PHYSICS 104A, FALL 2018
MATHEMATICAL PHYSICS

Assignment Six, Due Monday, November 19, 5:00 pm.

[1.] The Hamiltonian of a quantum mechanical system, and its initial wavefunction, are given by

$$H = \hbar\,\omega_0 \begin{pmatrix} 1 & 2 & 0 \\ 2 & 1 & 0 \\ 0 & 0 & 4 \end{pmatrix} \qquad\qquad \vec{\Psi}(t=0) = \begin{pmatrix} 1/2 \\ 1/2 \\ 1/\sqrt{2} \end{pmatrix}$$

Here ω_0 is a number with the units of inverse time (frequency). Using the basic rule for time evolution in quantum mechanics, $\vec{\Psi}(t) = \exp\left(-iHt/\hbar\right) \vec{\Psi}(t=0)$, compute $\vec{\Psi}(t)$.

[2.] For the same quantum mechanical system of problem 2, there is also a quantity Q you want to measure. It has the matrix

$$Q = Q_0 \begin{pmatrix} 1 & -1 & 0 \\ -1 & 2 & -1 \\ 0 & -1 & 1 \end{pmatrix}$$

What are the probabilities to get different possible values for Q? (Note: the answers will depend on time!)

[3.] In class we solved the problem of two *equal* masses $m_1 = m_2$ connected by a spring of force constant k. Generalize the solution to $m_1 \neq m_2$. Write equations for $x_1(t)$ and $x_2(t)$ given $x_1(0)$, $x_2(0)$, $v_1(0)$, and $v_2(0)$.

[4.] Solve for the eigenfrequencies and eigenvectors (i.e. the normal modes) of four equal masses connected by three springs (i.e. with open boundary conditions).