

Computational Quantum Physics

Week 9

Due on Week 11

Exercise 1: Ising Model

Consider N spin-1/2 particles on a one-dimensional lattice, described by the Hamiltonian

$$\hat{H} = \lambda \sum_i^N \sigma_z^i + \sum_i^{N-1} \sigma_x^{i+1} \sigma_x^i,$$

where σ 's are the Pauli matrices and λ is the interaction strength.

- (a) Write a program that computes the $2^N \times 2^N$ matrix representation of the Hamiltonian \hat{H} for different N .
- (b) Diagonalize H for different $N = 1, \dots, N_{max}$ and $\lambda \in [0 : 3]$. How big is N_{max} you can reach?
- (c) Plot the first k levels as a function of λ for different N . Comment the spectrum.