Quantum advantage in computation with current technology

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Background

Perfect quantum computers would be able to carry out certain tasks beyond the means of any classical computer, but what is the resource for that quantum advantage remains as a fundamental question yet to be answered.

We have reached the time in which current and near-future technology provide Noisy Intermediate-Scale Quantum (NISQ) computers [1], some of them available to the world, as the IBM 5-qubit processor. Nowadays, identifying the resources for speed-up in quantum algorithms is not only a fundamental theoretical problem, but also a key ingredient to create more powerful quantum technologies with state-of-the-art capabilities.

Master project

As a master student, you will join our group in Applied Quantum Physics, and acquire a general knowledge of quantum computation and superconducting circuits. At the MC2 department, you will have the possibility to interact with experimental groups building NISQ computers, which are part of the Wallenberg Center for Quantum Technology (WACQT).

The aim of the project is to determine what kind of interactions among qubits increases the efficiency of quantum computation protocols for hard optimization problems, and to provide hints about the hardware requirements in future available technology.

The work consists in analyzing performances of quantum algorithms with different interactions for relevant optimization problems in industry. Also, we will consider approximations of adiabatic quantum computation (AQC) [2] to create new protocols, and we will compare them with existing algorithms.

[1] J. Preskill, *Quantum Computing in the NISQ era and beyond*, Quantum **2,** 79 (2018).

[2] T. Albash and D. A. Lidar, *Adiabatic quantum computation*, Rev. Mod. Phys. **90,** 015002 (2018).