PHYS 451 Quantum Mechanics I (Spring 2018)
Homework #6, due Thursday March 1 in class

General formalism of quantum mechanics, Spherical harmonics

1. Problem 3.22 in Griffiths.

2. Problem 3.23 in Griffiths.

3. By considering the rate of change of operator xp_x derive the virial theorem in 1D:

$$2\langle T\rangle = \left\langle x\frac{\partial V}{\partial x}\right\rangle,$$

where T and V are the kinetic and potential energy respectively. Next, generalize the theorem to the 3D case, i.e. consider operator $\mathbf{r}\cdot\mathbf{p}$.

4. An electron is confined in an infinitely deep cubic potential well, whose sides are of length a and are parallel to the x, y, and z-axes.

   (a) Write the time-independent wave function corresponding to the states of the lowest and second lowest energy.

   (b) What is the degeneracy of energy levels for this system?

   (c) Find the number of states, N, that have energy less than some given E.

5. Write all spherical harmonics up to $l = 2$ (there are nine of them) in Cartesian form, i.e. give expressions in terms of x, y, z, and $r = \sqrt{x^2+y^2+z^2}$. You can either use the Rodrigues formula for the Legendre polynomials or start with the given expressions for Y_l^m in terms of θ and ϕ. In any event you must show your work.

Found an error or need a clarification? Email the instructor at sergiy.bubin@nu.edu.kz