Variational Monte Carlo study for superconductivity in multi-orbital systems

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Recently, the roles of orbital degrees of freedom on various physical quantities in strongly correlated electron systems have attracted much attention. A main reason is because the multi-orbital effect is considered to be important for many superconducting materials including Sr_2RuO_4, $Na_xCoO_2 \cdot yH_2O$, heavy-fermion superconductors, and iron-based superconductors. Among them, the iron-based superconductors have been extensively studied because of their rather high transition temperature T_c's. For this class of superconductors, even the details of the superconducting symmetry have not been settled: some theoretical studies propose the unconventional s_{+-}-wave symmetry and others indicate the conventional s_{++}-wave symmetry. Understanding the mechanism of superconductivity in multi-orbital systems is important for searching a novel superconductor with a higher T_c.

Here, we study the two- and three-orbital Hubbard models to clarify the mechanism of superconductivity observed in multi-orbital systems. The variational Monte Carlo method is used to investigate the ground state properties and establish the ground state phase diagram. We also examine the role of spin-orbit interaction, which is important especially in $4d$ and $5d$ electron systems.[1]

[1]H. Watanabe , T. Shirakawa, and S. Yunoki, Phys. Rev. Lett. **105**, 216410 (2010).