

Joint Quantum Institute Seminar
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Physics 1201

**Quantum Information Processing with Nuclear
Spins and Quantum Statistics in Group-II Neutral
Atoms**

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Implementations of quantum information processors require coherent quantum logical gates that induce entangling operations between qubits. In most cases, the same physical effect that gives rise to coherent couplings in the logical basis states leads to decoherence between them. We propose a new scheme for quantum logic based on an “exchange blockade” arising solely from the symmetry of identical composite particles rather than from differential coupling strengths. We consider a hybrid approach based on NMR and ultracold collisions of trapped neutral group-II atoms, whereby the nuclear spins store quantum information and act a quantum switch for mediating interactions. In addition, the decoupling of nuclear and electronic interactions allows one to re-cool motional heating via laser cooling or sympathetic cooling in a BEC without erasing or decohering the qubit. We present numerical studies of all these phenomena.

UMD Host Luis Orozco