Single-particle excitation spectrum in 1D ultracold fermionic optical lattices

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We clarify the single-particle excitation spectrum of ultracold fermions in one dimensional (1D) optical lattices by using dynamical density-matrix renormalization group (DDMRG) method. Systems are described by 1D Hubbard model with a harmonic-trap potential. In 1D systems, owing to the trap potential and on-site interaction, the obtained spectrum shows quite rich structure. In an analysis of weakly repulsive interaction, we find that the spectrum structure changes to band branching and discrete bound-state states as increasing the trap strength. On the other hand, we consider the case of strongly repulsive interacting regimes which local density profile is described by central Mott-plateau phase with surrounded by metallic regions. We confirm the multiple flat bound-state levels lying above 1D Tomonaga-Luttinger (TL) liquid spectrum. Moreover, as increasing the trap strength, we find the breakdown of TL spectrum which is alternative to an effective doping into the Mott phase. We also show the results in case of attractive interaction. We will present the various kinds of striking spectra, reveal the properties of growth of a dispersive band structure, and show the comparison of repulsive interaction case with attractive interaction one.