be a direct manifestation of these novel states of quantum matter.

To detect these particles in quantum materials, the aim of the project (which could later be pursued as a PhD project) will be to investigate materials capable of hosting new states of matter, such as quantum spin liquids, using thermal Hall effect experiments under extreme magnetic field and temperature conditions. The project will also focus on developing a unique new approach for performing thermal experiments using nanofabrication processes that will be carried out in a clean room – a major milestone that will open the door to many future perspectives in the field of quantum materials.

Your profile

- Good knowledge of condensed matter physics
- Taste for experimental and theoretical physics
- Curiosity for the development of new experimental tools

References

[1] Kasahara *et al.*, Nature **559**, 227 (2018).
[2] Yokoi *et al.*, Science **373**, 568 (2021)
[3] Grissonnanche *et al.*, Nature **571**, 376 (2019)
[4] Grissonnanche *et al.*, Nature Physics **16**, 1108 (2020)

Condensed Matter Physics: YES	Soft Matter and Biological Physics: NO
Quantum Physics: YES	Theoretical Physics: NO