Structure of matter: Series 6

Due on December 7th 2017 after the lecture

Please indicate your name and the name of your seminar group leader on the solution sheets!

1. Calculate the minimum angle formed between the angular momentum vector **L** and the z-axis in a d-state (l=2, m_z=-2,-1,0,1,2). (4 Points)
2. At t = 0 the electron in a hydrogen atom shall be described by the following state consisting of a superposition of eigenstates Ψ_{nlm}

$$\psi(\vec{r}, t=0) = \frac{1}{5}\left(3\psi_{100}(\vec{r},0) - 2\psi_{211}(\vec{r},0) + \sqrt{12}\psi_{21-1}(\vec{r},0)\right)$$

a) Calculate the expectation value of H (in units of the Rydberg-energy R_y) as well as the expectation values of $\hat{\boldsymbol{L}}^2$ and $\hat{L}_z$ at t = 0.

b) What is the probability to find the system at a certain time t in the n = 2 eigenstate ?

(5 points)

3. Analyze the atomic states $^3P_1$ and $^3D_2$.

a) What are the spin S, orbital angular momentum L and total angular momentum J quantum numbers of these states?
b) Are there (electric) dipole allowed transitions between these states possible?
c) Assume that the atoms described by the given atomic states are subject to a very strong external magnetic field. How many levels would you observe when we assume a gyromagnetic factor of the electron of g=2? (1+2+3points)