Homework #1, PHY 215C

Due: April 11, 2017

Problem 1. Hydrogen Atom in an t-dependent E-field. 20 points.

An H atom is in the ground state at $t = -\infty$. An electric field

$$\vec{E}(t) = (\hat{k}\mathcal{E})\frac{\tau^2}{t^2+\tau^2}$$

is applied until $t = \infty$. Calculate the probability that the atom ends up in any of the n=2 states, to first order. Compare to Shankar's Exercise 18.2.2, which gives the answer for a somewhat different time dependence: are they nearly the same for a given τ, or are there essential differences?

Problem 2. Effect of Shape of t-dependence. 20 points.

Do the perturbed oscillator problem what we went through in class, and is in Shankar just before Ex. 18.2.1. EXCEPT – turn on the perturbation (electric field) abruptly at $t = -\tau$ and turn it off abruptly at $t = \tau$. Find the similarities and differences. Are there effects of the abrupt turn on and turn off? What about the length of the interval 2τ?

Problem 3. An Old Problem: Angular Momentum Projection Operators. 20 points.

Back to $\vec{J_1} + \vec{J_2} = \vec{J}$ projections operators. Consider $J_1 = 1, J_2 = 2$. Let $\hbar = 1$ for simplicity. I will tell you that each of the three projection operators onto the total-J subspaces $J = 3, 2, 1$ are a linear combination of three operators: the identity $\mathcal{I}$, $\vec{J_1} \cdot \vec{J_2}$, and $(\vec{J_1} \cdot \vec{J_2})^2$. Work out the procedure for determining the coefficients of these operators for a given subspace. Hint: stay in the total-J representation throughout (not that you need to do any angular momentum calculations, you do not).