



PASQuanS - Programmable Atomic Large-Scale Quantum Simulation

PASQuanS will perform a decisive transformative step for quantum simulation towards programmable analogue simulators addressing questions in fundamental science, materials development, quantum chemistry and real-world problems of high importance in industry. PASQuanS builds on the impressive achievements of the most advanced quantum simulation platforms, based on atoms and ions. The neutral-atom simulators handle more than 50 cold atoms in optical lattices or arrays of optical tweezers, interacting via either collisional or Rydberg-state-mediated interactions. The ion-trap platform reaches unsurpassed control with up to 20 ions. By scaling up these platforms towards >1000 atoms/ions, by improving control methods and making these simulators fully programmable, PASQuanS will push these already well-advanced platforms far beyond both the state-of-the-art and the reach of classical computation. Full programmability will make it possible to address quantum annealing or optimization problems much sooner than digital quantum computation. PASQuanS will demonstrate a quantum advantage for non-trivial problems, paving the way towards practical and industrial applications. PASQuanS tightly unites five experimental groups with complementary methods to achieve the technological goals, connected with six theoretical teams focusing on certification, control techniques and applications of the programmable platforms, and five industrial partners in charge of the key developments of enabling technologies and possible commercial spin-offs of the project. PASQuanS will result in modular building blocks for a future generation of quantum simulators. Possible end-users of these simulators, major industrial actors, are tightly associated with the consortium. In a cross-fertilization process, they will be engaged in a dialogue on quantum simulation, and help to identify and implement key applications where quantum simulation provides a competitive advantage.

UNIPD Team Leader: Simone Montangero

Department: Department of Physics and Astronomy

Coordinator: Max-Planck-Gesellschaft zur Förderung der Wissenschaften e.V. (Germany)

Other Participants:

Institut d'optique théorique et appliquée IOTA - SupOptique (France)

Ruprecht-Karls-Universität Heidelberg (Germany)

Centre national de la recherche scientifique CNRS (France)

Österreichische Akademie der Wissenschaften (Austria)

Università degli Studi di Padova (Italy)

University of Strathclyde (United Kingdom)

Freie Universität Berlin (Germany)

My Cryo Firm (France)

Bull SAS (France)

Muquans (France)

Azur Light Systems (France)

TOPTICA Photonics AG (Germany)

Forschungszentrum Jülich GmbH (Germany)

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