Optical response and electron-phonon interaction in one-dimensional Mott insulators

Takami Tohyama [a], *Hiroaki Matsueda* [b], *Sadamichi Maekawa* [c]

[a] Yukawa Institute for Theoretical Physics, Kyoto University, Kyoto, Japan
[b] Sendai National College of Technology, Sendai, Japan
[c] Institute for Materials Research, Tohoku University, Sendai, Japan

Abstract: In strongly correlated electron systems, the electron-phonon interaction strongly affects elementary excitations. In order to see the effect of the electron-phonon interaction on electronic excitations, we examined the one-dimensional (1D) Hubbard- Holstein model at half filling by using dynamical density matrix renormalization group (DMRG) method. We focus on three topics. (1) *Spinon and holon excitations*: We find that both the spinon and holon branches are smeared out by phonons, and a small hump structure appears around the □point below the zero-phonon line. These features can be explained by a spin-charge-separation model, indicating that the spin-charge separation is robust against the electron- phonon coupling. (2) *Optical excitations* [2]: We find that an excitonic bound state due to long-range Coulomb repulsion splits into multiple peaks by the electron-phonon interaction. This splitting gets enhanced as the on-site Coulomb interaction increases. (3) *Relaxation dynamics after photoirradiation* [3]: We calculate time-evolution of excited states by DMRG. We find quite large number of phonons excited just after irradiation even for very small electron-phonon coupling, which affects on other internal degrees of freedom of correlated electrons. We discuss implications of the present results in light of recent angle-resolved photoemission spectroscopy, optical absorption, and pump-probe experiments in 1D Mott insulators such as Sr_2CuO_3.

[1] H. Matsueda, T. Tohyama and S. Maekawa, Phys. Rev. B **74**, 241103(R) (2006).
[2] H. Matsueda, A. Ando, T. Tohyama and S. Maekawa, Phys. Rev. B **77**, 193112 (2008).
[3] H. Matsueda, T. Tohyama and S. Maekawa, to be published.