Bose-Einstein condensates in optical lattices with artificial magnetic fields

Rashi Sachdeva

Quantum Systems Unit, Okinawa Institute of Science and Technology Graduate University, Okinawa, 904-0495, Japan
e-mail: rashi.sachdeva@oist.jp

Cold atomic gases are flexible laboratories with a great potential to investigate a variety of problems from many area of physics. Recent progress in the experimental realization of artificial magnetic fields, long range interacting Bose- Einstein condensates (BECs), and optical lattices, allows to ask interesting question about the interplay of these three influences on cold atomic systems and realize the idea of 'quantum simulation'.

In this talk, I will first introduce the general Bose Hubbard model which describes the bosonic system in optical lattices, along with the concept of 'artificial magnetic fields'. Subsequently, I will present results from our recent work on ground-state properties of ultracold atoms with long-range interactions trapped in a optical lattices in the presence of an artificial magnetic field. Using a Gross-Pitaevskii approach, a mean-field Gutzwiller variational method as well as strong coupling perturbation theory, we explore both the weakly interacting and strongly interacting regimes, respectively. We calculate the phase boundaries between the density-wave–supersolid and the Mott-insulator–superfluid phases as a function of magnetic flux and uncover regions of supersolidity, and show signatures of vortices in supersolid phase of matter. Further, I will also present our recent results for the staggered magnetic field configuration of the system and study the chiral current behavior in a vortex anti-vortex arrangement.

References :

1) Extended Bose Hubbard model for two-leg ladder systems in artificial magnetic fields.
Rashi Sachdeva, Manpreet Singh, and Thomas Busch
Physical Review A 95, 063601 (2017)

2) Two leg ladder Bose Hubbard models with staggered fluxes.
Rashi Sachdeva, Friederike Metz, Manpreet Singh, Tapan Mishra, and Thomas Busch
arXiv: 1808.05348 (2018)