Quantum Simulation of Many-body Dynamics and Entanglement

In the framework of the French Hybrid Quantum Initiative (HQI), first generation noisy intermediate-scale quantum (NISQ) simulators will be made accessible to a consortium of French research institutions (CNRS - CEA - Université Paris Saclay) and private actors (Eviden).

The aim of this 2 years post-doctoral position will be to contribute to this Quantum Initiative in collaboration with Michele Filippone (CEA Grenoble) and Nicolas Laflorencie (CNRS LPT Toulouse). The post-doc will devise novel theoretical concepts and methods to characterize the dynamics of quantum many-body systems. These ideas will be directly implemented and tested on the Pasqal quantum simulator handling Rydberg atoms. Special effort will be dedicated to:

- **Simulating and characterizing the evolution of correlated quantum systems** and in particular assessing under which conditions a controlled quantum simulation can achieve quantum advantage by outperforming state-of-the-art classical algorithms (Exact diagonalization, DMRG, ...). Case studies will address the evolution of initial product states after the quench of interacting and disordered Hamiltonians, a possible aim being to address the many-body localization (MBL) regime.
- **Quantum simulation of entanglement transitions.** Systems subject to a combination of unitary dynamics and measurement are known to exhibit an entanglement transition as a function of the measurement strength or frequency. We will choose a system that is favourable for simulation on available quantum hardware, locate the entanglement transition in the simulated system, and investigate its properties. This task focuses on simulating properties pertaining to an interplay of unitary and non-unitary (measurement-induced) dynamics.

The postdoctoral researcher will divide his/her time between two well-connected sites in France: CNRS Toulouse and CEA Grenoble. This arrangement offers significant advantages and fosters a stimulating collaboration between these 2 institutions, as described below.

CEA Grenoble— The lab is located on a big scientific campus gathering not only CEA, but also other major scientific institutions such as CNRS (Institut Néel), ERSF (synchrotron), ILL (neutron source) and many high-tech companies as well as the University Grenoble Alpes. Grenoble is a vibrant city offering many cultural activities, lovely bars and delicious restaurants. Located in the heart of the Alps, Grenoble is the paradise for all outdoor enthusiasts.

LPT Toulouse— The LPT is a CNRS unit, internationally recognized for its theoretical work in condensed matter physics, quantum information and statistical physics. It offers a very stimulating scientific environment, with 25 faculties and as many students and post-docs from all over the world. LPT belongs to the larger institute FeRMI which brings together 6 physics labs in Toulouse, covering a broad spectrum from nanoscience to cold atoms and high magnetic fields. Toulouse hosts prestigious engineering schools, contributing to its status as France's fourth largest student city, boasting a student population of nearly 140000, making Toulouse one of the most vibrant and lively city in France.

How to apply— Please send a curriculum vitae (including names of potential referees), a list of publications and a short statement of your research interests and how they relate to the project to Michele Filippone (michele.filippone@cea.fr) and Nicolas Laflorencie (nicolas.laflorencie@cnrs.fr).