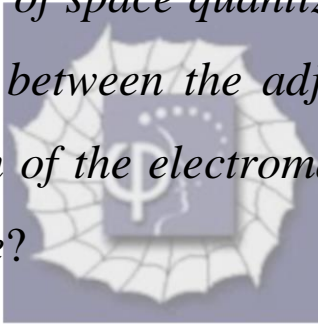


825.

**Problem 54.21 (RHK)**

*The spin and magnetic moment (maximum z component) of  ${}^7\text{Li}$  in its ground state are  $\frac{3}{2}$  and  $+3.26$  nuclear magnetons, respectively. A free  ${}^7\text{Li}$  nucleus is placed in a magnetic field of  $2.16\text{ T}$ . We have to answer the following: (a) Into how many levels will the ground state split because of space quantization? (b) What is the energy difference between the adjacent pairs of levels? (c) In what region of the electromagnetic spectrum does this wavelength lie?*



**Solution:**

The spin and magnetic moment (maximum z component) of  ${}^7\text{Li}$  in its ground state are  $\frac{3}{2}$  and  $+3.26$  nuclear magnetons, respectively.

(a)

As the spin of  ${}^7\text{Li}$  nucleus,  $s = \frac{3}{2}$  and it possesses magnetic moment, by space quantization the ground state

will split in  $2s + 1 = 4$  levels, when placed in a magnetic field.

(b)

The magnetic moment of  ${}^7\text{Li}$  is  $3.26 \mu_{\text{N}}$

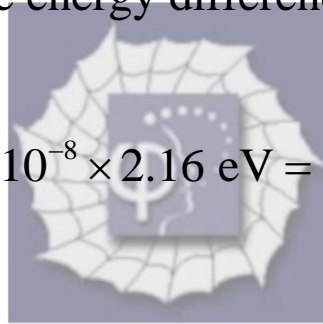
( $\mu_{\text{N}} = 3.15 \times 10^{-8} \text{ eV T}^{-1}$ ). In a magnetic field  $B$  the

ground state will split into four levels with energy difference

$$\Delta E = 3.26 B \mu_{\text{N}}.$$

As  $B = 2.16 \text{ T}$ , the energy difference between the levels will be

$$\Delta E = 3.26 \times 3.15 \times 10^{-8} \times 2.16 \text{ eV} = 2.218 \times 10^{-7} \text{ eV}.$$



(c)

The wavelength of light corresponding to a photon of energy  $2.218 \times 10^{-7} \text{ eV}$  will be

$$\begin{aligned} \lambda &= \frac{hc}{\Delta E} = \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{2.218 \times 10^{-7} \times 1.6 \times 10^{-19}} \text{ m} \\ &= 5.60 \text{ m}. \end{aligned}$$

The radiation will be in the TV FM range.