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Hunting for the Majorana fermion in magnet/superconductor heterostructures

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The Majorana fermion, initially theoricized in high-energy physics, has the particularity of being its own antiparticle. In 2001, Kitaev [1] proposed that Majoranas could be realized as low energy excitation in something called a *topological superconductor* triggering a huge number of theoretical and experimental studies, especially due to interesting possibilities in quantum computing. Eventhough major advances have been realized on the experimental side, the Majorana has not been unambiguously identified so far.

My theoretical work aims at studying novel platforms based on magnets and superconductors brought in close proximity to one another. More specifically, I have been looking in details at the properties of the induced superconductivity close to a magnetic skyrmion [2, 3], a nanoscale magnetic texture that is now routinely created and manipulated.

In this talk, I will introduce the basics of superconductivity and topology needed to understand the nature of the Majorana fermion and why it is searched for so intensively. I will then explain why the skyrmion/superconductor setup (and more generally magnet/superconductor heterostructures) is theoretically interesting to remedy some problems currently encountered while emphasizing the experimental relevance of such setups.

[1] A. Y. Kitaev, Unpaired Majorana fermions in quantum wires, *Fiz. Usp.* **44**, 2001.
[2] M. Garnier, A. Mesaros & P. Simon, Topological superconductivity with deformable magnetic skyrmions, *Communications Physics* **2**, 126, 2019.
[3] M. Garnier, A. Mesaros & P. Simon, Topological superconductivity with orbital effects in magnetic skyrmion based heterostructures, arXiv:1909.12671, 2019.

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