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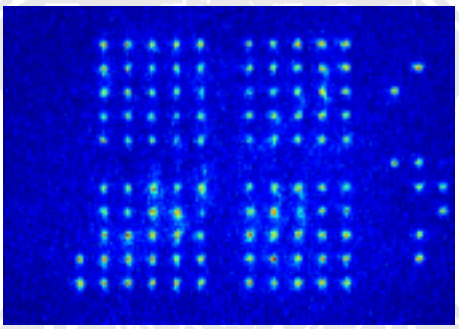

QUANTUM PHYSICS WITH ULTRA-COLD ATOMS: FROM ATOMTRONICS TO QUANTUM SIMULATION

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Research on ultra-cold atomic systems has developed an important role in the investigation of fundamental quantum principles but also towards quantum technological applications. Two important fields of research can be identified in the study of quantum degenerate gases, such as Bose-Einstein condensates, as well as in quantum simulation and quantum information processing based on individual atoms.

In this presentation, recent developments in our work towards these objectives are presented: We generate samples of BECs and of single ultracold atoms and apply external potential structures created by optical fields for the manipulation of atomic matter waves and for the development of a scalable architecture for quantum computing and simulation with ultra-cold atoms.

I show the experimental investigation of Bose-Einstein condensates in external guiding potentials, such as atomtronic devices based on the application of conical refraction as a new technique for creation of toroidal potentials and review the experimental progress towards quantum information processing and quantum simulation using neutral atoms in two-dimensional (2D) arrays of optical microtraps as 2D registers of qubits.