2e Werkcollege SdM: Atoms and Molecules: 2009

10 Juni 2009

6) Calculate the red-shift of an emitted Lyman-α photon due to the "recoil". Study Equation (3.61) and use it.
Think about what this means for observed spectra.

7) Consider a "two-level system" with energy levels E_2 (upper level) and E_1 (lower level) with populations $n_2(t)$ and $n_1(t)$. A rate equation including spontaneous emission with rate A, absorption with rate Bu_ν and stimulated emission with rate Bu_ν is as follows:

$dn_2(t)/dt = Bu_\nu n_1(t) - (A + Bu_\nu)n_2(t)$

- Solve this differential equation for $n_2(t)$ for boundary conditions $n_1(0)=N$ and $n_2(0)=0$, where $N = n_2(t) + n_1(t)$ is the total number of atoms.
- Show that at short times, defined as $(A + 2Bu_\nu)t << 1$, there is a steady growth of population in the excited state.
- How is the behaviour for $t \longrightarrow \infty$?
– Show that there is a maximum for ν_2 for all times and for all intensities u_ν. Consider even $u_\nu \longrightarrow \infty$. i.e. infinitely strong intensity.

8) Autoionization.
Consider an atom with Z=2. Calculate the binding energy for (n=2) and (n=4) electron orbitals. Assume now that the Z=2 atom has two electrons in states (n=2) and (n=4): calculate the binding energy of this two-electron system in the Bohr model. (*Hint*: neglect the energy related to the repulsive Coulomb potential between the two negatively charged electrons).
Explain why it is favourable that an atom rearranges via an "Auto-ionization process" by ejecting one electron, while the second makes a transition to a (n=1) state.
What is the kinetic energy of the ejected electron?

Uitgewerkte opgaven inleveren op Maandag 15 Juni