PH3521701 现代原子物理 **2019-03-15**

Lecture summary

- Angular momentum basics
- Coupling of angular momenta
  - The hyperfine structure of the hydrogen groundlevel
- Clebsch-Gordan coefficients
- Wigner's 3j symbol
- Rotation d-matrix
- Representation of vector in the spherical coordinates
- Polarization of light
- E1 transition
  - Lifetime
  - Oscillator strength
  - Selection rules
- Examples of the Wigner-Eckart Theorem
- Two-photon transition
- E2 transition
- Fluorescence, angular distribution and polarization

Homework

1. **Angular momentum coupling**. A system of two angular momenta j_1 m_1 and j_2 m_2 has a total number of $(2j_1 + 1)(2j_2 + 1)$ states. The two couple to form a combined system of angular momentum J, whose maximum value is $J_{max} = j_1 + j_2$. Find the minimum value for J based on the expectation that the total number of states in the coupled system should equal to that of the original uncoupled system.

2. The **3j symbols** satisfy the following exchange properties:

$$\begin{pmatrix} j_1 & j_2 & j_3 \\ m_1 & m_2 & m_3 \end{pmatrix} = \begin{pmatrix} j_2 & j_3 & j_1 \\ m_2 & m_3 & m_1 \end{pmatrix}$$

$$\begin{pmatrix} j_1 & j_2 & j_3 \\ -m_1 & -m_2 & -m_3 \end{pmatrix} = (-1)^{j_1+j_2+j_3} \begin{pmatrix} j_1 & j_2 & j_3 \\ m_1 & m_2 & m_3 \end{pmatrix}$$

   Express these two types of relations in terms of C-G coefficients.

3. In the table of **Clebsch-Gordan coefficients** (Figure 35.1), find each case of the C-G coefficient being equal to zero, and show that it should be zero based on symmetry properties.

4. Textbook Exercise (2.10) Transitions

5. Textbook Exercise (2.13) Selection rules in hydrogen

Reading Assignments:

Textbook, Appendix E, Raman and two-photon transitions