**PhD course in Physics, Astrophysics, and Applied Physics - Università degli Studi di Milano**
**PhD cicle 40 (2024-2025)**

**All lectures will be given in English.**

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| **Course title** | Quantum Coherent Phenomena |
| **Teacher in charge of the course** | Genoni Marco |
| **List of the teachers of the course** *[surname/name; affiliation; e-mail]* | Genoni Marco, UNIMI, marco.genoni@unimi.it<br>Ferraro Alessandro, UNIMI, alessandro.ferraro@unimi.it<br>Smirne Andrea, UNIMI, andrea.smirne@unimi.it<br>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** *[please insert details and also **state whether the course has advanced contents** suitable for students with prior knowledge of the topics or is also suitable for students without prior knowledge]* | Quantum mechanics. |
| **Detailed course program** | - Introduction to quantum optics: quantization, states, and operations.<br>- Introduction to quantum computation over continuous-variable systems: circuit- and measurement-based approaches, bosonic codes, simulatability and non-universal models.<br><br>- Introduction to the theory of open quantum systems: dynamical maps and master equations<br>- Markovianity and non-Markovianity in classical and quantum systems.<br>- Matrix Product State (MPS) representation of many-body quantum systems.<br>- Tensor-network simulation of (open) quantum systems.<br><br>- Introduction to continuously monitored quantum systems (derivation of stochastic master equations)<br>- Quantum feedback-control protocols (Markovian vs “state-based” feedback / Markovian feedback master equation)<br>- Introduction to quantum optomechanics<br>- 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** *[please indicate the weeks when the lectures will be given]* | From May 2025 to July 2025 |