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Ion traps and cold atoms for quantum computers

IGNACIO CIRAC¹, Max-Planck Institute for Quantum Optics

Atoms can be used to store and manipulate quantum information. In particular, their internal state can be considered to form a register, and they can also be manipulated using laser light. In the case of trapped ions, the Coulomb force gives the required interaction to perform two-qubit gates. For neutral atoms, cold collisions can be used for that purpose. During the last years there has been an extraordinary experimental progress with those systems, and it is now possible to perform simple quantum information tasks with them. In this talk I will review several proposals for implementing quantum computers and quantum simulators using trapped ions and neutral atoms in optical lattices, and I will report on the latest experimental advances. Then, I will consider two particular aspects of those systems: (i) the possibility of simulating spin and bosonic systems with trapped ions; (ii) the possibility of performing quantum computations with neutral atoms without addressing them and in the presence of defects.

¹Other authors (with same affiliation): Diego Porras, Karl Vollbrecht, and Enrique Solano