

PhD course in Physics, Astrophysics, and Applied Physics - Università degli Studi di Milano
PhD cycle 41 (2025-2026)

All lectures will be given in English.

Course title	Quantum Coherent Phenomena
Teacher in charge of the course	Genoni Marco
List of the teachers of the course	Genoni Marco, UNIMI, marco.genoni@unimi.it Ferraro Alessandro, UNIMI, alessandro.ferraro@unimi.it Smirne Andrea, UNIMI, andrea.smirne@unimi.it Tamascelli Dario, UNIMI, dario.tamascelli@unimi.it
Training objectives	The course will approach several topics at the forefront of research in quantum information and quantum technologies. Particular attention will be devoted to i) introduction to quantum optics and generation of non-classical states with application to bosonic quantum computing; ii) Markovian and non-Markovian open quantum systems and their simulation via tensor networks methods; iii) quantum feedback control of open quantum systems with application to quantum optomechanics.
Prerequisites	Quantum mechanics.
Detailed course program	- Introduction to quantum optics: quantization, states, and operations. - Introduction to quantum computation over continuous-variable systems: circuit- and measurement-based approaches, bosonic codes, simulatability and non-universal models. - Introduction to the theory of open quantum systems: dynamical maps and master equations - Markovianity and non-Markovianity in classical and quantum systems. - Matrix Product State (MPS) representation of many-body quantum systems. - Tensor-network simulation of (open) quantum systems. - Introduction to continuously monitored quantum systems (derivation of stochastic master equations) - Quantum feedback-control protocols (Markovian vs “state-based” feedback / Markovian feedback master equation) - Introduction to quantum optomechanics - Quantum control protocols for quantum optomechanical systems (sideband cooling and generation of mechanical squeezed states)
Examination modalities	Seminar about one or more research papers relating to the topics covered in the course
Preliminary schedule	From May 2026 to July 2026 Course enrolment deadline: December 27, 2025.