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Extended Dynamical Mean-Field Approximation and its application to strongly correlated electron systems

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Dynamics of strongly correlated electron systems has been investigated extensively in context of low-temperature physics in the heavy fermion compounds, the transition metals and some organic materials. A specific feature of such systems is a dual nature of electronic states in one-particle density of states, in which, the high-energy incoherent states (so-called the Hubbard bands) have a spatially localized character, while the low-energy states exhibit an itinerant character with strong temperature dependence. The interplay between the electronic states in two opposite extremes is a vital clue to understand magnetism and superconductivity realized in heavy-fermion systems. It is this aspect however that has hampered many theoretical attempts based on the one extreme, such as weak-coupling approaches or the dynamical mean-field approximation.

I propose a hybrid formalism, which takes account of the correction of the spatial fluctuations to the local self-energy obtained by the dynamical mean-field approximation [1]. Using the formalism, it is demonstrated that the one-particle spectral intensity in the two-dimensional Hubbard model at half-filling exhibits the pseudo-gap behavior in the central coherent quasi-particle peak due to the critical antiferromagnetic fluctuation (in Fig. 1 left panel). The specific heat is considerably enhanced by the short-range order, which assists a tendency of the Mott localization showing the reduction of the double occupancy (in Fig. 1 right panel). I will discuss possible future applications with the present formalism, including an anisotropic superconductivity in heavy-fermion systems.

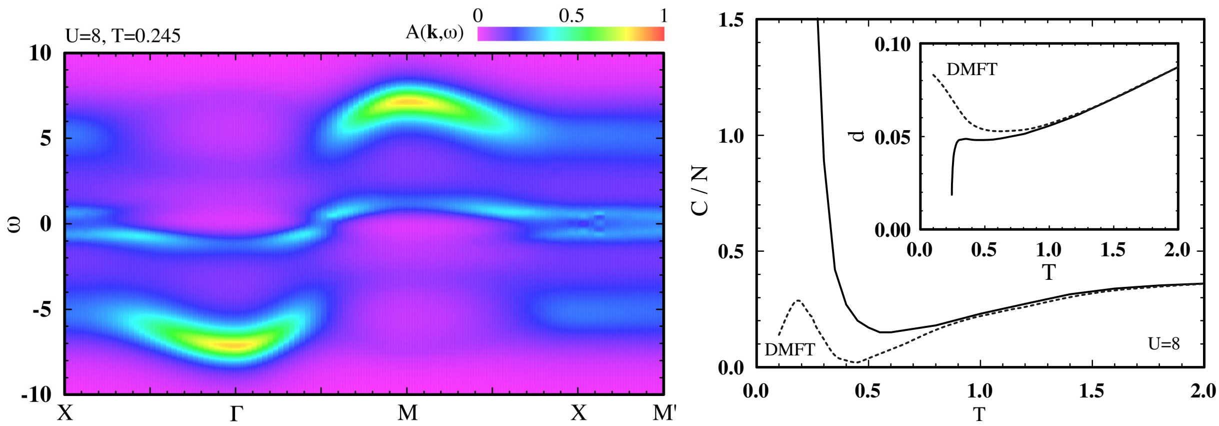

Figure 1: (left) The contour plot of the spectral intensity $A(\boldsymbol{k},\omega)$ along the high-symmetry lines of the Brillouin zone for 2D Hubbard model with $n=1$, $U/t=8$ and $T/t=0.245$. (right) The T dependences of the specific heat. The inset shows the T dependence of the double occupancy. The results of DMFT is shown for comparison.

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