(PS3)

Study of the Anderson lattice model with use of DMFT+1/N-expansion

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The dynamical mean field theory (DMFT) is one of the most powerful methods to investigate strongly correlated electron systems. With use of DMFT with $1/N$-expansion as a machinery of solving impurity problem (DMFT+1NE), we can calculate the electronic state of the Anderson lattice model over the whole temperature range. We compare our results with those from the 1/N-expansion (1NE), non-crossing diagram approximation (NCA), DMFT with NCA (DMFT+NCA).

The Anderson lattice model is given by

$$\begin{aligned} H &= \sum_{k\sigma}\varepsilon_k c^+_{k\sigma}c_{k\sigma} + \sum_{i\sigma}(\varepsilon_f-\mu)f^+_{i\sigma}f_{i\sigma} + \sum_i(2\varepsilon_f - 2\mu + U_f)d^+_i d_i \\ &\quad + \frac{V}{\sqrt{N_L}}\sum_{ki\sigma}\left\{c^+_{k\sigma}(f_{i\sigma}b^+_i + f^+_{i\bar{\sigma}}d_i)\mathrm{e}^{-\mathrm{i}k\cdot R_i} + h.c.\right\}, \end{aligned} \tag{1}$$

where b_i, d_i, $f_{i\sigma}$ are annihilation operators for the slave boson representing the f^0-state at the ith local site, the double occupancy representing the f^0-state, the pseudo-fermion representing the f^1-state with spin σ. and $c_{k\sigma}$ is that for the conduction electron. We set that the density of states is constant and the bandwidth $D = 1.0$, $\varepsilon_f = -0.5$, $V = 0.3$, $U_f = 1.1$, $T = 0.001$, $\mu = -0.1$.

Figs. 1 show the density of states (DOS) for the conduction electrons and f-electrons and imaginary part of the self-energy of the f-electrons with use of 1NE, NCA, DMFT+NCA and DMFT+1NE. The density of states (DOS) given by 1NE shows the coherent Kondo states at Fermi level but not the local incoherent state at f-level. The imaginary part of the self-energy of f-electrons is zero over whole frequency range. The Luttinger sum rule holds. The DOS given by NCA and DMFT+NCA show the local f-level, but not the coherent state. The hybridization gap does not appear because the imaginary part of the self-energy is large at Fermi level. NCA and DMFT+NCA are correct at high temperature or high frequency but incorrect at low temperature and low frequency. Last, the DOS given by DMFT+1NE show both of the local f-level and the coherent Kondo states at Fermi level. The imaginary part of the self-energy is proportional to ω^2 at low temperature.

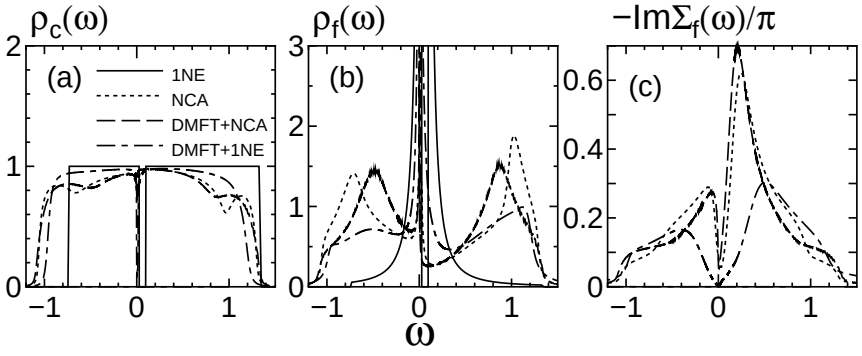

Figure 1: DOS of conduction electrons (a), DOS of f-electrons (b) and the imaginary part of the self-energy of the f-electrons (c).