Hybrid Algorithms for Quantum Simulations

Referente:
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PROGETTO

Quantum Simulations approaches tackle the central question of constructing nontrivial ground states of quantum many-body systems.

The focus of the project will be on *hybrid-algorithms* that exploit quantum resources to perform the computationally hard part of a problem and rely on classical numerical techniques to variationally find the optimal solution. Emphasis will be on Variational Quantum Algorithms, more specifically the Quantum Approximate Optimization Algorithm. This protocol can be tested in a variety of systems that exhibit interesting phase diagrams and that can be used as a benchmark for the application of already existing or newly proposed techniques, such as: paradigmatic classical disordered models that are widely used in statistical and information theory; Hamiltonians with long-range interactions that allow, e.g., topological phases; toy models with gauge symmetries with applications in condensed matter and high energy physics.

The ideal candidate should have research experience in Quantum Many Body Theory and Quantum Simulation/Computation. In addition knowledge of one or more of the following topics will be considered: classical numerical approaches and algorithms for optimization and (quantum) machine learning, use of platforms such as IBM, Pasqal, D-Wave and knowledge of the corresponding SDK (such as Qiskit, Pulser and Ocean), programming in Python, use of software libraries such as Cirq, PennyLane, TensorFlow Quantum or similar.

PIANO ATTIVITA’

The project will take place within a collaboration of the Department of Physics and Astronomy of the University of Bologna, SISSA and University of Camerino, under the PRIN2022 project "Hybrid Algorithms for Quantum Simulators".

The researcher will work on:

- Benchmarks of variational algorithms against Ising-like models
- Application of variational algorithms to state preparation of interacting Hamiltonians
- Implementation of the developed algorithms on superconducting and neutral atom platforms