

# Variational study of the extended periodic Anderson model

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We investigate the extended periodic Anderson model, where besides the standard on-site  $f$ -electron interaction ( $U_f \sum_{\mathbf{j}} \hat{n}_{\mathbf{j}\uparrow}^f \hat{n}_{\mathbf{j}\downarrow}^f$ ) there is an on-site interaction between the conduction electrons ( $U_d \sum_{\mathbf{j}} \hat{n}_{\mathbf{j}\uparrow}^d \hat{n}_{\mathbf{j}\downarrow}^d$ ) and another one between the doubly occupied  $f$ - and  $d$ - electron levels ( $\tilde{U}_{df} \sum_{\mathbf{j}} \hat{n}_{\mathbf{j}\uparrow}^f \hat{n}_{\mathbf{j}\downarrow}^f \hat{n}_{\mathbf{j}\uparrow}^d \hat{n}_{\mathbf{j}\downarrow}^d$ ). We use the modified Gutzwiller trial wave function which consists of projecting out the doubly occupied  $d$ - and  $f$ -sites with different amplitudes. The previous variational studies focused on the analytically tractable cases (e.g. weak or infinite interaction strength, weak hybridization). Our calculations do not need to assume such restrictions of the parameter regimes. Except for the Gutzwiller approximation no further approximations are applied.

The effect of the finite  $U_d$  interaction is investigated. We show that the above interaction between the doubly occupied  $f$ - and  $d$ - levels causes that the intermediate valent regime decreases and the Kondo-regime increases. The  $f$ -level occupancy as a function of the  $f$ -level energy is qualitatively in a good agreement with other numerical calculations. The variational investigation of the general  $d$ - $f$  interaction ( $U_{df} \sum_{\mathbf{j},\sigma,\sigma'} \hat{n}_{\mathbf{j}\sigma}^f \hat{n}_{\mathbf{j}\sigma'}^d$ ) is in progress.

9.7 cm

13.4 cm

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