凝縮系物理学ゼミナール

Condensed Matter Seminar

Location: Room 413, School of Science Bldg. 5 (理学 5 号館 413 号室)

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Topological Properties of 1D Bose-Hubbard Model in Quasiperiodic Superlattice

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Abstract:

The relation between one-dimensional (1D) quasicrystals and 2D topological insulators has recently been demonstrated theoretically and also experimentally by using optical waveguides [1]. It has been elucidated that 1D quasicrystals can be classified in terms of topology for 2D integer quantum Hall systems. Such quasicrystals can be also realized in ultracold atoms loaded in optical superlattices [2,3]. Motivated by the above-mentioned remarkable progress in the study of quasicrystals, we here investigate topological properties of quasicrystals by exploiting a 1D Bose-Hubbard model in a quasiperiodic superlattice.

It is known that a gap in the excitation spectrum is induced by the interaction, and the resulting Mott insulating phase is characterized by a nonzero Chern number [4]. The system is called a topological Mott insulator. In the 1D system, there are two typical quasiperiodic model known: the Fibonacci model and the Harper model. In the non-interacting case, the Fibonacci model and the Harper model is known to be topological equivalent [5]. We discuss the relationship between the Fibonacci-like Bose-Hubbard model and the Harper-like Bose-Hubbard model with interaction by using the exact diagonalization and the density matrix renormalization group method (DMRG).

Reference:

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[2] L. Fallani, J. E. Lye, V. Guarrera, C. Fort, and M. Inguscio, Phys. Rev. Lett. 98, 130404 (2007).
[3] G. Roati, C. D'Errico, L. Fallani, M. Fattori, C. Fort, M. Zaccanti, G. Modugno, M. Modugno, and M. Inguscio, Nature 453, 895-898 (2008).
[4] Shi-Liang Zhu, Z. -D. Wang, Y. -H. Chan, and L. -M. Duan, Phys. Rev. Lett. 110, 075303 (2013).
[5] Y. E. Kraus and O. Zilberberg, Phys. Rev. Lett. 109, 116404 (2012).