Homework Set 12

Due November 30, 2020

1. Consider a one-dimensional simple harmonic oscillator with classical angular frequency ω_0.

   It is in the ground state until time $t = 0$, when a small time-dependent potential is turned on

   $$V(t) = F_0 \ \hat{x} \cos(\omega t), \tag{1}$$

   where F_0 is a constant.

   Obtain the expectation $\langle x \rangle$ as a function of time to first order in time-dependent perturbation theory.

   Is this procedure valid for $\omega \simeq \omega_0$?

   Note the useful relation for energy eigenstates of the simple harmonic oscillator

   $$\langle n'|\hat{x}|n\rangle = \sqrt{\frac{\hbar}{2m\omega_0}} \left(\sqrt{n+1}\delta_{n',n+1} + \sqrt{n}\delta_{n',n-1} \right) \tag{2}$$