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Spin liquid phases of large spin Mott insulating ultracold atoms

TODD C. RUTKOWSKI, Binghamton Univ, MICHAEL J. LAWLER, Binghamton Univ, Cornell Univ — Understanding exotic forms of magnetism, primarily those driven by large spin fluctuations such as the quantum spin liquid state, is a major goal of condensed matter physics. But, the relatively small number of viable candidate materials poses a difficulty. We believe this problem can be solved by Mott insulating ultracold atoms with large spin moments that interact via whole-atom exchange. The large spin fluctuations of this exchange could stabilize exotic physics similar to condensed matter systems, all in an extremely tunable environment. We have approached the problem by performing a mean field theory for spin-f bosons in an optical lattice which is exact in the large-f limit. This setting is similar to that of SU(N) magnetism proposed for alkali-earth atoms[1] but without the SU(N) symmetry. We find that states with long-range order, such as the spin nematic phase of f = 1 Na atoms[2], become highly entangled spin-liquid-like states for f = 3 Cr atoms. This is evidence that the magnetic phase diagram for Mott insulating atoms at larger spins generically contains exotic forms of magnetism.

[1]A. V. Gorshkov et al., Nature Phys. **6**, 289-295 (2010)
[2]A. Imambekov, M. Lukin, and E. Demler, Phy. Rev. A **68**, 063602 (2003)

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