

Assignment XII: Boundary Value Problems

Due 11/29/2016

1. (6 pts) Consider the same 3D harmonic oscillator as in problem 2 of Homework 6.
 1. Set up a boundary value differential equation to solve for $l = 0$ and $u(\rho)$. Use *either* the Runge-Kutta 4th order code `rk4.f90` and the shooting method *or* implement the Numerov algorithm, which is of higher order. Calculate the ground state energy with a precision of 4 significant figures and demonstrate how you arrived at the required accuracy. Normalize your wave function and compare with the result you obtained in Homework 7. Plot both wave functions.
 2. Calculate the energy of the first excited state with the same accuracy and show that its wave function is orthogonal to the ground state wave function.
 3. Solve the lowest energy for $l = 2$ with the same accuracy, Normalize and plot your wave function.
 4. Add a quartic term $\lambda\rho^4$ to your oscillator as perturbation, and choose $\lambda = 0.1$. Calculate the ground state energy and wave function for $l = 0$.