Computational Manybody Physics

Problem Set #1

In this problem set, we will implement a Monte Carlo simulation of a 2D-Ising model

$$H = -\sum_{\langle ij \rangle} \sigma_i \sigma_j - h \sum_i \sigma_i$$

on a square lattice with dimensions $L \times L$ with periodic boundary condition.

1. Use Jupyter notebook to plot m vs T, $|m|$ vs T, E vs T, C_v vs T, χ vs T, and U_2 vs T for system sizes of $L = 8, 16, 32, 64$. Determine T_c.

2. Implement the Wolff cluster update with improved estimator χ. Compare with the result you obtained previously.

3. Measure the autocorrelation time of E and $|m|$ for the Metropolis and Wolff updates.

4. Using the simulation data, determine the critical exponents α,β, γ and ν. Plot the data collapse for $|m|$, χ, and C_v