

# Quantum Information and Computing

Assignment 7 (due in two weeks)

December 6, 2022

1. **Ising model** Consider  $N$  spin-1/2 particles on a one-dimensional lattice, described by the Hamiltonian:

$$\hat{H} = \lambda \sum_i^N \sigma_i^z + \sum_i^{N-1} \sigma_i^x \sigma_{i+1}^x \quad (1)$$

where  $\sigma_x$  and  $\sigma_z$  are the Pauli matrices and  $\lambda$  is the interaction strength.

- (a) Write a program to compute the  $2N \times 2N$  matrix representation of the Hamiltonian  $\hat{H}$  for different  $N$ .
- (b) Diagonalize  $H$  for different  $N = 1, \dots, N_{max}$  and  $\lambda \in [0 - 3]$ . What is the largest  $N_{max}$  you can reach?
- (c) Plot the first  $k$  levels as a function of  $\lambda$  for different  $N$  and comment on the spectrum.