

Physics 7502 Quantum Mechanics Spring 2019

Assignment 3

Given: Monday Jan 21, 2019, Due Mon Jan 28

The goal of this assignment is to derive all the steps involved in the derivation of the Stark effect.

Problem 1 By any method you like, find and normalize the spherical harmonics Y_{00}, Y_{1m} , and check that you get the results given in chapter 7 of the text (pg 127).

Problem 2 Solve the recursion relation for the function $H(\rho)$, and thus write the radial wavefunctions for the levels $(n, l) = (1, 0), (2, 0), (2, 1)$. Normalize the radial wavefunctions $R_{n,l}$, and check that you get the results given in chapter 8 in the text (pg 138).

Problem 3 Using the two problems above, write the full normalized wavefunctions for the levels $(n, l, m) = (1, 0, 0), (2, 0, 0), (2, 1, 0), (2, 1, \pm 1)$.

Problem 4 Find the perturbation Hamiltonian \hat{H}_1 starting from the fact that it describes the effect of an electric field \mathcal{E} on an electron.

Problem 5 Use symmetry arguments to find which elements of \hat{H}_1 are nonzero between the states you have written in problem 3.

Problem 6 Find the nonzero matrix elements of \hat{H}_1 that will be involved in the linear order Stark effect.

Problem 7 Diagonalize \hat{H}_1 to find the energy levels and the wavefunctions for the Stark effect.