

MAR11-2010-003078

Abstract for an Invited Paper
for the MAR11 Meeting of
the American Physical Society

A quantitative analysis of small atomic systems

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Ultracold atoms in an optical lattice provide a unique toolbox for emulating the prototypical models of condensed matter physics. Before the optical lattice system can be trusted as a quantum simulator however, it needs to be validated and benchmarked against known results, for which quantum Monte Carlo simulations are ideally suited. In this talk, an overview of recent numerical studies of ultracold bosonic and fermionic systems in an optical lattice will be given, starting with a full comparison based on experimental time-of-flight images of bosons in an optical lattice and ab-initio simulations. Next, the advantages of single-site resolution detection tools will be highlighted. Finally, the temperature and entropy in present experiments on fermions in an optical lattice will be estimated, and the full thermodynamics on approach to the Neel temperature will be presented. Nearest-neighbor spin-spin correlations are shown to be useful for thermometry.