PROBLEM SET 5 [Due Tuesday, March 5]

Physics 210– Computational Physics

The goals of this problem set are (i) to learn how to solve the spin-1/2 Heisenberg model by exact diagonalization, and (ii) to learn to solve the time independent Schroedinger equation numerically to get the energy eigenvalues.

[**1.**] Solve the four site (2x2) Heisenberg model by exact diagonalization. That is, enumerate the sixteen possible states and compute the action of the Hamiltonian on each state. Then use your diagonalization routine to compute the eigenvalues of the resulting matrix. Compare with the exact answer.

[**2.**] *This problem is optional.* Solve the eight site ($\sqrt{8}$ x $\sqrt{8}$) Heisenberg model by exact diagonalization.

[**3.**] Find the lowest energy eigenvalue of a particle in a infinite square well $V(x) = 0$ for $|x| < L$ and $V(x) = \infty$ for $|x| > L$ using the numerical procedure discussed in class. Compare with the exact answer.

[**4.**] Find the first excited state energy eigenvalue of a particle in a infinite square well $V(x) = 0$ for $|x| < L$ and $V(x) = \infty$ for $|x| > L$. Compare with the exact answer.

[**5.**] *This problem is optional.* Find the lowest energy eigenvalue of a particle in a harmonic oscillator potential $V(x) = \frac{1}{2}m\omega^2x^2$. Compare with the exact answer.