



ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

Project title: Variational Quantum Computing and Quantum Spin Glasses in Una Europa

Acronym: QUANTUMUnaE

Name and Department of the UNIBO scientific coordinator: De Palma Giacomo - Department of Mathematics

Project objectives

QUANTUMUnaE is an 18-month Una Europa seed project coordinated by UNIBO, bringing together three Una Europa partner universities: UCM, KUL and UoE.

The project builds a new interdisciplinary collaboration at the intersection of mathematics, physics and computer science, with a strong focus on quantum information, quantum algorithms and mathematical physics and with a clear benefit for PhD students and early-career researchers through joint training and structured mobility.

The project aims to establish a durable Una Europa research and training nucleus focused on:

- Quantum spin systems and quantum spin glasses as fundamental models for hard computational problems
- Variational Quantum Algorithms (VQAs) and their realistic prospects for delivering quantum advantage
- Computational complexity of preparing Gibbs (thermal) states on quantum computers
- Numerical linear algebra and data-representation primitives enabling scalable quantum circuits for near-term hardware

A key strategic objective of QUANTUMUnaE is to act as a proposal incubator, laying the groundwork for a competitive follow-up application to QuantERA or an MSCA Doctoral Network.

Activities

The partnership will implement a tightly connected programme of training, mobility and research exchange, including:

- A 20-hour PhD course on quantum spin systems, hosted at UNIBO and taught by UCM, with hybrid participation and reusable recorded materials
- A one-week international summer school on quantum computing, hosted at UNIBO, covering VQAs, quantum algorithms, Gibbs-state preparation and rigorous assessments of quantum advantage, with contributions from all partners
- Structured reciprocal PhD mobility among the four universities, with research stays and seminars at host institutions
- Regular online network meetings and research seminars to foster continuous exchange
- A final consolidation meeting to define a shared scientific roadmap and prepare a joint European proposal

Partner institutions

- University of Bologna (UNIBO) – Coordinator
- Complutense University of Madrid (UCM)
- KU Leuven (KUL)
- University of Edinburgh (UoE)

Expected impact

QUANTUMUnaE will strengthen Una Europa collaboration in quantum technologies and mathematical foundations, delivering high-visibility joint training events, reusable educational materials, and an operational mobility framework for early-career researchers. The project will consolidate an interdisciplinary consortium with a clear pathway towards large-scale European funding and long-term cooperation within the alliance.