Statistische Physik im Gleichgewicht

Dr. Milos Knezevic, Dr. Jeanine Shea   Abgabe 29.01.2024

Problem 18: Ising model with an interface   (*5 Points*)

Use a different boundary condition for the simulation of the Ising model. Instead of periodic boundary conditions, we set the boundary sites to a constant value: the inside of the system should have a box length $L_{\text{int}} = 32$, and the box length including the boundary layer is $L = 34$. Set all spins on the boundary in the upper half of the system to -1 and those in the lower half to $+1$. After equilibration, plot the state of the system every 10 steps (for example by using different colors for $S = \pm 1$) for a total of 100 steps. Do this for one temperature below and one temperature above T_C.

Problem 19: XY model   (*5 Points*)

Adapt the importance sampling method such that you simulate the Hamiltonian of the XY model:

$$H = -J \sum_{\langle ij \rangle} \cos \left(\phi_i - \phi_j \right) - h \sum_i \cos \left(\phi_i \right).$$

Here, the spins (expressed by the cosine term) can take on continuous values. Write a simulation algorithm with periodic boundary conditions, where the box length, the interaction strength J and the external field h can be set. Perform a simulation with $L = 32$. Use $\phi_i = \pi \forall i$ as your initial condition. Use $\beta = 1$, $J = 2.5$ and $h = 0.1$. Plot the end state after 100 sweeps.

Hint: In principle, the method functions similar to the Ising model. However, instead of flipping the spin, one tries out a new random angle ϕ_i successively for every site i. Here, the random angle should lie between $\phi_i = -\pi$ and $\phi_i = \pi$.

Feedback:

Roughly how much time did you spend on this problem set?