X-Method

icf

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1 X-Method

The problem will be solved in five steps:

1) Pre-analysis
2) Matlab Program Modification
3) Input/Output
4) Discussion

Notice:
Calculation used these parameters below if no special mention:
L_y=1;
L_z=1;
N_y=1;
kx=0;
ky=0;
kz=0;
tx=1;
ty=1;
tz=1;
U=4;

1.1 Pre-analysis

Model:

$$|\varphi>=\sum_{\overrightarrow{x},\overrightarrow{y}} e^{\overrightarrow{x}^{\dagger} W \overrightarrow{y}} *(e^{\sum_i a_i*x_i*n_i}|\phi_{1_{up}}>)\bigotimes(e^{\sum_i -a_i*x_i*n_i}|\phi_{1_{dn}}>)\bigotimes(e^{\sum_i a_i*x_i*n_i}|\phi_{2_{up}}>)\bigotimes......$$

where $|\phi_* >$ is one particle state, n_i is particles number operators and $\overrightarrow{a}$, w are variational parameters and the number of variational parameters is linear to $N\_sites * N\_par$. (the size of lattice: N_sites, the number of particles N_par.)

Many symmetry can be used in the calculation to accelerate this algorithm. In this report, "half-filled" (Spin symmetry) is used.

1.2 Matlab Program Modification

X.m;
Energy_X_RBM.m;
X_RBM_update.m;
X_RBM_Initialzation.m;
H_K.m;

1.3 Input/Output

1.fig;
2.jpg;
3.jpg;

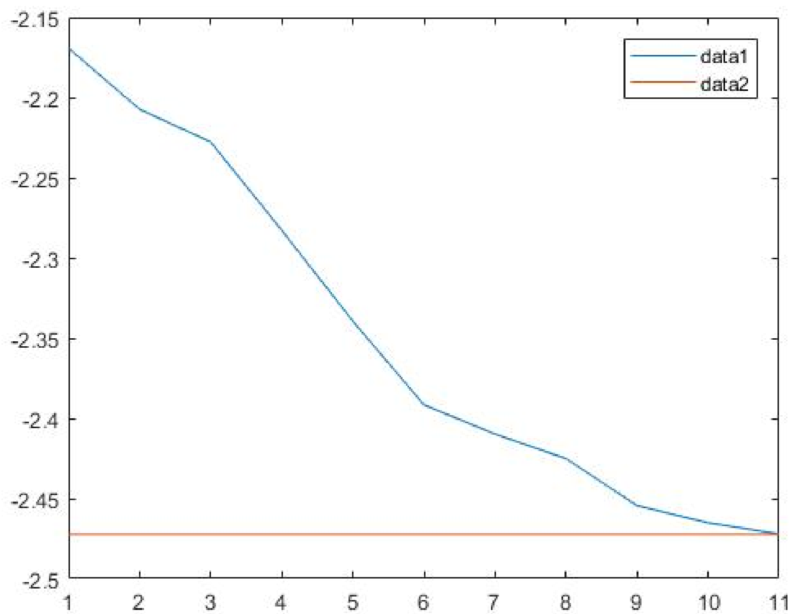

Figure 1: 1.fig; L_x=2,N_up=1,N_dn=1; data1 are X-Method results and data2 is PCMC result.

1.4 Discussion

1. Since this code is a "brute force" application of this algorithm, many methods can be used in improving efficiency like QMC and other efficient variational approach.

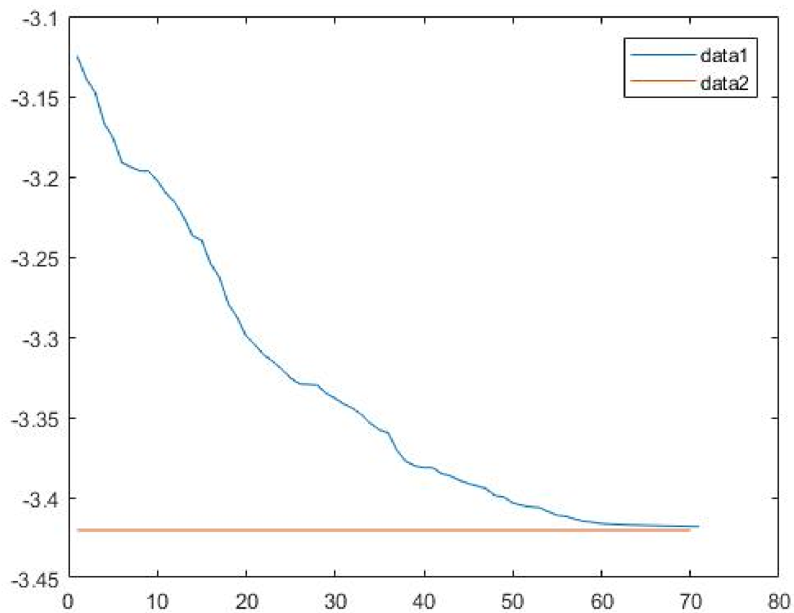

Figure 2: 2.fig; L_x=4,N_up=1,N_dn=1; data1 are X-Method results and data2 is PCMC result.

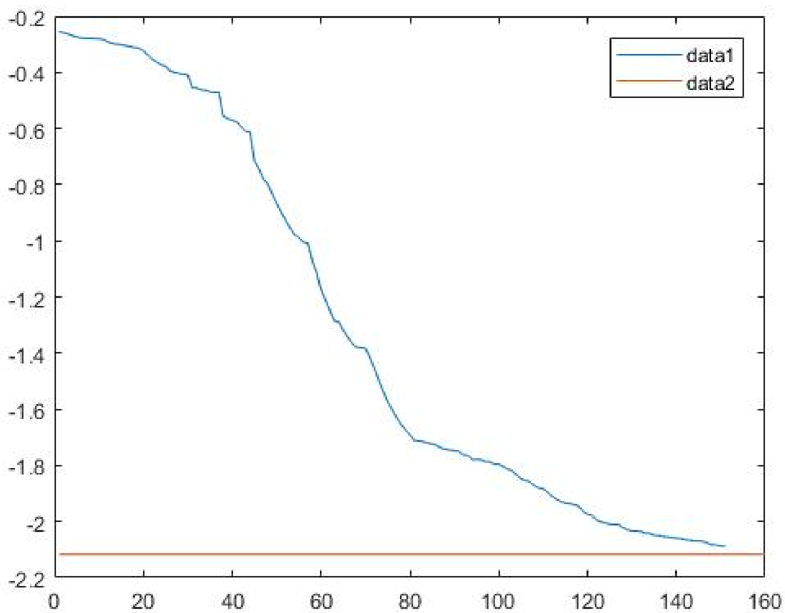

Figure 3: 3.fig; L_x=4,N_up=2,N_dn=2,kx=0.0819; data1 are X-Method results and data2 is exact result.

2. By observing optimized parameters a and w, many hidden symmetry can be found and also those symmetry can be used immediately in following calculation.

3. The variational field is very smooth which means it is hard (never) to be trapped in local minimal.