Phase transitions in the extended periodic Anderson model

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Strongly correlated electron systems with orbital degrees of freedom pose a variety of problems. Typical examples are the transition metal oxides $\mathrm{LiV_2O_4}$, [1] and $\mathrm{Ca_{1.8}Sr_{0.2}RuO_4}$, [2] where heavy fermion behavior is realized due to the degeneracy of t_{2g}-orbitals in combination with the crystal structure. It was suggested that t_{2g} electrons play distinct roles in the compounds, where localized and itinerant electrons in the same subshell hybridize with each other to stabilize the heavy electrons. [3] This may be closely related to the concept of the orbital-selective Mott transition, [4] which stimulates further theoretical investigations on correlated electron systems with orbital degeneracy.
To discuss how the heavy fermion behavior is realized in these compounds, we investigate the extended periodic Anderson model, which includes the interorbital interactions as well as the intraorbital interactions. By combining the dynamical mean field theory with the numerical renormalization group, we study the ground state properties in the particle-hole symmetric system. We clarify that the Hund coupling between degenerate orbitals plays an important role in realizing the quantum phase transition between the Kondo insulating phase and the Mott insulating phase. We also address how the heavy fermion behavior emerges in the doped case.

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