825.

Problem 54.21 (RHK)

The spin and magnetic moment (maximum z component) of $^{7}\mathrm{Li}$ *in its ground state are* $\frac{3}{2}$ *and* $+3.26$ *nuclear magnetons, respectively. A free* $^{7}\mathrm{Li}$ *nucleus is placed in a magnetic field of* 2.16 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 $^{7}\mathrm{Li}$ in its ground state are $\frac{3}{2}$ and $+3.26$ nuclear magnetons, respectively.

(a)

As the spin of $^{7}\mathrm{Li}$ 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 $^{7}\mathrm{Li}$ is 3.26 μ_{N} $\left(\mu_{\mathrm{N}}=3.15\times10^{-8}\ \mathrm{eV\ T^{-1}}\right)$. In a magnetic field *B* the ground state will split into four levels with energy difference

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

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

$\Delta E=3.26\times3.15\times10^{-8}\times2.16\ \mathrm{eV}=2.218\times10^{-7}\ \mathrm{eV}$.

(c)

The wavelength of light corresponding to a photon of energy $2.218\times10^{-7}\ \mathrm{eV}$ will be

$$\lambda=\frac{hc}{\Delta E}=\frac{6.63\times10^{-34}\times3\times10^{8}}{2.218\times10^{-7}\times1.6\times10^{-19}}\ \mathrm{m}$$
$$=5.60\ \mathrm{m}.$$

The radiation will be in the TV FM range.