MAR08-2007-006746

Abstract for an Invited Paper
for the MAR08 Meeting of
the American Physical Society

Quantum Control with Ultracold Atoms[1]

IVAN DEUTSCH, University of New Mexico

Ultracold atoms have long been considered as a platform for quantum information processing. Of critical importance is the ability to coherently control both internal degrees of freedom such as spin and also interactions between atoms that depend on "external" motional degrees of freedom. In this talk I will review a variety of advances, including the ability to perform qudit operations such as state preparation and unitary gates, quantum-state reconstruction via continuous measurement, and cooling of atomic motion without decohering spin qubits. Two different platforms will be presented – alkali atoms transported in a lattice with microwave-induced spin-flips, and alkaline-earth atoms in which quantum information is stored in nuclear spins. Microwave-induced spin flips provide a robust mechanism for inducing cold collisions between atoms that can form the basis of a quantum logic gate. As an alternative, cold alkaline-earth atoms are attractive since the ground state is a closed shell, with zero electron angular momentum. The nuclear spin is thus decoupled from the system and can acts as robust decoherence-free qubit.

[1]NSF, ONR, DTO