Universität Leipzig, Fakultät für Physik und Geowissenschaften

Exercises for Experimental Physics 4 – IPSP

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Exercise Sheet 10 (Summer Term 2013)

Date of Issue to Students: June 18st 2013

Date of Submission: June 25th 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. A mixture of iron and another unknown element is irradiated with electrons. The wavelength of the K_α line is 194 pm for pure iron and 229 pm for the unknown materials. Determine the unknown material. (4 Points)

2. (a) A laser applied to re-attach a retina in the eye emits light pulses of 25 ms of wavelength 640 nm which corresponds to a laser power of 0.65 W per pulse. How much energy per pulse can be emitted and how many photons is that?
(b) Estimate the divergence (angular width) of the laser beam (wavelength: 694 nm) due to diffraction, when the laser beam leaves a semi-transparent mirror of 3.0 mm diameter. (7 Points)

3. The difference between the $2P_{3/2}$ and the $2P_{1/2}$ energy level of the hydrogen atom is $5 \cdot 10^{-5}$ eV due to spin-orbit coupling. (a) Estimate the internal magnetic field due to orbital motion of the electron by using Bohr's magnetron for the magnetic moment of the electron. (b) Estimate the internal magnetic field by assuming a simple nucleus which moves on a circular orbit around the electron. (9 Points)

4. In the so-called vector model of the atom the quantization of the angular momentum direction can be illustrated as in Figure 1. Assume that the vector of the angular momentum with absolute value $L = \sqrt{l(l+1)}\hbar$ employs a precession around the z-axis (similar to a gyro) that the z-component of the angular momentum $L_z = m\hbar$ remains constant. Calculate the possible values of the angle θ between **L** and the z-axis for (a) $l = 1$, (b) $l = 2$, and (c) $l = 3$. (d) Determine the minimal value of θ for $l = 100$ and $l = 10^6$. Is the result in agreement with the principle of correspondence?

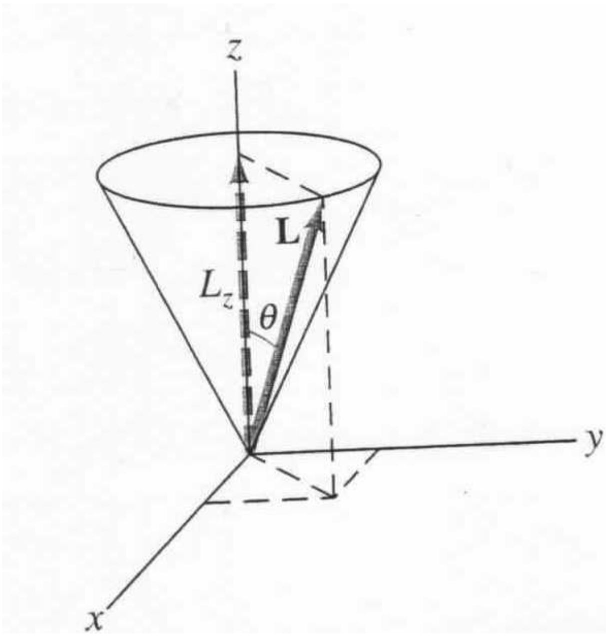

Figure 1: Exercise 1: Vector model of the angular momentum. Precession around the z-axis for L and L_z constant, L_x and L_y vary with time.