Obital potential quench in the IHM

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1 Introduction

Here interaction quench in paramagetic Hubbard model(HM) is studied using non equilibrium DMFT IPT developed by Naoto Tsuji. This code is attached as supplementary material of 2014 RMP paper[1]. I have tried to reproduce the published results in PRL [2] paper 2009 and [4] in 2013.

In the public version of code they have implemented bare 2 nd order perturbation theory with Kadanoff-Baym formalism.

2 double occupancy(d) and jump in distribution function(Δn)

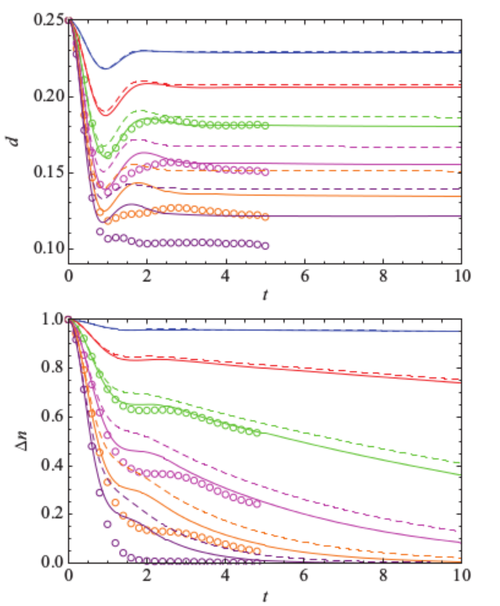
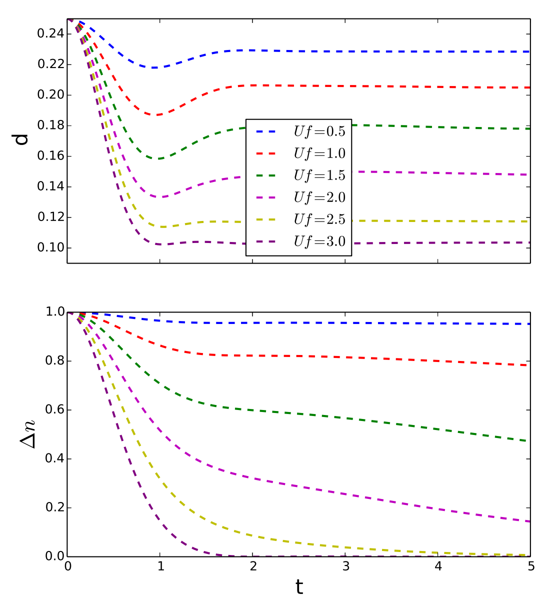


FIG. 19. (Color online) Time evolution of the double occupancy (top panel) and the jump of the momentum distribution function (bottom) after the interaction quenches $U = 0 \to 0.5, 1, \ldots, 3$ (from top to bottom) in the PM phase of the Hubbard model at half filling calculated by the nonequilibrium DMFT with QMC (circles, taken from Ref. 23), the bold second-order (dashed curves), and the bold fourth-order (solid curves) self-consistent perturbation theories.

(a)



(b) parameters are same as figure (a). d and Δn calculated using second order bare IPT. main code is written by Naoto Tsuji and attached to RMP[1]. Δn measurement part is added later with original code by Soumen Bag

Figure 1

In figure 1.(b) double occupancy(d) and jump of the momentum distribution function(Δn) calculated using bare second order IPT code is written by Naoto Tsuji and attached to RMP[1] compared with dashed line in 1.(a) calcuted using bold second order IPT taken from [4]. one notice that bare second order IPT underestimat both d and Δn compare with bold second order IPT.

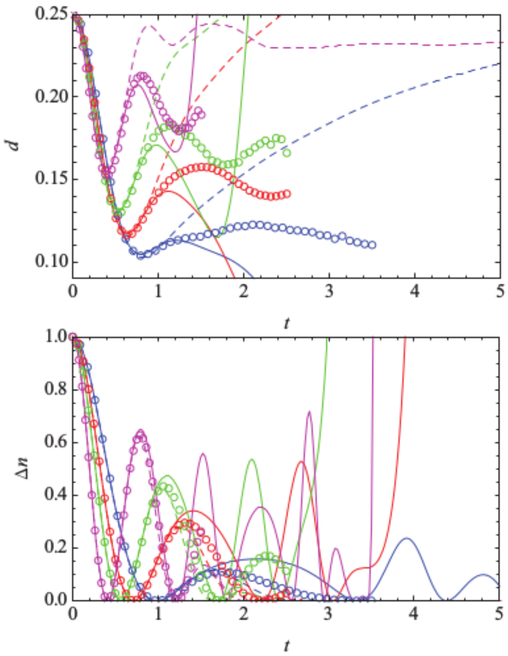
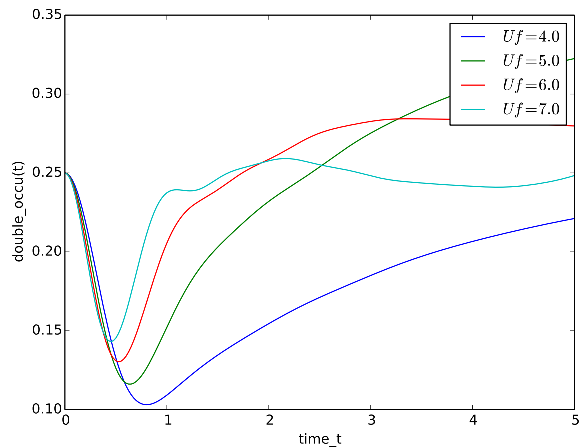


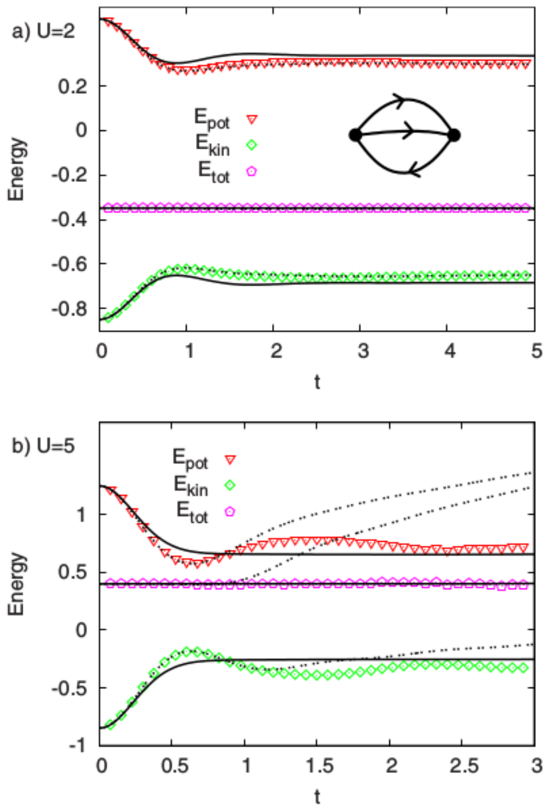
FIG. 16. (Color online) Time evolution of the double occupan (top panel) and the jump of the momentum distribution function (bottom) after the interaction quenches $U = 0 \rightarrow 4,5,6,8$ (from bottom to top in the first minima of d, and from top to bottom in the initial decrease of Δn) in the PM phase of the Hubbard model at half filling calculated by the nonequilibrium DMFT with QMC (circles, taken from Ref. 23), the bare second-order (dashed curves), and bare fourth-order (solid curves) perturbation theories.

(a)

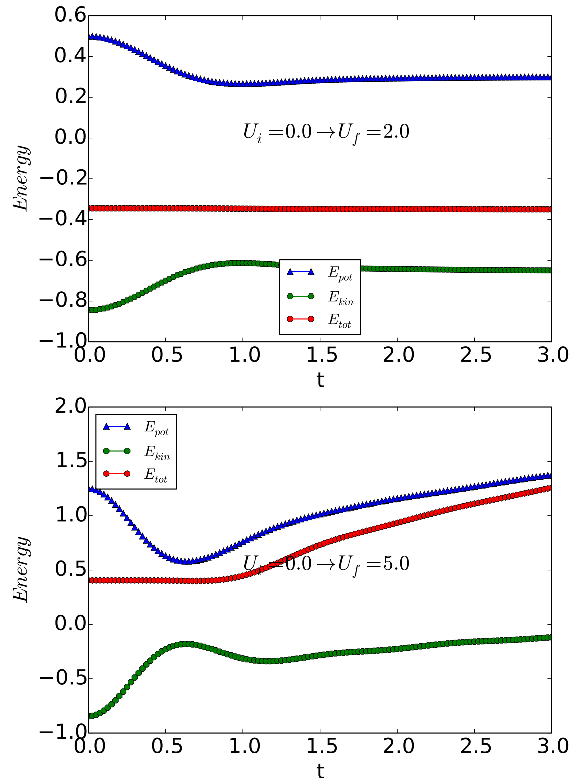


(b)

3 Total energy



(a) symbol for CTQMC, dashed line are IPT, solid line are SPT(self-consistent perturbation theoty) is taken from [3]

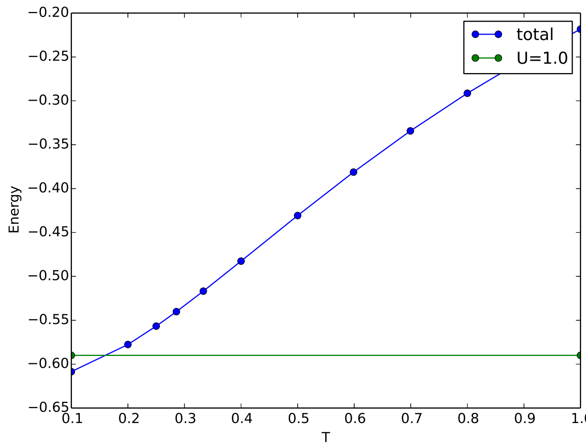


(b) 2 nd order bare IPT

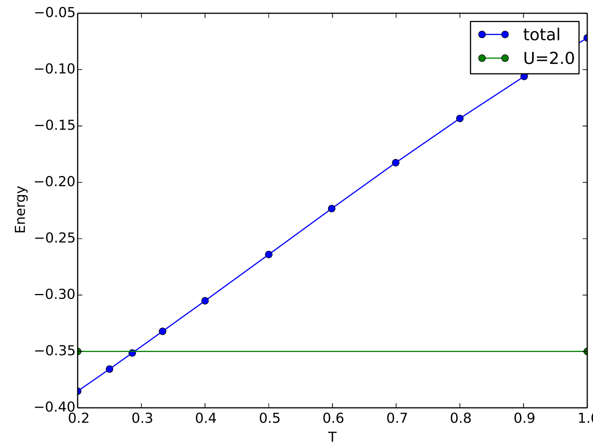
Figure 3

For U_f ¿ 3.3 we see the 2 nd order IPT does not conserve the energy. it has been observed that if one do more accurate calculation like ctqmc [4] energy remain converse which is expected.

4 effective temparature

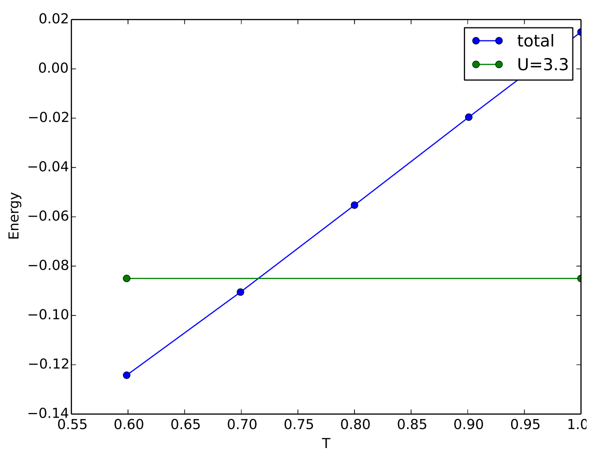


(a) sustem is quenched form U = 0.0 at β = 16 or T=0.0625 to U=1.0t. then effective temperature(T*) of the system is crossing point. T*=0.15

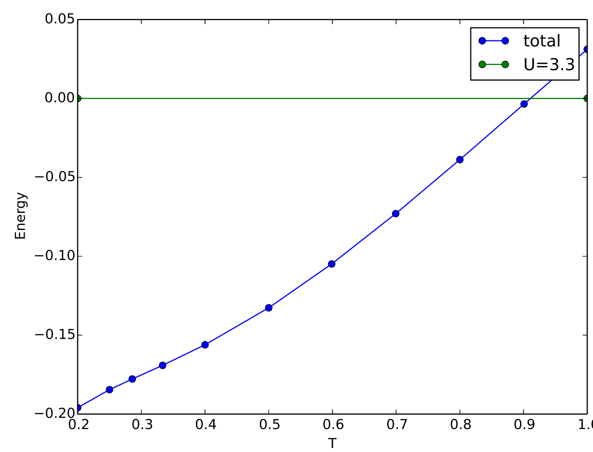


(b) effective temperature(T*)=0.28

total energy of the HM at U=1.0, 2.0 is plotted as a function of beta(β). Horizontal line correspond the energy after interaction quench. Intersection point is the temperature of the system after interaction quench.



(a) effective temprature(T*) = 0.70



(b) effective temprature(T*) = 0.90

we see the interaction is quenched with initial non-interating state at T=0.0625. effective temperature of the system increases with the quenched interaction value.

References

[1] Hideo Aoki, Naoto Tsuji, Martin Eckstein, Marcus Kollar, Takashi Oka, and Philipp Werner. Nonequilibrium dynamical mean-field theory and its applications. *Rev. Mod. Phys.*, 86:779–837, Jun 2014.

[2] Martin Eckstein, Marcus Kollar, and Philipp Werner. Thermalization after an interaction quench in the hubbard model. *Phys. Rev. Lett.*, 103:056403, Jul 2009.

[3] Martin Eckstein, Marcus Kollar, and Philipp Werner. Interaction quench in the hubbard model: Relaxation of the spectral function and the optical conductivity. *Phys. Rev. B*, 81:115131, Mar 2010.

[4] Naoto Tsuji and Philipp Werner. Nonequilibrium dynamical mean-field theory based on weak-coupling perturbation expansions: Application to dynamical symmetry breaking in the hubbard model. *Phys. Rev. B*, 88:165115, Oct 2013.