

HW 11 solution

Note Title

11/30/2011

$$\begin{aligned}
 1. \quad \Delta E &= -\vec{\mu}_S \cdot \vec{B} = -\left(-g \frac{e}{2m}\right) \vec{S} \cdot \vec{B}, \quad g \approx 2 \\
 &= 2\left(\frac{e}{2m}\right) B S_z \\
 &= 2\left(\frac{e}{2m}\right) B \cdot m_s \hbar = 2 \underbrace{\left(\frac{e \hbar}{2m}\right)}_{\mu_B} B \\
 &= (m_s)(2) \mu_B \cdot B \\
 &= \left(\pm \frac{1}{2}\right)(2) \mu_B B = \pm \mu_B B
 \end{aligned}$$

$$\begin{aligned}
 \Rightarrow \Delta E_{\text{spin up}} - \Delta E_{\text{spin down}} \\
 &= \mu_B B - (-\mu_B B) = 2\mu_B B \\
 &= 2\left(5.8 \times 10^{-5} \frac{\text{eV}}{\text{T}}\right)(0.8 \text{ T}) = \underline{9.3 \times 10^{-5} \text{ eV}}
 \end{aligned}$$

$$2. (a) \quad 2S_{3/2} \Rightarrow s=0, l=0, \quad \bar{j} = \frac{3}{2}$$

(b)

$$\begin{aligned}
 |l-s| &= |l+s| = 0 \\
 \therefore \bar{j} &\text{ should be zero i.e. impossible}
 \end{aligned}$$

$${}^3D_2 \Rightarrow s=1, l=2, \bar{j}=2$$

$$|l-s|=1, \quad l+s=3$$

$$\therefore \bar{j}=2 \text{ is possible}$$

$${}^5P_3 \Rightarrow s=2, l=1, \bar{j}=3$$

$$|l-s|=1, \quad l+s=3$$

$$\therefore \bar{j}=3 \text{ is possible}$$

$$3. \quad 4^2 \bar{F}_{5/2} \Rightarrow n=4, s=\frac{1}{2}, l=3$$

$$\bar{j} = \frac{5}{2}$$

$$\Rightarrow \frac{5}{2} = 3 - \frac{1}{2}$$

The fine structure is degenerate with the same $\bar{j}$ value.

$$\text{Thus } \frac{5}{2} = 2 + \frac{1}{2}$$

$$\Rightarrow l=2, \bar{j} = \frac{5}{2}, s = \frac{1}{2}$$

$$\text{gives } \underline{4^2 D_{\frac{5}{2}}}$$