

INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI

Department of Physics

PH415: Simulation Techniques in Physical Systems Ising Model: Test-4

Simulate the following.

Problem.1: Write a program for a Monte Carlo (MC) simulation to study the phase transition in 2-dimensional Ising model on a square lattice (128×128) with periodic boundary conditions. Set the interaction strength $J = 1$ and the Boltzmann constant $k_B = 1$. Implement the single spin flip Metropolis algorithm for sampling. The critical temperature of the 2d Ising model is $T_c = \frac{2}{\ln(1+\sqrt{2})} = 2.269185$.

(a) Plot energy per site $E(t)$ and magnetization per site $m(t)$ against the MC time steps t up to $t_{max} = 50,000$ at $T < T_c$, $T = T_c$ and $T > T_c$ (the values of T below and above T_c as per your choice). Print the final lattice configurations for all three temperatures.

(b) Varying the temperature from $T = 1.25$ to $T = 3.25$ in steps of $\Delta T = 0.05$, measure and plot the average energy per site $\langle E(T) \rangle$, magnetization per site $\langle m(T) \rangle$, susceptibility $\chi(T)$ and heat capacity $c(T)$ with respect to temperature T . Mention the initial number of configurations N_I skipped to achieve equilibrium for different temperature regions.

Note: For ensemble average take at least 1000 configurations. During ensemble average, skip at least 100 MC cycles per lattice site between two configurations to avoid correlation.