A-2

Experimental Realization of the SU(N) Hubbard Model with Ultracold Atomic Fermi Gases

Shintaro Taie[1], Rekishu Yamazaki[1,2], Seiji Sugawa[1], Yoshiro Takahashi [1,2]
[1] Kyoto University; [2] JST-CREST
E-mail address: taie@scphys.kyoto-u.ac.jp

[キーワード] ultracold Fermi gas, optical lattice, Mott insulator

Ultracold atomic gases enables not only to emulate existing quantum many-body systems in controlled environment, but also to create novel systems which does not have traditional solid-state counterpart. We report the experimental realization of the Hubbard model with enlarged SU(N) spin symmetry in 3D optical lattices using ytterbium (Yb) atoms. Fermionic isotopes of Yb have SU($2I + 1$) symmetric interactions for nuclear spin I, which originate from the absence of hyperfine structure [1, 2]. SU($N > 2$) Hubbard models are predicted to have rich quantum phases, including valence-bond-solid and spin liquid [3]. Despite much theoretical interests, these models have been experimentally left unexplored.
The SU(6) Hubbard system can be realized by loading a degenerate gas of ^{173}Yb ($I = 5/2$) into an optical lattice. Using photoassociation method, we investigate the strongly correlated regime where atoms form an SU(6) Mott insulator. We find significant reduction of double occupancy, which indicates that the system is highly incompressible, as expected for a Mott insulating state. Furthermore, we observe the charge excitation gap through the resonant enhancement of double occupancy after the periodic modulation of the lattice depth at the frequency close to the on-site interaction [4]. Quantitative analysis of lattice modulation spectra provides information of the spin-correlation in optical lattices [5]. We compare this correlation between the SU(6) and SU(2) cases, and find that significant cooling occurs for the SU(6) case during the loading process into optical lattices. This is due to the larger spin entropy $\ln(6)$ per atom in a SU(6) Mott insulator, and analogous to the Pomeranchuk cooling in solid ^{3}He systems.

[1] M. A. Cazalilla, *et al.*, New J. Phys. **11**, 103033 (2009).
[2] A. V. Gorshkov, *et al.*, Nature Phys. **6**, 289 (2010).
[3] M. Hermele, *et al.*, Phys. Rev. Lett. **103**, 135301 (2009).
[4] R. Jördens, *et al.*, Nature **455**, 204 (2008).
[5] D. Greif, *et al.*, Phys. Rev. Lett. **106**, 145302 (2011).