Proposta QS_HEP

Quantum Simulations for High-Energy and Nuclear Physics

Responsabile nazionale: Saverio Pascazio (BA)

Unità partecipanti e Responsabili locali:

- BARI: L. Cosmai
- BOLOGNA: E. Ercolessi
- LNGS: S. Pirro
- NAPOLI: F. Tafuri
- PADOVA: S. Montangero
- PISA: M. D'Elia
- ROMA1: L. Cardani
- TRENTO: G. Ferrari
- TRIESTE: A. Scardicchio

KEY GOAL: development of experimental platforms and theoretical expertise aimed at the quantum simulation of lattice gauge theories.

• Lattice QCD in one of the main targets of "classical" HPC since a few decades

INFN has played and is still playing a major role (development of APE machines, leading theoretical groups)

• Classical computation fails in some significant cases, e.g., in predicting the behavior of QCD at high baryon density (EoS for neutron stars)

Such problems are one of the main goals of **Quantum Computation** the final target is likely far away, but it is time for expertise formation and technological development The core of the project are the technological platforms, with strong interactions with theoretical/algorithmic development

WP1 Superconducting Qubits and interface with SFQ control (170 person*months)

WP2 Alkali-earth Rydberg qubits (158 person*months)

WP3 Quantum Simulations of Lattice Gauge Theories (182 person*months)

Total budget of the project: 990Keuro Pisa mostly involved in WP3 (50 person*months, 105Keuro)

Activity in PISA

Staff: M. D'Elia (PI), C. Bonati (PI), D. Rossini (PI), F.S. Schifano (FE) PhD: C. Bonanno, M. Cardinali, G. Clemente, L. Maio

- Theoretical activity is already ongoing within COM IV NPQCD
- Main questions:

How to compute quantum thermal averages with a Quantum Computer? What is the best way to implement gauge theories on a Quantum Computer? G. Clemente et al., Phys. Rev. D101, 074510 (2020)

• Main goal within this project:

consider such questions within the framework of real computing platforms

• Main needed resources in PISA:

computing facilities for simulations (GPUs), which are already available.