Physics 622

Problem set 4 *(due February 27)*

Sakurai and Napolitano problems (each problem is 10 points):

5.28, 5.29, 5.30

A1. **Hydrogen atom in electric field**. A hydrogen atom is in the ground state at $t = -\infty$. A pulsed electric field in z-direction $\mathcal{E}\cdot exp(-t^2/\tau^2)\hat{}$ is applied until $t = \infty$.

a) Show that the probability that the atom ends up in any of the $n = 2$ states is, to first order, is

$$\left(\frac{e\mathcal{E}}{\hbar}\right)^2 \left(\frac{2^{15} a_0^2}{3^{10}}\right) \pi\tau^2 e^{-\omega^2\tau^2/2}$$

where $\omega = (E_{2lm} - E_{100})/\hbar$.

b) Discuss (without calculations) if the answer depend on whether or not we take into account the electron's spin?

The following problem is very relevant to our current topic, but it is also a former qualifier problem.

A2. **Moving quantum well**. An infinitely deep quantum well of width L is moving with a constant speed v along the x-axis as shown below.

(a) Find wave functions and corresponding energies of a particle of mass m in such a potential. Verify that your answer is a solution of the Schrodinger equation.

(b) Suppose that at time t= 0 the potential well instantaneously comes to stop. Assuming that the particle was in the ground state of the moving potential well, write down the expression for the probability of finding it in the k^{th} state of the stationary well. *You don't have to evaluate the final integrals.*

(c) Assign a condition for the smallness of the well velocity, such that the particle most likely does not change its quantum state when after the well stops. Give some intuitive physical explanation for your answer.