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# NMR

(Nuclear Magnetic resonance spectroscopy)

$$\text{frequency } (\nu) = 3\times10^{6} - 3\times10^{8}\ sec^{-1}.$$

$$\lambda = \frac{c}{\nu} = \frac{3\times10^{8}\ m\ \cancel{sec^{-1}}}{3\times10^{6}\ \cancel{sec^{-1}}}$$

$$= 10^{8}\times10^{-6}\ m$$

$$= 10^{2}\ m$$

$$\lambda = 100\ m - 1\ cm.$$

$$E = h\nu = 6.626\times10^{-34}\ J\ \cancel{sec} \times 3\times10^{6}\ \cancel{sec^{-1}}$$

$$= 19.87\times10^{-28}\ J.$$

$$- 19.87\times10^{-26}\ J.$$

## Introduction:-

NMR involves the interaction between oscillating electro-magnetic radiation and the magnetic properties of certain magnetic nuclei i.e. the nucleus of H-atom (proton).

The magnetic isotopes are — $^{1}H$, $^{13}C$, $^{19}F$, $^{14}N$, $^{17}O$, $^{31}P$, $^{32}S$.

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## Introduction :-

The NMR spectroscopy concerned with absorption of light usually radio wave by some spining nucleus (nuclei) in a molecule when placed in a magnetic field. The spectrum results from the transition of nucleus from one spin state to another. each energy state is called the Zeeman energy levels. The energy needed to induce the transition falls in the region of very large wavelength (very small frequency i.e. $10^6$ to $10^8$ Hz).

## Nuclear spin Angular moment :-

Certain nuclei (proton & neutron), like electron spin around their axis and hence possess 'spin angular momentum'. given by -

$$\omega_N = \sqrt{I(I+1)} \cdot \frac{h}{2\pi} \quad -(1)$$

where, $I$ = Nuclear spin quantum number.

$h$ = Plank's constant.

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The ~~x~~ spin quantum no. for the nucleus may have values $0, \frac{1}{2}, I, 2 \ldots$ etc. depending upon the no. of neutron & proton having parallel & anti-parallel spin.

for proton $^{1}_{1}H$

$$I = 1/2 .$$

for ~~d~~. $^{2}_{1}D$

$$I = 1$$

for. $^{12}_{6}C$.

$$I = 0 .$$

(1). For nuclei in which the sum of proton & neutron are even (At. no. & mass no. even) then

$I = 0$ value.

eg $^{12}_{6}C$, $^{4}_{2}He$, $^{16}_{8}O$, $^{32}_{16}S$ etc

$^{12}_{6}C$

| | |
|---|---|
| $A = 12$ | $P = 6$ |
| $Z = 6$ | $e = 6$ |
| | $n = 6$ |

$A = p + n$

$12 = 6 + 6$ even

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(2) For nuclei in which the sum of protons & neutrons are even but the no. of protons is ~~even~~ odd. (mass no. even, & At. no. odd).
then $I = 1, 2, 3$ ......

eg:- $^{2}_{1}D$, $^{10}_{5}B$, $^{14}_{7}N$ etc

$^{10}_{5}B$

| | |
|---|---|
| $Z = 5$ | $n = 5$ |
| $A = 10$ | $p = 5$ |
| | $e = 5$ |

$p + n = 5 + 5 = 10$ even.
$p = 5$ odd.

(3). For nuclei in which the sum of protons and neutrons is odd (mass no. odd).
$I = 1/2, 3/2, 5/2$ ....etc

eg:- $^{1}_{1}H$, $^{23}_{11}Na$, $^{35}_{17}Cl$

$^{1}_{1}H$

| | |
|---|---|
| $Z = 1$ | $e = 1$ |
| $A = 1$ | $p = 1$ |
| | $n = 0$ |

$^{23}_{11}Na$

| | |
|---|---|
| $Z = 11$ | $e = 11$ |
| $A = 23$ | $p = 11$ |
| | $n = 12.$ |