Master 2: *International Centre for Fundamental Physics*

INTERNSHIP PROPOSAL

Laboratory name: **LPTMS (Paris-Saclay, Orsay)**
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Internship location: **LPTMS, bât 530, campus d'Orsay, Université Paris Saclay**
Thesis possibility after internship: **YES**
Funding: **NO**
If YES, which type of funding: **Application to several scholarship agencies**

The quantum Zeno effect in a dissipative SU(N) atomic gas

The quantum Zeno effect is one of the most remarkable quantum effects associated to open quantum system. In its standard formulation, it states that the continuous measurement of an unstable quantum system prolongs its lifetime. Moreover, a careful analysis shows that this enhanced lifetime can also be the consequence of a strong coupling to an environment, which acts as an unread measurement apparatus.
In this internship, that can become a Ph.D. thesis, we will consider what happens when a quantum simulator interacts with an environment, so strongly that the Zeno regime sets in. We will specifically consider the case of ultra-cold gases, and more in particular the case of atomic gases with an SU(N) nuclear spin (such as fermionic ytterbium or strontium). Here dissipation can be represented by atomic losses from the gas, or simply by heating and dephasing; in all cases, it can be controlled from outside and tuned to the Zeno regime at will. [1, 2]
The interplay of the quantum Zeno effect with the unconventional spin symmetry of these gases is a promising way for creating in a dissipative fashion entangled states or topological states, here we want to further investigate this [3,4]. Experiments on this subject are being developed allover the world [5] but also in the Parisian area, and interactions with experimentalists is possible.

References:
[1] N. Syassen et al. Strong dissipation inhibits losses and induces correlations in cold molecular gases, Science 320, 1329 (2008).
[2] D. Rossini, L. Mazza et al. Strong correlations in lossy one-dimensional quantum gases: From the quantum Zeno effect to the generalized Gibbs ensemble, Phys. Rev. A 103, L1060201 (2021)
[3] M. Foss-Feig et al, Steady-state many-body entanglement of hot reactive fermions, Phys. Rev. Lett. 109, 230501 (2012)
[4] L. Rosso, L. Mazza and A. Biella, Eightfold way to dark states in SU(3) cold gases with two-body losses, Phys. Rev. A 105, L051302 (2022)
[5] K. Honda et al. Observation of the sign reversal of the magnetic correlation in a driven-dissipative Fermi-Hubbard system, arXiv:2205.13162 (2022)

Please, indicate which speciality(ies) seem(s) to be more adapted to the subject:

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