Resource estimation of quantum algorithm for strongly correlated materials

Context: Alice & Bob is pursuing the development of a quantum computer utilizing cat qubits, with the goal of achieving a 100-logical-qubit system by the end of the decade. Hamiltonian simulation is regarded as the earliest and most fundamental application of quantum computing. Such a machine will be capable of simulating quantum systems that are particularly difficult to model on classical computers, such as strongly correlated systems.

Project Summary

In this internship, the student will design and implement a quantum algorithm for simulating strongly correlated materials on a fault-tolerant quantum computer. Strongly correlated quantum systems are widely regarded as one of the most promising candidates for the early practical applications of fault-tolerant quantum computing, due to their complexity and relevance to condensed matter physics and material science.

The primary objective of the internship is to develop and test a quantum algorithm based on Quantum Singular Value Transformation [1], an advanced technique particularly well-suited for reducing circuit depth in Hamiltonian simulations. The student will explore how QSVT can be applied to efficiently compute the Green's function of the Anderson impurity model, a fundamental problem at the heart of strongly correlated electron systems.

Where

This internship will be done at Alice & Bob, 49 Bd du Général Martial Valin, 75015 Paris. The intership will be in close collaboration with Thomas Ayral (CPHT, Ecole Polytechnique) and Michel Ferrero (CPHT, Ecole Polytechnique)

[1] G.H Low and I.L Chuang, Hamiltonian Simulation by Qubitization, Quantum **3**, 163 (2019).