Higher Bloch bands in optical lattices.

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Abstract

To describe a gas of cold bosonic atoms in the optical lattice, a discrete lattice hamiltonian, the Bose-Hubbard model is widely used. It simplifies description of phyics, by providing discretization, and its dependence on only two parameters: J — controling hopping of particles between different sites, and U describing on-site interacions. The model assumes restriction of physics to the lowest Bloch Band of the lattice and only local interaction.

Recently a new appraoch [2] has been proposed. Instead of resctricting to the lowest Bloch band, a restriction to a smartly chosen subspace of the on-site hamiltonian takes place. The new, effective hamiltonian can be derived. It also has the form of the Bose-Hubbard hamiltonian, but with renormalized constants J and U, which become density-dependent. In our reseach we study what consequeces, the renormalization of hamiltonian parameters may have on a trapped bosonic atom gas experiments. We analyze phase diagrams of the homogeneous systems for different lattice geometries. We also focus on the renormalization procedure itself. We have found the renormalization procedure to be difficult and devious: we propose a new numerical approach that significantly enhances renormalization accuracy.

In my talk I will briefly outline main results of our research.

References

[1] M. Łącki, D. Delande, J. Zakrzewski, in preparation .

[2] Ole Jürgensen, K. Sengstock, Dirk-Sören Lühmann, New Journal of Physics, (Volume 14, Number 3, March 2012,pp. 33021-33040(20)).