Prof. Dr. B. Eckhardt
Fachbereich Physik

Philipps Universität Marburg
14. May 2018

Computational Physics II
SS 2018

Deadline: 23. May 2018
Please turn in a written documentation of your results and submit the programs to Jonathan Prexl at *jonathan.prexl@physik.uni-marburg.de*

5.1. Ising models

The aim here is to explore the properties of the 2-d Ising model with Hamiltonian

$$H = -J \sum_{nn} S_i S_j + H \sum S_i \tag{1}$$

where $S_i = \pm 1$ and nn means nearest neighbors on a square lattice.

Set up a programme that efficiently simulates the system on an $N \times N$ square lattice with suitable boundary conditions (periodic or cyclic). Extract as the primary observables the mean magnetization per spin $\langle M \rangle$ and the mean energy per spin $\langle H \rangle$.

a) Estimate the critical temperature T_c for $H = 0$ by comparing results for different lattice sizes.

b) Estimate the critical exponent for the magnetization for $T < T_c$,
i.e. $\langle M \rangle \sim 1/|T_c - T|^{\beta_M}$.

c) In all preceeding problems, $H = 0$. Now turn on an external magnetic field H and calculate $M(T, H)$ for four cases of $H \neq 0$.

d) Ferromagnets have a remnant magnetization even at zero field. Compare $\langle M \rangle(H)$ for fixed T, when H is slowly switched from large negative values to large positive values. What are the differences for T above and below T_c?