POS-A14

PD en Ciencia y Tecnología Cuántica

DIGITAL QUANTUM SIMULATIONS WITH SUPERCONDUCTING CIRCUITS

U. Las Heras (1), L. García-Álvarez(1), M. Sanz (1), L. Lamata (1), E. Solano (1,2)

(1) Department of Physical Chemistry, University of the Basque Country UPV/EHU, Apartado 644, 48080 Bilbao, Spain (2) IKERBASQUE, Basque Foundation for Science, Maria Diaz de Haro 3, 48013 Bilbao, Spain

Superconducting circuits are a promising quantum technology for the implementation of quantum information protocols. In particular, digital quantum simulations are an efficient method for reproducing quantum dynamics that are not produced naturally in controllable quantum platforms. In this way, complex quantum system dynamics can be reproduced and measured in circuit quantum electrodynamics (cQED) architectures . We propose a method for simulating efficiently the dynamics of prototypical spin and fermionic models in superconducting circuit architectures. For this purpose, the information is processed in quantum bits (qubits), which are the minimum unitof information. In superconducting circuits, qubits are made of circuits which at low temperatures can behave as a two-level quantum system. Either coupling the superconducting qubits with pairwise interactions, or making use of resonators that act as quantum buses, interesting problems can be reproduced. We show how to implement Ising and Heisenberg spin models considering transverse magnetic fields, and the Fermi-Hubbard model, which addresses the behavior of elementary particles as the electron. In order to perform fermionic interactions in our system, it is necessary to make use of the Jordan-Wigner mapping, which allow us to map local fermionic interactions onto many-body spin interactions, and Mølmer-Sørensen gates, that allow us to implement many body gates in our superconducting setup. Furthermore, we propose digitized adiabatic quantum computing protocols for spin Hamiltonians where the generality of the adiabatic algorithm and the universality of the digital approach are combined. In this sense, too complex optimization problems for classical computers can be solved by digital quantum simulators. Finally, we consider genetic algorithms inspired in biological systems, for the minimization of both experimental and digital errors in the simulations.