Abstract Submitted
for the MAS15 Meeting of
The American Physical Society

Large effective three-body interaction in a double-well optical lattice SAURABH PAUL, Joint Center for Quantum Information and Computer Science, Joint Quantum Institute, University of Maryland, College Park, EITE TIESINGA, Joint Quantum Institute, National Institute of Standards and Technology and University of Maryland, Gaithersburg — We study ultracold atoms in an optical lattice with two local minima per unit cell and show that the low energy states of a multi-band Bose-Hubbard (BH) Hamiltonian with only pair-wise interactions is equivalent to an effective single-band Hamiltonian with strong three-body interactions. We focus on a double-well lattice with a symmetric double well along the x axis and single well structure along the perpendicular directions. Tunneling and two-body interaction energies are obtained from an exact band-structure calculation and numerically-constructed Wannier functions in order to construct a BH Hamiltonian spanning the lowest two bands. Our effective Hamiltonian is constructed from the ground state of the N-atom Hamiltonian for each unit cell obtained within the subspace spanned by the Wannier functions of two lowest bands. The model includes hopping between ground states of neighboring unit cells. We show that such an effective Hamiltonian has strong three-body interactions that can be easily tuned by changing the lattice parameters. Finally, relying on numerical mean-field simulations, we show that the effective Hamiltonian is an excellent approximation of the full BH Hamiltonian over a wide range of lattice parameters, both in the superfluid and Mott insulator regions.

Saurabh Paul
Univ of Maryland-College Park

Date submitted: 01 Oct 2015 Electronic form version 1.4