PROBLEMA 1

Gas He^+ $Z = 2$

STATO INIZIALE $n = 2$

RADIAZIONE: 140 - 142 nm

$140 \cdot 10^{-9}$ m $\rightarrow$ 71400 cm^{-1}

$142 \cdot 10^{-9}$ m $\rightarrow$ 70400 cm^{-1}

$$E_{n_x} - E_2 = Z^2 R \left(\frac{1}{2^2} - \frac{1}{n_x^2} \right)$$

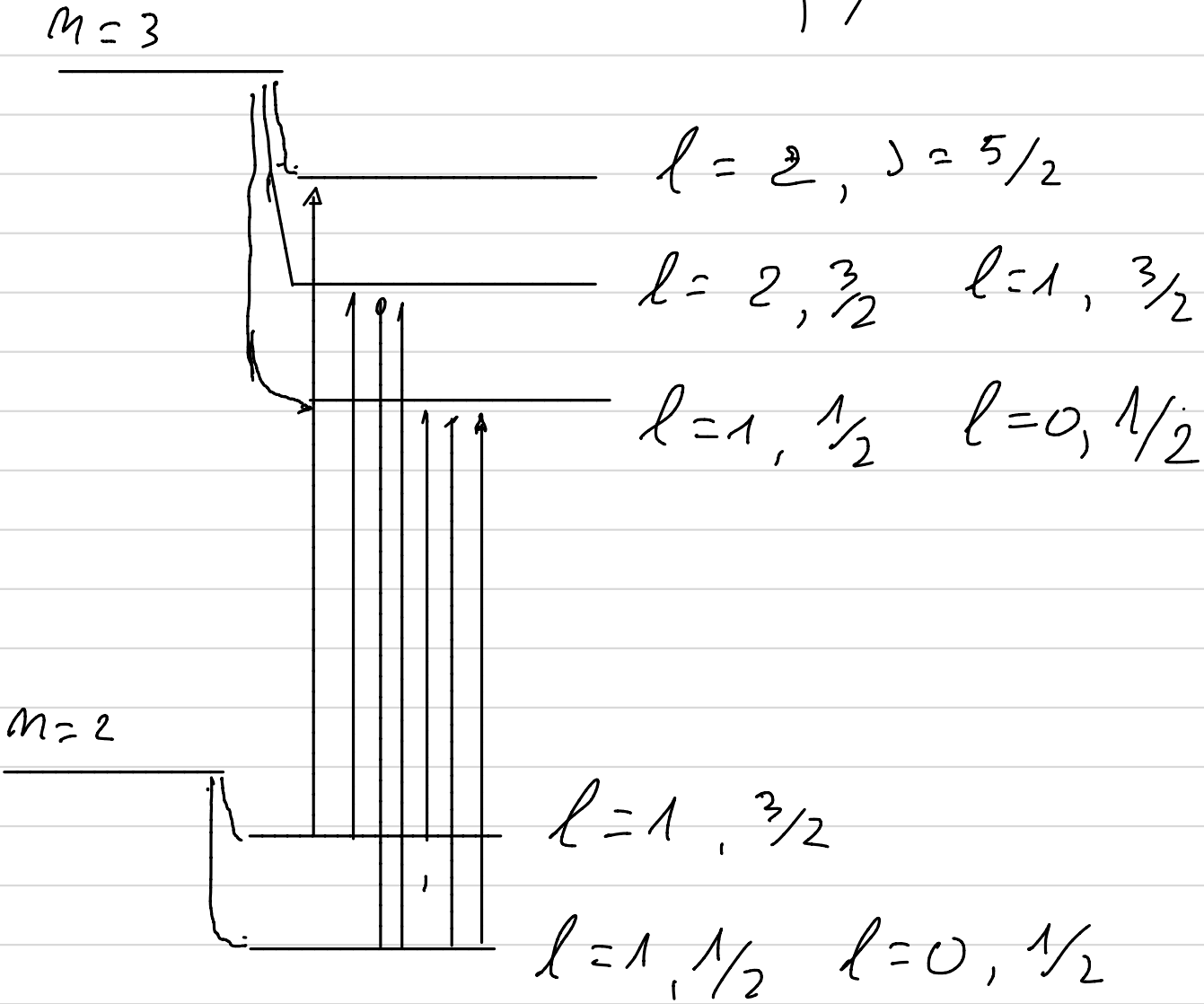
$R = 109737$ cm^{-1}

$n_x = 3$ $\Delta E_{32} = 60965$ cm^{-1}

$n_x = 4$ $\Delta E_{42} = 82300$ cm^{-1}

quindi $n_x = 3$: $l = 0, 1, 2$

l, j



$\Delta l = \pm 1$ $\Delta j = 0, \pm 1$

(1) $2(\ell=1, 3/2) \rightarrow 3(\ell=2, 5/2)$

(2) $2(\ell=1, 3/2) \rightarrow 3(\ell=2, 3/2)$

(3) $2(\ell=1, 1/2) \rightarrow 3(\ell=2, 3/2)$

(4) $2(\ell=0, 1/2) \rightarrow 3(\ell=1, 3/2)$

(5) $2(\ell=1, 3/2) \rightarrow 3(\ell=0, 1/2)$

(6) $2(\ell=1, 1/2) \rightarrow 3(\ell=0, 1/2)$

(7) $2(\ell=0, 1/2) \rightarrow 3(\ell=1, 1/2)$

$$\Delta E_{nj} = E_n \frac{(Z\alpha)^2}{n^2} \left(\frac{n}{j+1/2} - \frac{3}{4} \right)$$

$$\Delta E_{3\,5/2} = -0.29 \text{ cm}^{-1}$$

$$\Delta E_{3\,3/2} = -0.87 \text{ cm}^{-1}$$

$$\Delta E_{3\,1/2} = -2.40 \text{ cm}^{-1}$$

$$\Delta E_{2\,3/2} = -1.46 \text{ cm}^{-1}$$

$$\Delta E_{2\,1/2} = -7.31 \text{ cm}^{-1}$$

IN ASSORBIMENTO

① $= \Delta E_{32} + \Delta E_{3\,5/2} - \Delta E_{2\,3/2}$

$= 60966\ cm^{-1}$

② $= \Delta E_{32} + \Delta E_{3\,3/2} - \Delta E_{2\,3/2}$

$= 60965.6\ cm^{-1}$

③ $= \Delta E_{32} + \Delta E_{3\,3/2} - \Delta E_{2\,1/2}$

$= 60971.4\ cm^{-1}$

④ = ③

(5) $= \Delta E_{32} + \Delta E_{31/2} - \Delta E_{23/2} =$

$= 60964 \text{ cm}^{-1}$

(6) $= \Delta E_{32} + \Delta E_{31/2} - \Delta E_{21/2} =$

$= 60969.9 \text{ cm}^{-1}$

(7) $= \Delta E_{32} + \Delta E_{31/2} - \Delta E_{21/2}$

(7) = (6)

$B > Z^4 T \qquad Z^4 = 16$

con $B = 60\ T$ Zeeman normale

$n = 2 \quad l = 1, l = 0$

$n = 1 \quad l = 0$

$E_n' = E_n + \mu_B B (m + 2 m_s)$

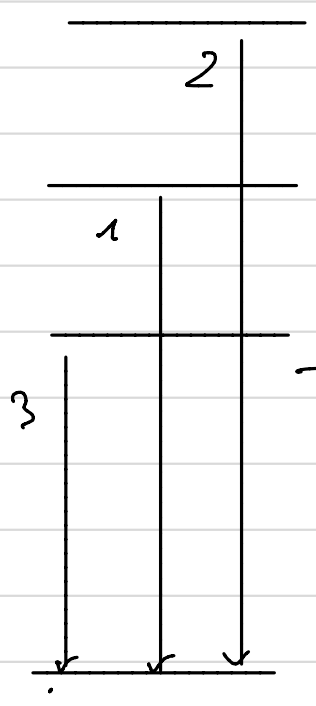
$\Delta l = \pm 1 \qquad \Delta m = 0, \pm 1 \qquad \Delta m_s = 0$

$(n = 2 \quad l = 1 \quad m_s = 1/2) \rightarrow (n = 1, l = 0, 1/2)$

$(n = 2 \quad l = 1 \quad m_s = -1/2) \rightarrow (n = 1 \quad l = 0, -1/2)$

$l = 1 \quad (m = +1, 0, -1)$

$$\left(n=2,\ l=1,\ \tfrac{1}{2}\right) \longrightarrow \left(n=1,\ l=0,\ \tfrac{1}{2}\right)$$



$1, 1/2 \qquad E_{2p} + 2\mu_B B$

$0, 1/2 \qquad E_{2p} + \mu_B B$

$-1, 1/2 \qquad E_{2p}$

(N.B. $E_{2p} = E_{2s} = E_2$)

$0, 1/2 \qquad E_{1s} + \mu_B B$

$0, -1/2 \qquad E_{1s} - \mu_B B$

1 : $E_{2p} + \mu_B - (E_{1s} + \mu_B B) = E_{2p} - E_{1s}$

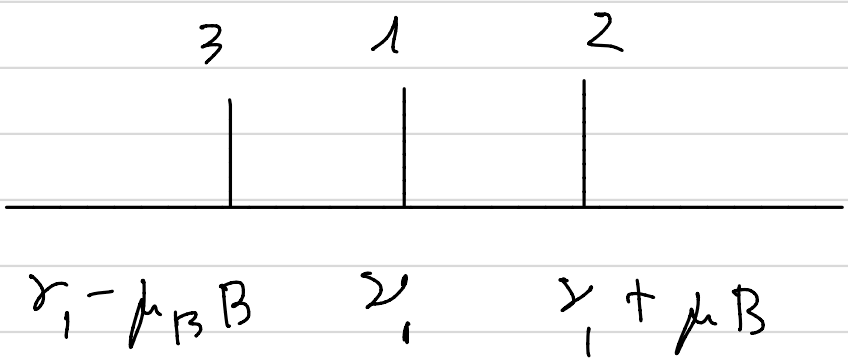
2 : $E_{2p} - E_{1s} + \mu_B B$

3 : $E_{2p} - E_{1s} - \mu_B B$

$\mu_B B = 28.02 \ cm^{-1}$

CI SONO 3 TRANS. EQUIVALENTI

$(n=2,\ l=1,\ -\frac{1}{2}) \rightarrow (n=1,\ l=0,\ -\frac{1}{2})$



$\nu_1 = E_2 - E_1 = 32911\ cm^{-1}$

TRIPLETTO DI LORENTZ

PROBLEMA 2

K=3	K=2	K=1	K=0	K=1	K=2
211.5	212.4	213.3	215.1	216.0	216.9

P R

$2B = 0.9\ cm^{-1}$ $B = 0.45\ cm^{-1}$

$\nu_0 = 214.2\ cm^{-1}$ $\mu = 4.6\ 10^{-27}\ kg$

$$R_0^2 = \frac{\hbar^2}{2\mu B(J)}\ m^2$$

$B(cm^{-1}) \rightarrow B(J)$

$$R_0^2 = \frac{\hbar^2}{2\mu\ hc\ 2\pi B}$$

$$R_0^2 = \frac{1.0546\ 10^{-34}}{4\pi\ 46 \cdot 3 \cdot 0.45}\ 10^{27}\ 10^{-10}\ m^2$$

$$R_0^2 = 0.0135\ 10^{-18}\ m^2$$

$$R_0 = 1.162\ \text{Å}$$

$$\bar{\nu}_0 = 214.2\ cm^{-1}$$

$$\nu_0 = 2\pi c\, \bar{\nu}_0 = 2\pi\ 3 \cdot 10^{10} \cdot 214.2\ s^{-1}$$

$$\nu_0 = 4.037\ 10^{13}\ s^{-1}$$

$$k = \nu_0^2\, \mu =$$

$$= (4.037)^2\ 10^{26} \cdot 46\ 10^{-27}\ J/m^2$$

$$k = 75\ J/m^2 \quad (6\ N/m)$$

$$\frac{I_1}{I_6} \simeq 0.86$$

$I_1 \rightarrow K = 3$

$I_6 \rightarrow K = 2$

$$\frac{I_1}{I_6} = \frac{(2\cdot 3+1)\ \exp\left[-B\,3(3+1)/k_B T\right]}{(2\cdot 2+1)\ \exp\left[-B\,2(2+1)/k_B T\right]}$$

$$0.86 \times \frac{5}{7} = e^{-6B/k_B T}$$

$$k_B T \simeq 5.54\ cm^{-1} \rightarrow T \simeq 8\ K$$

$$K_{MAX} = \sqrt{\frac{k_B T}{2B}} - 1/2 \simeq 1.98 .$$

$$K_{MAX} \simeq 2$$