Master 2: Physics of Complex Systems

INTERNSHIP PROPOSAL

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Research area:
Theoretical condensed-matter and cold-atom physics

Title: Searching for topological physics in dissipative Ytterbium gases

Dissipation is ubiquitous in experiments on quantum matter and it typically reduces the time-scales over which pristine quantum phenomena can be investigated or lowers the quality of the measurements. It's an "enemy" that has to be fought harshly and roughly. In this internship we will change the paradigm and consider dissipation as a resource. Dissipation can induce genuine and interesting quantum effects (see for instance Ref. 1) and we are interesting in proposing realistic experiments that can reveal them.

We will focus on the experiments on ultracold ytterbium gases that are currently realized in several laboratories around the world, among which those at Collège de France in Paris (see Ref. 2). The goal of this internship is to characterize theoretically the interplay between (i) the dissipative mechanisms that distinguish these atoms and (ii) the unavoidable presence of atom-atom interactions (Ref. 3 presents some first data obtained in Hamburg, Germany). We will inspect whether the dissipation-induced topological properties presented in the model of reference 4, where interactions are neglected, can be observed in Ytterbium gases, where interactions cannot be neglected. The main investigation tool will be advanced numerical algorithms based on matrix-product states, that allow for the study of dissipative many-body systems (see Ref. 5 for an article where such methods have been used to characterize dissipative topological models).

References:

1. F. Verstraete, M. W. Wolf and J. I. Cirac, Nature Physics **5**, 633 (2009).
2. R Bouganne *et al.*, *New J. Phys.* **19,** 113006 (2017).
3. K. Sponselee et al., arXiv:1805.11853 (2018).
4. M. S. Rudner and L. S. Levitov, Phys. Rev. Lett. **102**, 065703 (2009).
5. F. Iemini, D. Rossini, R. Fazio, S. Diehl and L. Mazza, Phys. Rev. B **93**, 115113 (2016)