Contribution ID: **68** Type: **not specified**

Supersolid states in two-dimensional hard-core bosonic Hubbard model with dipole interactions

Wednesday, 27 March 2024 18:51 (3 minutes)

For realizing supersolid [1,2], many efforts have been made so far. Theoretically, short-range frustrated interactions in lattice Bose-Hubbard models play a key role to stabilize the supersolid states. Ultracold-atomic gases in optical lattices are promising experimental systems for the supersolid state. However, the presence of the dipole-dipole interactions is expected there. The effect of the dipole-dipole interactions in the two-dimensional bosonic Hubbard model has been investigated [3] and the authors have studied the ground state phase diagram by using the mean-field (MF) approach and infinite entangled-pair-state (iPEPS) calculations. The MF approach and iPEPS calculations have predicted that several supersolid phases appear in between solid phases with different commensurate fillings, when the dipole axis is tilted on the two-dimensional lattice plain and the range for the dipole-dipole interactions is finite.
In this study, we investigate the ground-state phase diagram of a two-dimensional bosonic Hubbard model with dipole-dipole interactions by quantum Monte Carlo (QMC) calculations. To characterize the nature of each phase appeared, we apply not only conventional finite-size-scaling approaches but also a machine-learning assisted approach. We confirm that QMC results reproduce the phase diagram obtained by the MF approach and iPEPS calculations [3]. Next, by changing the cut-off distance for the long-range dipole interactions, we further investigate the phase diagram. When the cut-off distance becomes longer, two quarter solid states (ρ=1/4 and 3/4) observed in ref. [3] becomes unstable and diagonal stripe solid states (ρ=1/3 or 2/3) are stabilized. This means that the corresponding quarter-supersolid states becomes unstable and the diagonal-stripe supersolid states are stabilized instead.

References:

[1] G. V. Chester, Phys. Rev. A 2, 256 (1970).
[2] A. J. Leggett, Phys. Rev. Lett. 25, 1543 (1970).
[3] H. -K. Wu and W. -L. Tu, Phys. Rev. A 102, 053306 (2020).

Primary author: SUZUKI, Takafumi (University of Hyogo)

Presenter: SUZUKI, Takafumi (University of Hyogo)

Session Classification: Poster

Track Classification: Poster presentation