ESR (Electron Spin Resonance spectra)

OR

EPR (Electron Paramagnetic Resonance spectra)

Introduction :-

A substance which have unpaired electron will be paramagnetic in nature. eg - all free radical, NO etc.

When such a magnetic species placed in a strong magnetic field there occurs splitting due to interaction. In this conditions if a radiation of proper frequency is allowed to pass through the species, absorption will take place and we get a spectra called ESR spectra.

Theory :-

All the theory applied in case of NMR can be applied in ESR also.

Let us suppose a electron as in case of H-atom which has spin $s = 1/2$. Due to spinning of the electron. The electron spin magnetic moment $\vec{\mu_e}$ will be given by —

$$\vec{\mu_e} = g_e \cdot B \cdot \vec{s}$$

where, g_e = Lande-g-factor having value 2.0023

B = Bohr magnatone

$$= \frac{eh}{4\pi me} = 9.273 \times 10^{-24} \text{ J/T (tesla)}$$

$\vec{s}$ = electron spin angular momentum.

When this electron is subjected to a strong magnetic field of strength 'H' then the energy of interaction will be given by :-

$$\epsilon = -\vec{M_e} \cdot H$$

$$\text{or} \quad \epsilon = g_e \cdot B \cdot \vec{S} \cdot H$$

The spin $\vec{S}$ is given by m_s, which have value $+1/2$ & $-1/2$ so,

$$\epsilon = g_e \cdot B \cdot H \cdot m_s$$

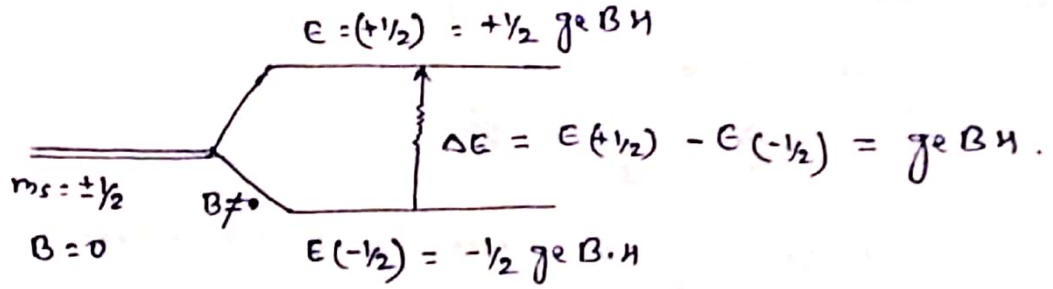
When $m_s = +1/2$

$$\epsilon(+1/2) = \frac{1}{2} g_e B H$$

When $m_s = -1/2$

$$\epsilon(-1/2) = -1/2 \, g_e B \cdot H$$

Thus, we see that the degeneracy is lost in the presence of external magnetic field and splitting occurs as shown below :-



Since, $\Delta E = h\nu$

$$\nu = \frac{\Delta E}{h} = \frac{g_e \cdot \beta \cdot H}{h}$$

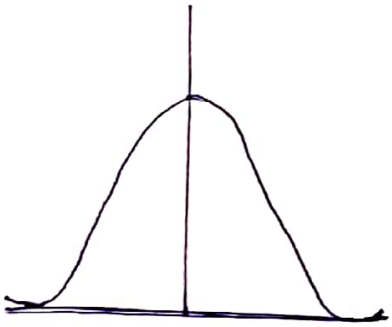
This frequency generally fall in microwave region.

This is because the magnetic moment of electron is 660 times greater than the magnetic moment of the nucleus.

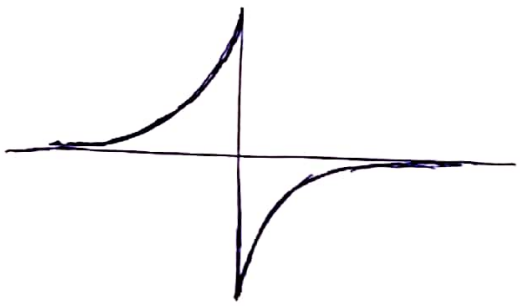
ESR spectra is required by two types of curves.—

(1) Absorption curve

(2) Derivative curve



(Absorption curve)



(Derivative Curve)

By:
Dr. A.K. Gupta.
L.S. College, Muz.