

# École Doctorale de Physique et Chimie-Physique 2020-2021

## Quantum simulation and quantum computing with atomic qubits

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Quantum simulation and quantum computing represent revolutionary ways to process information and to learn about our world. The basic idea is to prepare a set of quantum objects (e.g., atoms, ions, electrons, photons) in a well defined quantum state and to transform this state by making them interact in controlled ways, thereby overcoming the intrinsic limitations of classical devices when it comes to representing quantum states and their evolution. While this technology is still in its early days, quantum simulators and quantum computers are set to become indispensable tools for high-performance scientific computing and hybrid quantum-classical computing for many-body physics, quantum chemistry, material science, mathematics, optimization, machine learning, and presumably other, yet undiscovered applications. These systems are now approaching a landmark point where quantum computations with hundreds or thousands of qubits and low error rates will soon become possible, opening up new ways to solve important outstanding problems beyond the reach of even the most powerful classical supercomputers. In this lecture series I introduce the principles of quantum simulation and quantum computing, focusing on cutting edge implementations with real physical devices - particularly arrays of optically trapped atoms which have recently emerged as one of the most promising physical platforms.

Topics of the course include how to realize high fidelity quantum logic operations, how to engineer many-body Hamiltonians for quantum simulation, an overview of the current status in the field and a look forward toward near term applications and computing schemes that will be particularly suited to the next generation of intermediate scale quantum computers.

4 online lectures, including problem solving sessions (3h each)

The dates of the course are as follows:

- 18/01/2021
- 19/01/2021
- 25/01/2021
- 26/01/2021

always from 3pm to 6pm.