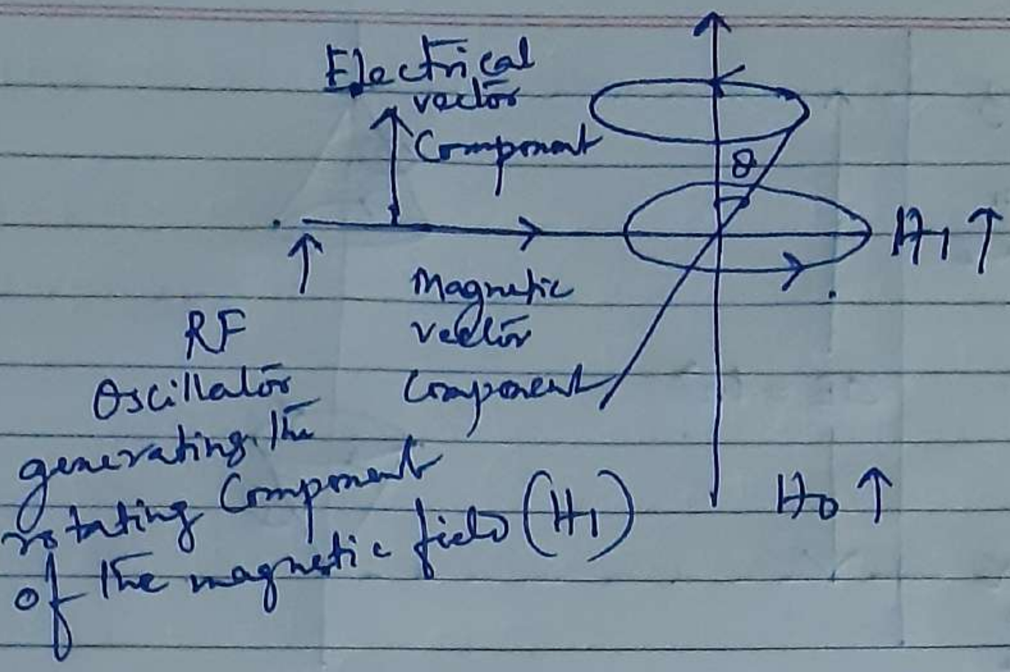
What is the nature of precessional frequency of the spinning nuclear magnet and the relation between the precessional frequency and the applied magnetic field (H_0)?

The precessional frequency (ν) of the nuclear magnet is directly proportional to the strength of the applied magnetic field (H_0) and exactly equal to the frequency of the electromagnetic radiation supplied by the radiofrequency oscillator

$$\nu = \gamma \cdot \frac{H_0}{2\pi}$$

The precessional frequency of the spinning nucleus is exactly equal to the frequency of electromagnetic radiation necessary to induce a transition from one nuclear spin state to another

The fact of turning over the nucleus from one orientation to the other corresponds to the change in the angle 'θ'. This can be brought about by the application of secondary magnetic field (H_1) in a direction perpendicular to the main magnetic field (H_0) which is shown in the following figure -

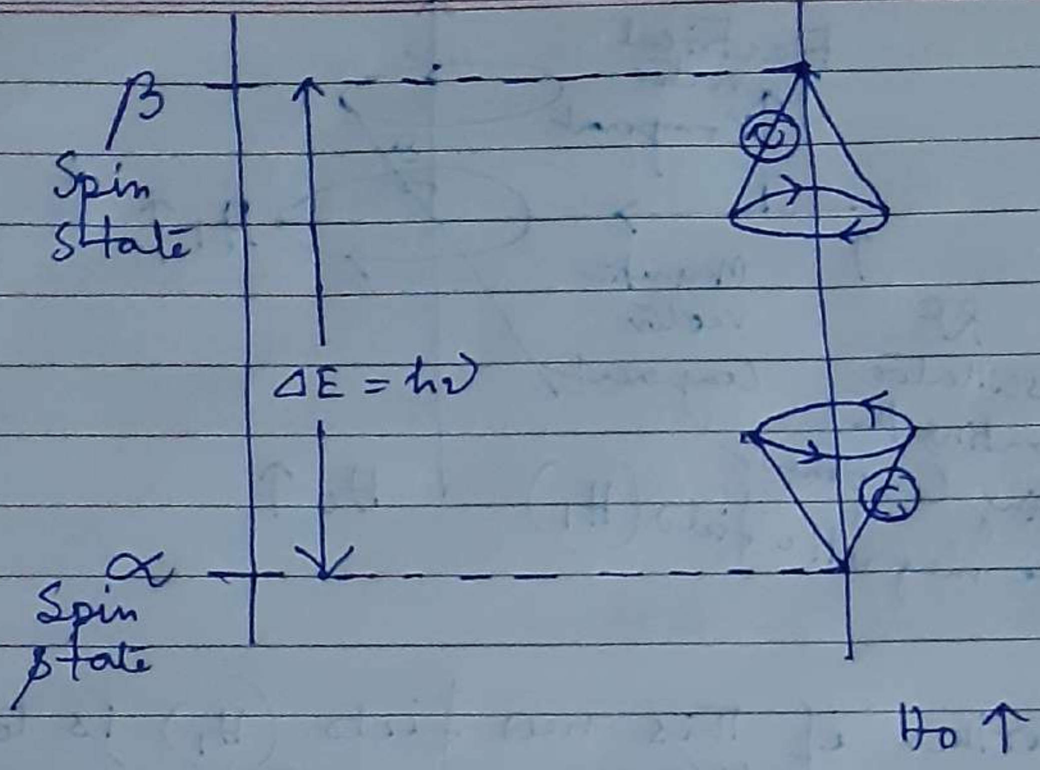


Further if this new field (H_1) is to be continuously affecting on the precessional nuclear magnet it must rotates in the plane perpendicular to the direction of H_0 in the same phase with the precessional nucleus.

This secondary magnetic field which is not applied from outside is infact the magnetic vector component of the electromagnetic radiation supplied by the R.F. oscillator.

When the frequency of the rotating magnetic field (H_1) becomes exactly equal to the frequency of the precessing nucleus then processing nucleus of the rotating magnetic field are said to be in "RESONANCE" and absorption or emission of energy by the nucleus can occur to give the NMR signal.

Thus nuclear magnetic resonance will occur when a nucleus ($I > 0$) is placed in a stable magnetic field and subjected to electromagnetic field and subjected to electromagnetic radiation of appropriate frequency.



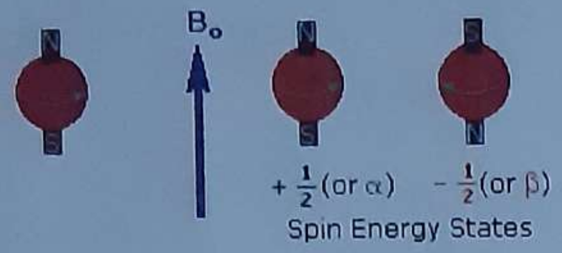
Nuclear transition in the resonance condition.

Thus, a nucleus is in resonance when it is irradiated with radiofrequency photons having energy equal to the energy difference between the spin states. Under these conditions, a proton in the α-spin state can absorb a photon and flip to the β-spin state.

Mathematical Problems :-

① Calculate the NMR frequency (in MHz) on the proton (^1H) in a magnetic field of intensity 1.4092 Tesla. Given that $g_N = 5.585$ and $\mu_N = 5.05 \times 10^{-27}\ JT^{-1}$.

Magnetic Field and Larmor Frequency

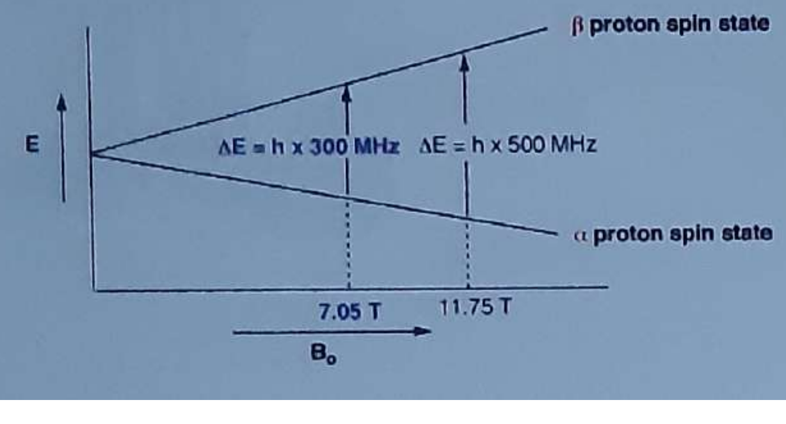


$$\Delta E = h\nu = \frac{h}{2\pi}\gamma B_o = \frac{\mu B_o}{I}$$

$$\Rightarrow \nu = \gamma \frac{B_o}{2\pi}$$

$$\mu = \frac{h}{2\pi}\gamma I \quad \gamma = \frac{2\pi\mu}{hI}$$

Figure 1. Graphical relationship between field B_o and frequency ν.



I: Spin quantum number

μ: Magnetic moment

γ: Gyromagnetic ratio
a measurement of the strength of the tiny nuclear magnet which is *atom dependent*.

For a magnet of B_o = 11.74 T,
^1H Larmor frequency ν = 500 MHz
in radio frequency (RF) range.
(γ/2π for proton is 42.58 MHz/T)