Marie Curie Postdoc Fellowship

2026

1. Supervisor

Supervisor: Sebastiano Pilati – School of Science and Technology, Physics Division, Complex Quantum Matter group

https://cqm.unicam.it/sebastianopilati

My research focuses on computational methods for quantum many-body systems, ultracold atoms, adiabatic and gate-based quantum computers. I am actively involved in the development of novel quantum Monte Carlo algorithms and deep learning techniques for quantum many-body problems.

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5 publications (selected):

- L. Brodoloni, J. Vovrosh, S. Julià-Farré, A. Dauphin, S. Pilati, "*Spin-glass quantum phase transition in amorphous arrays of Rydberg atoms*", Physical Review A **112**, L051303 (2025).
- L. Brodoloni, S. Pilati, *"Zero-temperature Monte Carlo simulations of two-dimensional quantum spin glasses guided by neural network states*", Physical Review E **110**, 065305 (2024), Editors' Suggestion.
- G. Spada, S. Pilati, S. Giorgini, "*Quantum droplets in two-dimensional Bose mixtures at finite temperature*", Physical Review Letters **133**, 083401 (2024), Editors' Suggestion.
- S. Cantori, A. Mari, D. Vitali, S. Pilati, "*Synergy between noisy quantum computers and scalable classical deep learning*", EPJ Quantum Technology **11**, 45 (2024).
- G. Scriva, E. Costa, B. McNaughton, S. Pilati, "*Accelerating equilibrium spin-glass simulations using quantum annealers via generative deep learning*", SciPost Physics **15**, 018 (2023).

Recently funded projects/awards:

- Call of the National Centre for HPC, Big Data and Quantum Computing (ICSC), code CN00000013 (SPOKE 7 Materials & Molecular Sciences, CUP B93C22000620006), part of (PNRR) Missione 4, funded by NEXTGENERATIONEU. Project title: "*In silico engineering of novel material properties*", INNOVATOR.
- PRIN2022 project "*Hybrid Algorithms for Quantum Simulators*", code 2022H77XB7, 24 months.
- EuroHPC Regular Access Call, No. EHPC-REG-2024R02-140, titled "*Monte Carlo simulations of spin glasses for quantum-simulation experiments*", awarded with 72000 node hours on LUMI-C for 12 months, from 17-2-2025 to 16-2-2026.
- EuroHPC Development Access Call, No. EHPC-DEV-2024D09-073, titled "*Computing energy gaps via projection quantum Monte Carlo*", 4000 node hours on LUMI-C for a period of 6 months, 25-9-2024 to 31-3-2025.
- PRACE-ICEI project entitled "*Supervised learning of large quantum systems via scalable neural networks*", involving an allocation of 25000 node hours on the Galileo 100 supercomputer at CINECA. Started Sept. 2021.
- FAR2018 Unicam project entitled "*Supervised machine learning for quantum matter and computational docking*", 24 months.
- PRIN2017 project "CEnTraL", code 20172H2SC4, title "*Engineering coherent transport of atoms and electrons in layered structures*", 36 months.

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2. Research Group and Facilities

Laboratory & Facilities: The Complex Quantum matter group provides access to state-of-the-art computational resources, including HPC multicore servers equipped with GPUs, as well as access to national and European supercomputing facilities, such as the Leonardo cluster at CINECA (Italy) and the LUMI supercomputer (Finland). The CQM group also provides access to the experimental lab working on the transport properties of superconducting materials.

Research Network:

The research project of the MSCA postdoctoral fellow will be carried out within the Complex Quantum Matter (CQM) group of the Physics Division of the University of Camerino. The members of the CQM group are interested in the following research themes: Superconductors; Electron-hole superfluids; Ultracold atom matter; Complex systems and neural networks; Adiabatic and gate-based quantum computers.

The CQM group has strong national and international research collaborations, including the COMMIT group of the University of Antwerp, the Pitaevskii Center for Bose-Einstein Condensation (Trento, Italy), the University of Barcelona. Furthermore, members of the CQM group take part in the International Multisuper Network, and they perform research within the National Quantum Science and Technology Institute (NQSTI).

3. Research Thematic Area/Project Idea

Title of the project: Deep learning for complex quantum matter

Macroarea: Panel: Physics (PHY)

Keywords: Computational physics, deep learning, quantum simulation, and quantum enhanced optimization.

Project Overview:

The goal of this MSCA project is to integrate deep learning techniques with conventional computational techniques to boost computer simulations of complex quantum matter. The focus will be on models for quantum simulation platforms, including Rydberg atoms, trapped ions, ultracold atomic gases, and superconducting adiabatic and/or gate-based quantum computers. The long-term goal is to implement hybrid classical-quantum computational frameworks to tackle otherwise intractable computational problems relevant in condensed matter physics (e.g., spin glasses) and other disciplines, including finance (portfolio optimization) or drug design (molecular docking).

4. Candidate and Career Plan

Expected background of the candidate: The ideal candidate has a background on computational methods and in condensed matter physics. Expertise with the implementation of deep learning methods and with the use of high-performance computers is appreciated.

Competences and knowledge to be developed by the candidate: The candidate with develop advanced competences on how to integrate deep learning methods, stochastic classical computational algorithms, and quantum-simulation platforms (D-Wave quantum annealers, Rydberg-atom quantum simulators, superconducting gate-based quantum computers).