Quantum computers offer the promise of very fast computation of certain types of computational problems. This includes problems such as factoring numbers, simulating quantum many-body problems, and database search. Here we describe what physical systems are being considered for building a quantum computer today, and our research about using Bose-Einstein condensates for the use in quantum information.

Recent advances in atom chip BEC technology has allowed for the coherent control of BECs between hyperfine states, which may be used as qubits states. Strong coupling between an optical cavity has also been achieved.

Our research focuses on using Bose-Einstein condensates (BECs) as a way of storing quantum information. Using two different types of bosons in the BEC it is possible to store and manipulate them such that quantum algorithms can be executed in the same way as standard qubits. We illustrate this by a simulation of Grover’s algorithm on BECs which shows the same quadratic speedup as standard qubits.

The qubit states here are not simple a two level system, but macroscopic collective states which have the form. Byrnes Phys. Rev A 85 040306(R) (2012)

Our approach for atomchip: Magnetic Traps within cavities QED

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