Quantum Mechanics II

Assignment 5

Due: November 14 (Thursday), 2013

1. A particle is in the nth state of a one-dimensional harmonic oscillator with the energy eigenvalues $E_n = \hbar\omega(n + 1/2)$. Suppose the system is perturbed by

$$V(t) = \begin{cases} 0, & t < 0 \\ \lambda x \sin \omega_1 t e^{-\alpha t}, & t \geq 0 \end{cases} \tag{1}$$

   Calculate the transition probability to the mth state. What are the possible m values for nonzero transitions?

2. A particle with electric charge q is placed in a magnetic field $\mathbf{B} = (0, 0, B)$ and an electric field $\mathbf{E} = (E, 0, 0)$. What are the energy eigenvalues of the system? (Choose the gauge properly.)

3. Compute the $2p \to 1s$ transition rate for a harmonic oscillator. In this case, we are given that the energy eigenvalues are $E = \hbar\omega(n + 3/2)$ and the energy quantum number $n = 2n_r + l$ with $n_r = 0, 1, 2, \cdots$, $l = 0, 1, 2, \cdots$.