

PHY 491 - 2013

Atomic, Molecular, and Condensed Matter Physics

Problem Set 3

1. Consider a hydrogen atom. Seek the variational electron wave function in the form $\psi(\mathbf{r}) = (\pi a^3)^{-1/2} \exp(-r/a)$ with an unknown a (the function should be normalized!). Find the energy $\int \psi^*(\mathbf{r}) \hat{H} \psi(\mathbf{r}) dV$ using the electron Hamiltonian in the hydrogen atom. This energy will be a function of a . Minimize this function with respect to a and find the variational value of the energy in the ground state (5 pt)
2. Consider a helium atom. Seek the electron wave function of the ground state in the Hartree form, $\Psi(\mathbf{r}_1, \mathbf{r}_2) = \psi(\mathbf{r}_1)\psi(\mathbf{r}_2)$ and use for $\psi(\mathbf{r})$ the same form as for the wave function of the ground state of the hydrogen atom in problem 1, and again assume that a is a variational parameter. Find the ground-state energy (10 pt).

The solution is due on September 25.