Fisica Atomica e Molecolare

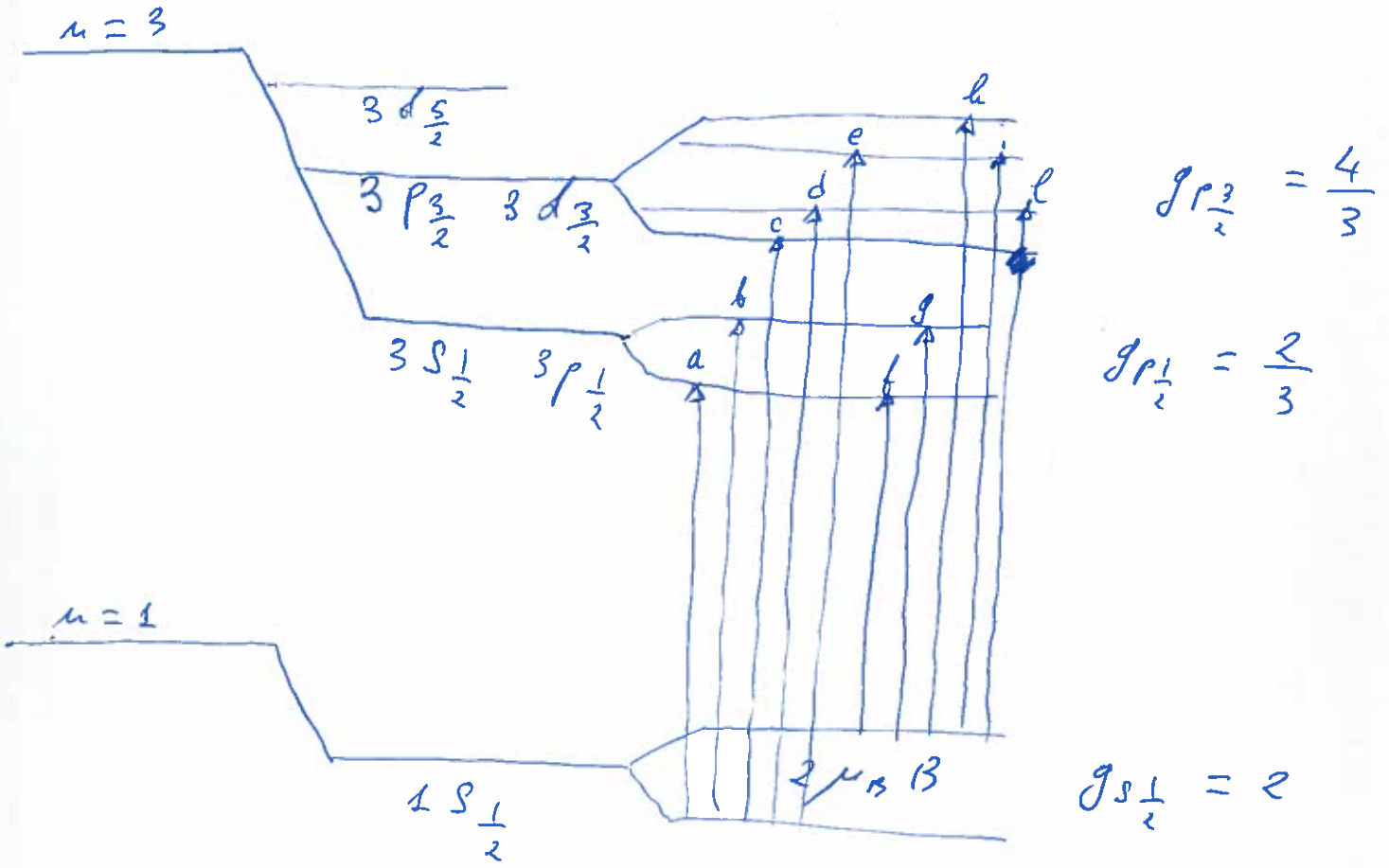
Compito di esame 12/07/2018

Problema 1

$Z = 2$

$B = 0.01\ T \ll Z^4\ T$

Zeeman anomalo



$g_{P\frac{3}{2}} = \frac{4}{3}$

$g_{P\frac{1}{2}} = \frac{2}{3}$

$g_{S\frac{1}{2}} = 2$

$\bar{\varepsilon}_{\text{risonanza}} = 389966\ cm^{-1}$

$$\varepsilon_n^{(0)} = -R(\infty)\frac{Z^2}{n^2}$$

$$\Delta\varepsilon_{nJ} = \varepsilon_n^{(0)}\frac{(Z\alpha)^2}{n^2}\left(\frac{n}{J+\frac{1}{2}} - \frac{3}{4}\right)$$

per $k_B T \simeq 347{,}5\ cm^{-1}$ tutti gli stati $n = 1$ sono occupati.

$$\Delta\varepsilon^B = \mu_B B g m_J \qquad g = 1 + \frac{J(J+1) + \frac{3}{4} - \ell(\ell+1)}{2(J+1)J}$$

Regole di selezione in app. di dipolo elettrico

$\Delta l = \pm 1 \qquad \Delta J = 0, \pm 1 \qquad \Delta m_J = 0, \pm 1$

Potere risolutivo $P.R = \dfrac{\bar{\varepsilon}_{rad}}{\frac{2}{3} \mu_B B} \simeq 12 \cdot 10^7$

$\vec{k} \perp \vec{B}$

a) $\vec{\varepsilon} \parallel \hat{z} \Rightarrow \Delta m_J = 0$ righe a, d, g,

b) $\vec{\varepsilon} \perp \hat{z} \Rightarrow \Delta m_J = \pm 1$

$\vec{k} \parallel \vec{B}$

a) $\vec{\varepsilon}_{R.H} \Rightarrow \Delta m_J = 1$ righe b, e, h

b) $\vec{\varepsilon}_{L.H} \Rightarrow \Delta m_J = -1$ righe c, f, l

Problema 2

$$\left.\frac{d\,\mathcal{E}(R)}{dR}\right|_{R=R_0} = 0 \quad \Rightarrow \quad \sigma = R_0$$

$$\mathcal{E}(R_0) = -1.8\ eV \quad \Rightarrow \quad A = 10.8\ eV$$

$$K = \left.\frac{d^2\,\mathcal{E}(R)}{dR^2}\right|_{R=R_0} = \frac{9A}{R_0^2}$$

$$\nu_0 = \frac{1}{2\pi c}\sqrt{\frac{K}{\mu}} \simeq 1780\ cm^{-1}$$

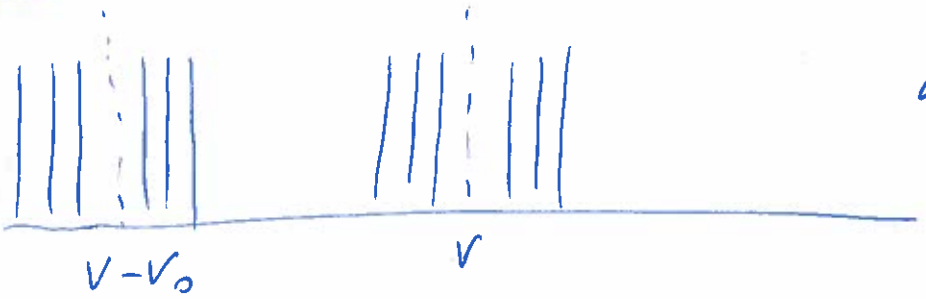
$$\left(\mu = \frac{14}{2}\ a.m.u.\right)$$

$$B = \frac{\hbar}{4\pi\mu c R_0^2} \simeq 2\ cm^{-1}$$

Si tratta di spettro Raman (molecola biatomica omonucleare)

@ $T = 10\ K$ 1% cade sugli stati con $v = 0$

$$\Delta k = 0, \pm 2$$



@ $T = 3000\ K$

Idem così anche gli stati con $v = 1$