Dynamical properties of 1D optical fermionic lattices by using DDMRG

Atsushi Yamamoto[1,2], Susumu Yamada[1,2] and Masahiko Machida[1,2]

[1] CCSE, Japan Atomic Energy Agency, 6-9-3 Higashi-Ueno, Taito-ku, Tokyo 110-0015, Japan

[2] JST-CREST, 5, Sanbancho, Chiyoda-ku, Tokyo, 102-0075, Japan

Recently, a new measurement technique has been developed in the research field for atomic Fermi gases by JILA D. S. Jin 's group [1]. The measurement is equivalent with the angle resolved photoemission spectroscopy (ARPES), which probes one particle excitation spectrum, $A(k,\omega)$ and the latest intriguing issue via using the probe is now a direct observation of the pseudo-gap observable in BCS to BEC crossover. Besides, it will be a challenging theme in atomic Fermi gas to directly compare more exotic spectrum of $A(k,\omega)$ in 1D, strongly-correlated, and frustrated systems with experimental results. Thus, we examine spectral properties on one dimensional (1D) trapped ultracold fermions loaded on optical lattice by using the dynamical density-matrix renormalization group (DDMRG) method [2] in this paper. Consequently, in interaction free and weak regimes, we observe a spectral change from a simple band picture as obtained from periodical 1D lattice to band branching and finally bound-state level spectra by narrowing the harmonic trap. This is easily understandable but implies that the trap control makes it possible to examine details of changes from the band picture to confined one. In contrast, in strongly-interacting regime, we find several bound-state levels above 1D Tomonaga-Luttinger (TL) liquid spectrum on a central Mott plateau phase surrounded by metallic wings and pursuit breakdown of TL spectrum together with a band picture recovery by narrowing the trap. A striking spectral change in the breakdown is the growth of the dispersive band from the bound-state level spectrum by effectively doping into the Mott phase. We will present more details of these spectral changes.

References

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