LABORATOIRE DE PHYSIQUE ET
MODELISATION DES MILIEUX CONDENSES –UMR 5493

PhD proposal

Topic: **Measurement and control of the Hamiltonians of quantum computers.**

Group: Laboratoire de Physique et Modélisation des Milieux Condensés (LPMMC), Grenoble

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Summary

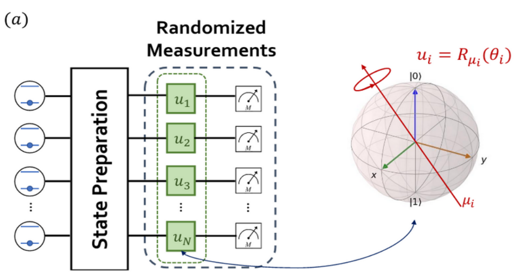
A central aspect for the future of quantum simulation and computation is the development of experimental tools to probe a new generation of many-body quantum states, *which could not be realized so far*. While standard measurement techniques give typically access to low-order correlation functions, accessing experimentally true quantum features, such as entanglement, was considered for many years as an outstanding challenge for quantum technologies. Recently, we have developed and demonstrated protocols known as *randomized measurements* (RM) [1], that have the potential to address this challenge.

Quantum computers are usually used in terms of quantum circuits that are made of single and two qubit gates. The underlying physical processes are described by time-dependent Hamiltonians acting on one/two qubits [2]. The goal of the PhD is to study the possibility to characterize these Hamiltonians.

The first part of the PhD consists in characterizing such Hamiltonians, and also to explore the possibility to generate Hamiltonians that act on a larger number of qubits. This is of interest both for quantum computing applications (multi qubit gates), and quantum simulation (understanding condensed matter problems described by many-body Hamiltonians).

We will perform the experimental part of the work on IBM quantum computers. In order to create the relevant experimental data, we will use the Qiskit library Pulse. This allows one to drive the qubits of IBM quantum computers, and make them interact in order to generate a tunable Hamiltonian. We will then use the measurement toolbox to measure this Hamiltonian, as well as the effects of decoherence. In a second step of the PhD, we will build on these results to propose methods to engineer with high fidelity specific Hamiltonians for quantum computing and/or quantum simulation.

Our results will be of interest for our experimental colleagues, in particular our collaborators in Grenoble and in Paris.



References

[1] https://www.nature.com/articles/s42254-022-00535-2

[2] https://journals.aps.org/prxquantum/pdf/10.1103/PRXQuantum.2.040336