Dynamics of Photoexcited Correlated Electrons - DMRG Study and MPS Viewpoint -

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Irradiation of ultrashort pulse laser into strongly correlated electron systems is a possible candidate for controlling their various electronic phases. In order to construct the basic concepts in this field, it is fundamental to understand coupling and separation of charge, spin, orbital and phonon degrees of freedom under the nonequillibrium conditions in the presence of the laser pulse.

The one-dimensional Mott insulators show instantaneous insulator-to-metal transition after irradiation and subsequent picosecond decay. Here, it has been shown experimentally that the photocarriers do not couple strongly with both of spin and phonon degrees of freedom. Then, the problem is to find the pathway of energy dissipation. Our dynamical and time-dependent DMRG calculations show that the phonon relaxation is essential even for weak coupling [1]. The strong photoirradiation destroys the spin-charge separation, but the efficient relaxation does not occur in the spin channel. We also find that this phonon relaxation depends on the mangitude of the on-site Coulomb repulsion, and the decay into an Mott insulating state would be much faster than that in semiconductors [2].

I will comment on future perspective of this research field. The above problems can be efficiently treated by transformation of standard DMRG to MPS formulation. The MPS at each step optimizes a local matrix with a relatively small dimension instead of the total Hilbert space with huge environmental degrees of freedom. Therefore, we can handle much bigger system size and wide parameter range. Additionally, the matrix defined on photocarrier site may contain important information of how the carrier is dressed with phonon cloud. In an another viewpoint, when we study photo-domain growth after irradiation, what we should do in each time step is to modify only few matrices defined near the domain boundary. This greatly accerelates numerical simulations.

References

[1] H. Matsueda, T. Tohyama, and S. Maekawa, arXiv:1005.1690v1.

[2] H. Matsueda, A. Ando, T. Tohyama, and S. Maekawa, Phys. Rev. **B77** (2008), 193112(1-4).