Abstract Submitted
for the DAMOP10 Meeting of
The American Physical Society

Pseudospin and spin-spin interactions in ultra-cold alkali DEBORAH SANTAMORE, Physics Department, Temple University, EDDY TIMMERMANS, Los Alamos National Laboratory — By Raman coupling two selected hyperfine states of alkali atoms in an external magnetic field cold atom experiments simulate magnetic-like spin 1/2 dynamics in a controlled quantum many-body environment. We describe the effective spin (or pseudospin) degrees of freedom in accordance with choosing one hyperfine state as "spin-up," the other as "spin-down." state We derive the corresponding short-ranged spin-spin interactions which are anisotropic and include the interaction of a particle pseudospin with an effective, short-ranged pseudospin independent internal pseudomagnetic field carried by the other particles. In the degenerate internal state approximation we find that a magnetically controlled Feshbach resonance can vary the ratio and relative sign of spin-independent to spin-dependent interactions. In contrast, the relative magnitudes of the spin-dependent interactions, such as anisotropy, are not affected by a Feshbach resonance. When including the indistinguishability of the interacting particles, we find that the effective interaction takes the form of short-range ising spin interactions. We discuss implications for experimental quantum magnetism simulations.

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Date submitted: 26 Jan 2010 Electronic form version 1.4