凝縮系物理学ゼミナール

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場所：理学部5号館　413号室

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「Effects of orbital fluctuations and spatial fluctuations in strongly correlated systems」

Strongly correlated electron systems with orbital degrees of freedom have attracted much attention. The importance of orbital degrees of freedom has been suggested in the newly discovered iron-based superconductors. Another interesting orbital dependent physics is the orbital-selective Mott transition studied in the ruthenate $Ca_{2-x}Sr_xRuO_4$. The heavy fermion behavior observed in this material have also attracted much interest.

Theoretically, the dynamical mean field studies have made considerable progress in understanding the Mott transition, magnetic properties, etc. in the multi-orbital strongly correlated systems. However, this method does not treat the spatially extended correlations. Recently, nontrivial momentum-dependent dynamics, which is extremely relevant to the spatial correlation effects, have been observed in $Ca_{2-x}Sr_xRuO_4$. Therefore, it is desirable to investigate the strong correlation effects in multiorbital systems using an extended method which incorporates spatial fluctuations of spin and orbital.

In this study, we investigate the two-orbital Hubbard model on the square lattice at quarter filling, using a cluster extension of the dynamical mean field theory. It has been clarified that the strong Hund's coupling enhances the ferromagnetic-antiferroorbital fluctuations, which give rise to insulating behavior. On the other hand, large difference of the bandwidths enhances the antiferromagnetic-ferro-orbital fluctuations, which induce insulating behavior. We have demonstrated that the competition between the antiferromagnetic-ferro-orbital and ferromagnetic-antiferro-orbital states gives rise to the heavy quasiparticle metallic state.

Reference: Phys. Rev. B 79, 245128 (2009)