Universität Leipzig, Fakultät für Physik und Geowissenschaften

Exercises for Experimental Physics 4 – IPSP

Prof. Dr. J. Käs, Dr. M. Zink

Exercise Sheet 8 (Summer Term 2013)

Date of Issue to Students: June 4st 2013

Date of Submission: June 11th 2013

Submission Place: Marked mailbox next to room 302 (Linnestr. 5)
Submission Time: 11:00 a.m. at the submission day noted above

Please note: Write your name and matriculation number on EACH sheet of paper.
Only submit the calculations and results for exercise 1-3, exercise 4 will be discussed during the instruction classes.

Exercises:

1. An electron in an atom has principle quantum number $n = 3$. (a) What are the possible values of l? (b) What are the possible combinations of l and m. (c) Using the fact that there are two quantum states for each combination of l and m because of electron spin, find the total number of electron states for $n = 3$ from calculation. (8 Points)

2. Show that the radial probability density for the $n = 2$, $l = 1$, and $m = 0$ state of a one-electron atom can be written as $P(r) = A \cos^2 \theta r^4 e^{-Zr/a_0}$, where A is a constant. (6 Points)

3. Show that the number of states in the hydrogen atom for a given n is $2n^2$. (6 Points)

4. (a) A hydrogen atom is in the state $n = 3$, $l = 2$. What are the possible values of j?
(b) Using a scaled vector diagram, show how the orbital angular momentum $\vec{L}$ combines with the spin angular momentum $\vec{S}$ to produce the two possible values of total angular momentum $\vec{J}$ for the $l = 3$ state of the hydrogen atom.