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Pseudospin and spin-spin interactions in ultra-cold alkali atoms
D.H. SANTAMORE, Dept. of Physics, Temple University, EDDY TIMMERMANS, CNLS, Los Alamos National Laboratory — Ultra-cold alkali atoms trapped in two distinct hyperfine states in an external magnetic field can mimic magnetic systems of spin-1/2 particles, therefore, the spin-dependent effective interaction can be described as a spin-spin interaction. We present the short-range, effective pseudospin-spin interaction potential that describes s-wave interactions of ultra-cold atoms that occupy a superposition of two hyperfine states in an external magnetic field. The interaction of spin1/2 bosons can be described as either a short-range Ising spin-spin coupling or an XY-coupling. Our work illustrates the advantage of the spin-spin interaction form by mapping the system of N spin-1/2 bosons confined by a tight trapping potential on that of N spin-1/2 spins coupled via an infinite range interaction. We also show the advantage of the spin-spin interaction description by deriving the many-spin Hamiltonian of N boson particles contained in a tightly confining trap. This system, a controllable quantum magnet, is a promising system to probe macroscopic quantum tunneling, realize spin squeezing and Heisenberg-limited interferometry.

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