

## **Bosons in Hofstadter Model: mesoscopic phenomenon and effective theory for superfluid**

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A synthetic magnetic field for neutral atoms has been successfully realized through engineering an atom-light interaction. This technique can be applied to cold atom system in optical lattice straightforwardly. Here in this talk, I will present our study on boson systems in optical lattices with a uniform magnetic field (Hofstadter Model). First, I shall present a theorem that shows the degeneracy of many-body states in this model depends on the total particle number and the flux filling ratio. Second, I will talk about the behavior of the ground state of mesoscopic boson system with flux filling ratio  $1/3$ . Numerical simulation of the quantum ground states and theoretical understanding will be given. Also, I shall present an effective theory for superfluid in thermodynamic limit of this model, together with the mean-field study and analysis of low-energy excitation.