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Thermodynamics for reaching SU(N) quantum magnetism in ultracold alkaline earth atoms KADEN HAZZARD, JILA, NIST, CU-Boulder, LARS BONNES, Institute for Theoretical Physics, University of Innsbruck, SALVATORE MANMANA, Institute for Theoretical Physics, University of Göettingen, VICTOR GURARIE, MICHAEL HERMELE, Dept. of Physics, CU-Boulder, STEFAN WESSEL, Institute for Theoretical Solid State Physics, Aachen University, ANA MARIA REY, JILA, NIST, CU-Boulder — Motivated by the prediction that SU(N) Hubbard models in a large-N limit possess a chiral spin liquid ground state, we investigate how to exploit the large number of degrees of freedom to cool alkaline earth atoms in optical lattices, which are described by the SU(N) Hubbard model with N as large as 10. Combining analytic high temperature expansions and sophisticated quantum Monte Carlo calculations, we show that the entropy increases with N for $T > t^2/U$ independent of dimension and lattice geometry, and down to temperatures $T = 0.1t^2/U$ in one dimensional chains. As a consequence, when one loads these atoms into optical lattices, the final temperatures can be orders of magnitude colder for $N = 10$ than for the usual $N = 2$ case. The use of alkaline earths with large N is thus particularly exciting for cold atoms experiments, where achieving low entropy states displaying quantum magnetism remains an outstanding challenge. This finding explains the dramatic cooling seen in recent Yb ($N = 6$) experiments [Y. Tanaka et al., Nature Physics 8, 800 (2012)].

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