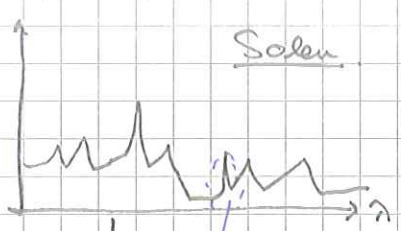
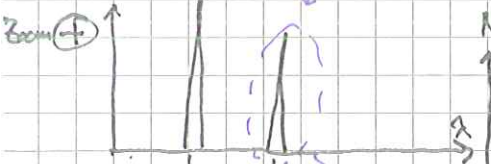
16/10 2012

{Atom} Zeemaneffekt finstrukturen.

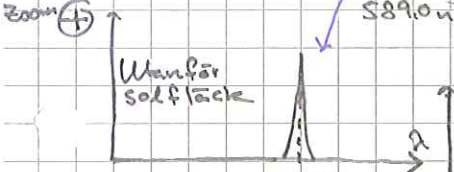
Solen



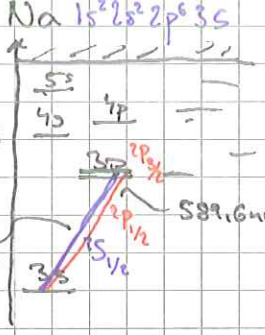
Zoom



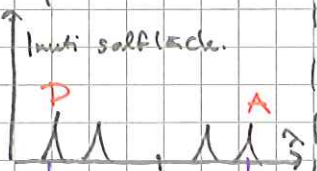
Zoom



Na $1s^2 2s^2 2p^6 3s$



Inuti solfläcke.



Beror på ett starkt magnetiskt fält i solfläcken!

$\Delta\lambda = 0{,}022\,nm$

$\mathcal{H}_{s-o} = -\vec{\mu}_s \cdot \vec{B}_{orb} = \beta \cdot \vec{S} \cdot \vec{L}$

$3s3p\ {}^3P$ → $^3P_2$, $^3P_1$, $^3P_0$

$\mathcal{H}_{ZE} = -\vec{\mu}_{atom} \cdot \vec{B}_{ext.}$ (*)

$\vec{\mu}_{atom} = -\mu_B \cdot \vec{L} - g_S \mu_B \cdot \vec{S} = -\mu_B \cdot \vec{J} - \beta \cdot \vec{S}$

$\Rightarrow (*) = -\frac{\langle \vec{\mu} \cdot \vec{J} \rangle}{\langle \vec{J}^2 \rangle} \cdot \vec{B} \cdot \hat{e}_z \cdot \beta \cdot J_z =$

$= -\frac{\langle (-\mu_B \cdot \vec{L} - g_s \cdot \mu_B \cdot \vec{S}) \cdot \vec{J} \rangle}{J(J+1)} \cdot \beta \cdot J_z =$

$= +\frac{\langle \vec{L} \cdot \vec{J} \rangle + g_s \langle \vec{S} \cdot \vec{J} \rangle}{J(J+1)} \cdot \mu_B \cdot B \cdot J_z \Rightarrow$

$\Rightarrow E_{ze} = g_J \cdot \mu_B \cdot B \cdot \mu_J$

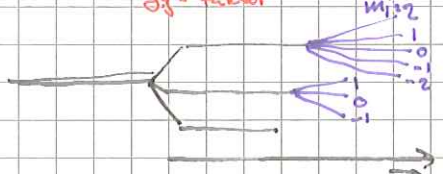
$\mu_L = -g_L \cdot \mu_B \cdot \vec{L}$, $g_L = 1$

$\mu_S = -g_S \cdot \mu_B \cdot \vec{S}$, $g_S \approx 2{,}00(2319\ldots)$

$9{,}27 \cdot 10^{-24}\ J/T = 5{,}78 \cdot 10^{-5}\ eV/T$

Landé's g-faktor

g_J - faktor



$\vec{L} \cdot \vec{J} = \vec{L}(\vec{L} + \vec{S}) = \vec{L}^2 + \vec{L} \cdot \vec{S} \Rightarrow L(L+1) + \frac{J(J+1) - L(L+1) - S(S+1)}{2}$

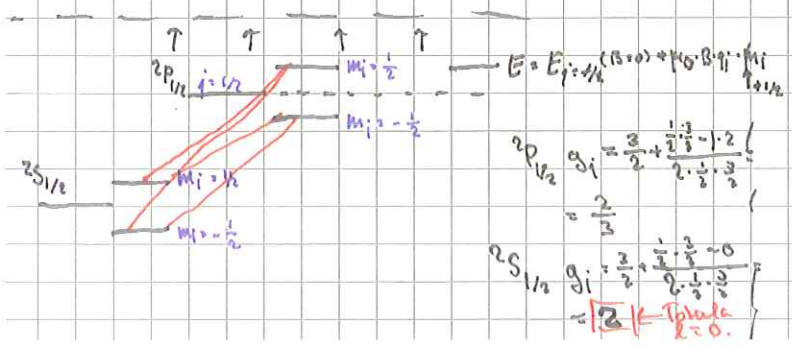
$\vec{S} \cdot \vec{J} = \vec{S}(\vec{L} + \vec{S}) = \vec{L} \cdot \vec{S} + \vec{S}^2 \Rightarrow S(S+1) + \frac{J(J+1) - L(L+1) - S(S+1)}{2}$

$g_S = 2.$

$\Rightarrow \boxed{g_J = \frac{3}{2} + \frac{S(S+1) - L(L+1)}{2J(J+1)}}$

Singletter $g_J = 1$.

Totala $L = 0 \Rightarrow g_J = 2$



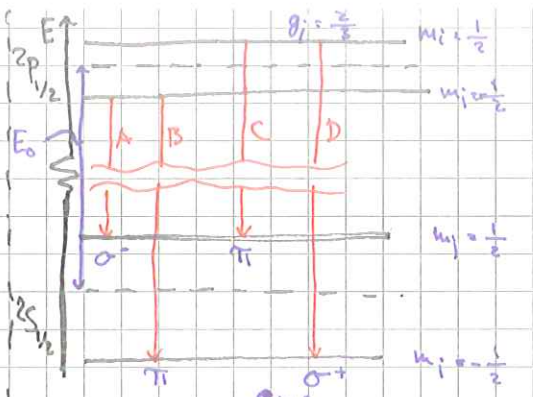
$E = E_{j=1/2}^{(B=0)} + \mu_B \cdot B \cdot g_j \cdot m_j$

$^2P_{1/2}$ $g_j = \frac{3}{2} + \frac{\frac{1}{2}\cdot\frac{3}{2} - 1\cdot 2}{2 \cdot \frac{1}{2} \cdot \frac{3}{2}} =$

$= \frac{2}{3}$

$^2S_{1/2}$ $g_j = \frac{3}{2} + \frac{\frac{1}{2}\cdot\frac{3}{2} - 0}{2 \cdot \frac{1}{2} \cdot \frac{3}{2}} =$

$= \boxed{2}$ ← Totala $L = 0$.



$g_j = 2.$

$E_D = E_0 + \frac{2}{3}\mu_B \cdot B \cdot \frac{1}{2} + 2\mu_B \cdot B \cdot \frac{1}{2}$

$E_A = E_0 - \frac{2}{3}\mu_B \cdot B \cdot \frac{1}{2} + 2\mu_B \cdot B \cdot \frac{1}{2}$

$\Delta E = 0 + \frac{4}{3}\mu_B B \cdot \frac{1}{2} + 4\mu_B \cdot B \cdot \frac{1}{2} = \frac{8}{3}\mu_B B$

$\Delta\lambda = 0{,}022\,nm.$

$E = hf = \frac{hc}{\lambda} \Rightarrow \Delta E = (-) \frac{\Delta\lambda \cdot hc}{\lambda^2} = \frac{0{,}022 \cdot 10^{-9} \cdot 6{,}626 \cdot 10^{-34} \cdot 3 \cdot 10^8}{(5{,}89 \cdot 10^{-9})^2}$

$= 1{,}26 \cdot 10^{-23}\ J$

$\Rightarrow B = 0{,}51\,T$