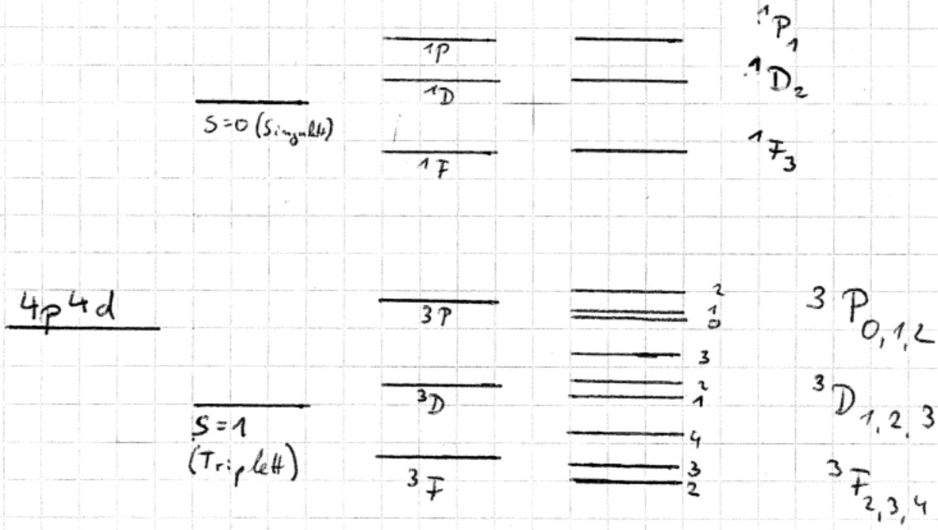
29)



Landé'sche Intervallregel: $\Delta E_{LS} = \lambda \hbar^2 J_>$

30 a) $^2S_{\frac{1}{2}}$ spaltet im B-Feld in 2 Niveaus auf:

$$E = g \mu_B \, m_s \, B \qquad m_s = \pm \tfrac{1}{2}$$

$$E_1 = + \mu_B B \qquad E_2 = -\mu_B B$$

b)

$$N_1 = A \cdot e^{-E_1/k_B T} \qquad N_2 = A \cdot e^{-E_2/k_B T}$$

$$N = N_1 + N_2 = A\left(e^{-\frac{E_1}{k_B T}} + e^{-\frac{E_2}{k_B T}}\right)$$

$$\Rightarrow A = \frac{N}{e^{-\frac{E_1}{kT}} + e^{-\frac{E_2}{kT}}}$$

$$\frac{N_1}{N} = \frac{e^{-\frac{E_1}{k_B T}}}{e^{-\frac{E_1}{k_B T}} + e^{-\frac{E_2}{k_B T}}} = \frac{e^{-\mu_B B/k_B T}}{e^{-\frac{\mu_B B}{k_B T}} + e^{\frac{\mu_B B}{k_B T}}} = \frac{1}{1 + e^{\frac{2\mu_B B}{k_B T}}}$$

$$\frac{N_2}{N} = \frac{1}{1 + e^{-2\mu_B B/k_B T}} \qquad \text{mit} \quad \frac{2\mu_B B}{k_B T} = \frac{2 \cdot 9{,}27 \cdot 10^{-24} \cdot 1}{1{,}38 \cdot 10^{-23} \cdot 1} = 1{,}34$$

$$\Rightarrow \frac{N_1}{N} = 0{,}21 \qquad \frac{N_2}{N} = 0{,}79$$

c) Besetzungsdichten ändern sich nicht:

$$\frac{2\mu_B B_1}{k_B T_1} \overset{!}{=} \frac{2\mu_B B_2}{k_B T_2} \qquad \frac{B_1}{B_2} = \frac{T_1}{T_2}$$

$$\frac{1\,T}{1\,K} = \frac{1\,mT}{1\,mK}$$

31)

a) $\left.\begin{array}{l}\Delta E \cdot \Delta t \approx \frac{\hbar}{2} \\ \Delta t = 10\,ns\end{array}\right\} \Rightarrow \Delta E \approx \frac{\hbar}{2 \cdot 10\,ns} \approx 0{,}5 \cdot 10^{-26}\,J = 3{,}3 \cdot 10^{-8}\,eV$

$E_n = -13{,}6\,eV \; \frac{1}{n^2}$

$\left|\frac{\Delta E}{E_2}\right| = \left|\frac{3{,}3 \cdot 10^{-8} \cdot 4}{-13{,}6}\right| = 1 \cdot 10^{-8}$ $\quad (\Delta E \ll E_2)$

b) $E_1 - E_2 = -13{,}6\,eV\left(1 - \frac{1}{4}\right) = -10{,}2\,eV$

$p_{Photon} = p_P = \frac{E}{c} = \frac{10{,}2\,eV}{3 \cdot 10^8\,\frac{m}{s}} = 3{,}4 \cdot 10^{-8}\,\frac{eVs}{m} = 5{,}44 \cdot 10^{-27}\,\frac{kg \cdot m}{s}$

$p_P \stackrel{!}{=} p_H \longrightarrow v_H = \frac{p_P}{m_H} = 3{,}3\,\frac{m}{s}$

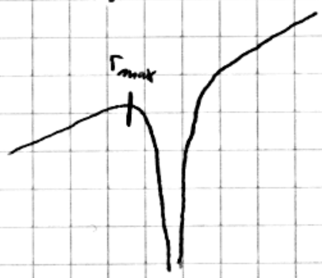
$E_{kin} = \frac{m}{2} v^2 = 9{,}09 \cdot 10^{-27}\,J = 5{,}6 \cdot 10^{-8}\,eV$

32) a) Coulombpotential und Potential des ext. Felds $\mathcal{E}$

$$V = -\frac{1}{4\pi\varepsilon_0}\,\frac{e^2}{r} - e\mathcal{E}r$$

mit Maximum bei : $\frac{dV}{dr} = \frac{1}{4\pi\varepsilon_0}\,\frac{e^2}{r^2} - e\mathcal{E} \overset{!}{=} 0$

$$\Rightarrow\ r_{max} = \sqrt{\frac{e}{4\pi\varepsilon_0}\,\frac{1}{\mathcal{E}}}$$



$$V_{max} = V(r_{max})$$

$$= -2e\sqrt{\frac{\mathcal{E}e}{4\pi\varepsilon_0}}$$

Ionisierung, wenn

$$E_n = -R_y\frac{1}{n^2} \overset{!}{=} -2e\sqrt{\frac{\mathcal{E}e}{4\pi\varepsilon_0}} \qquad (n=50)$$

$$\Rightarrow\ \mathcal{E} = \frac{R_y^2\cdot 4\cdot\pi\cdot\varepsilon_0}{\cancel{4}e^3 n^4} = \frac{R_y^2}{n^4}\cdot\frac{\pi\cdot\varepsilon_0}{e^3} = 5142\,\frac{V}{m} = 51{,}4\,\frac{V}{cm}$$

b) $r = n^2 a_0 = 1325\,Å = 0{,}1325\,\mu m$

maximales Dipolmoment $\quad p_{el} \approx e\cdot r = n^2 e a_0 = 2{,}12\cdot 10^{-26}\ C\,m$

c) $p_{el}\,\mathcal{E} = R_y\left(\frac{1}{n^2} - \frac{1}{(n+1)^2}\right)$

$$\Rightarrow\ \mathcal{E} = 1529{,}4\,\frac{V}{m} = 15{,}3\,\frac{V}{cm}$$