UCSD Physics 130b *Quantum Mechanics* Assignment 1

Prof. B. Keating Assigned: October 8 Due: October 15, 2014: in Class

LATE HOMEWORK INCURS -10%/WEEKDAY LATE, UP TO 50% MAXIMUM

The purpose of this homework set is to make sure you are familiar with the basic "tools" of quantum mechanics.

1 Angular Momentum

Using the quantum mechanical angular momentum operators expressed in Cartesian coordinates:

(i) Prove that $[L_x, L_y] = L_x L_y - L_y L_x = i\hbar L_z$.

(ii) Prove that $[\mathbf{A}^2, \mathbf{B}] = \mathbf{A}[\mathbf{A}, \mathbf{B}] + [\mathbf{A}, \mathbf{B}]\mathbf{A}$, where **A,B** are quantum operators that do not commute.

(iii) Prove that $[L^2, L_z] = 0$

(iv) Discuss briefly the physical significance of the results derived in parts (i) (ii) and (iii).

2 Central potential

Solutions to the Schrodinger equation for all central potentials can be written using separation of variables into a radial part $R(r)$ multiplying an angular part $Y_\ell^m(\theta, \phi)$. Using the radial equation for the hydrogen atom as given in the text

(i) By substituting into the radial equation and collecting terms, find the values of a, ℓ and E for which the function $R(r) = Cr^2 \exp[-r/a]$ is a solution. Here, C is a normalization constant.

(ii) What is the magnitude of the angular momentum for the state with this wave function?

(iii) What are the physical significances of the terms a and E?

3 Griffiths Problem 4.33