Week 8: Quantum States for Many-Electron Atoms

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Diskusjonsoppgaver

- Q11.1 Without invoking equations, explain why the energy of the triplet state is lower than that of the singlet state for He in the $1s^1 2s^1$ configuration.
- Q11.6 Why are n, l, m_l, and m_s not good quantum numbers for many electron atoms?
- Q11.4 Why is atomic absorption spectroscopy more sensitive in many applications than atomic emission spectroscopy?
- P11.29 The principal line in the emission spectrum of sodium is yellow. On close examination, the line is seen to be a doublet with wavelengths of 589.0 and 589.6 nm. Explain the source of this doublet.
- Q12.4 Why is it reasonable to approximate H_{11} and H_{22} by the ionization energy of the corresponding neutral atom?
- Q12.23 If there is a node in an ungerade wavefunction Ψ_u, is the electron in this wave function really delocalized? How does it get from one side of the node to the other?

Regneoppgaver gjort av meg

- How many states are consistent with a d^3 configuration? What L values result from this configuration?
- What atomic terms are possible for the following electron configurations? 1. ns^1np^1 2. ns^1np^2
- P12.3 Follow the procedure outlined in Section 12.3 to determine c_u in Equation (12.17), i.e. find c_u such that

$$\psi_u = c_u(\phi_{H1s_a} - \phi_{H1s_b})$$

is normalized.

Regneoppgaver for dere

- P11.3 How many ways are there to place three electrons into an f subshell? What is the ground-state term for the f^3 configuration, and how many states are associated with this term?
- P11.14 What J values are possible for a $^6\mathrm{H}$ term? Calculate the number of states associated with each level and show that the total number of states is the same as that calculated from

$$(2S + 1)(2L + 1)$$

- P11.19 Two angular momenta with quantum numbers $j_1 = 3/2$ and $j_2 = 5/2$ are added. What are the possible values of J for the resultant angular momentum states?

Flere regneoppgaver

- P11.25 As discussed in Chapter 9, in a more exact solution of the Schrödinger equation for the hydrogen atom, the coordinate system is placed at the center of mass of the atom rather than at the nucleus. In that case, the energy levels for a one-electron atom or ion of nuclear charge Z are given by

$$E_n = -\frac{Z^2 \mu e^4}{32\pi^2 \varepsilon_0^2 \hbar^2 n^2}$$

where μ is the reduced mass of the atom. The masses of an electron, a proton, and a tritium $\left({}^3\mathrm{H} \text{ or T}\right)$ nucleus are given by $9.1094 \times 10^{-31}\ \mathrm{kg}, 1.6726 \times 10^{-27}\ \mathrm{kg}$, and $5.0074 \times 10^{-27}\ \mathrm{kg}$, respectively. Calculate the frequency of the $n = 1 \rightarrow n = 4$ transition in H and T to five significant figures. Which of the transitions, $1s \rightarrow 4s, 1s \rightarrow 4p$, or $1s \rightarrow 4d$, could the frequencies correspond to?