Numerical study on interplay between stripes and electron-phonon interactions in the Hubbard model

Takahiro OHGOE

Department of Applied Physics, The University of Tokyo,

7-3-1 Hongo, Bunkyo-ku, Tokyo 113-0033

Since the discovery of high- T_c cuprates, many experiments have been performed to unveil its mechanism and revealed its rich and complex physics. Especially in the underdoped region, exotic phenomena such as pseudogap or stripe order were observed and they are still intensively studied both experimentally and theoretically. Owing to the recent advancements of the scanning tunneling microscope (STM) and X-ray experiments, charge orders have been widely observed in the underdoped region of several families of high-T_c cuprates, establishing their presence as a universal feature [1].

In our recent work [2], we studied the stripe states in the Hubbard model by using the many-variable variational Monte Carlo (mVMC) method. As a result, we found that several stripes with different periodicities are severely competing especially in the underdoped region. Furthermore, we found that the ground states are stripe states instead of homogeneous superconducting state for the doping concentration $0.1 \lesssim \delta \lesssim 0.3$. However, the electron-phonon interactions are neglected and its roles on stripes remains elusive.

In this study, we studied the effect of electron-phonon interactions on the competition between stripe states and homogeneous states. To this purpose, we used the extended VMC method for electron-phonon coupled systems which we proposed [3]. As a result, we found that electron-phonon interactions with realistic phonon frequencies do not change the physical quantities such as spin/charge structure factors so much. On the other hand, it has been turned out that the electron-phonon interactions can change the ground states from stripe states to homogeneous states. In this study, we considered the particular modes of phonons individually. The more realistic analysis based on fully ab-initio electron-phonon interactions will be reported elsewhere.

References

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