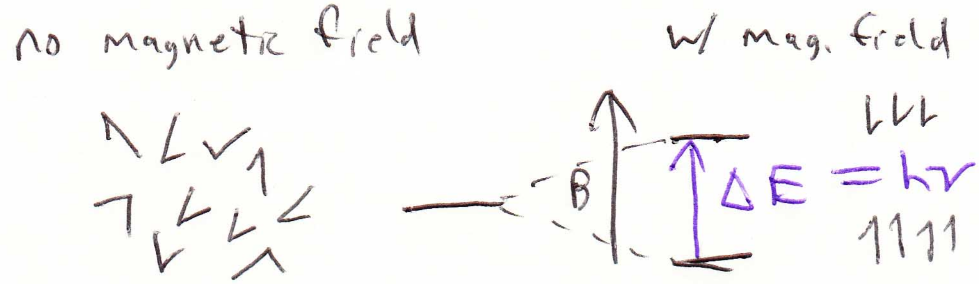
Many nuclei have spin. For example, ^1H (protium) and ^{13}C have spin $\frac{1}{2}$ [technically $\frac{1}{2}\frac{1}{2\pi}h = \frac{1}{2}\hbar$].

Nuclei with spin are randomly arranged in the absence of a magnetic field; in the presence of a magnetic field, nuclei with spin ½ can align either with the magnetic field or against it. This causes an energy gap to form.

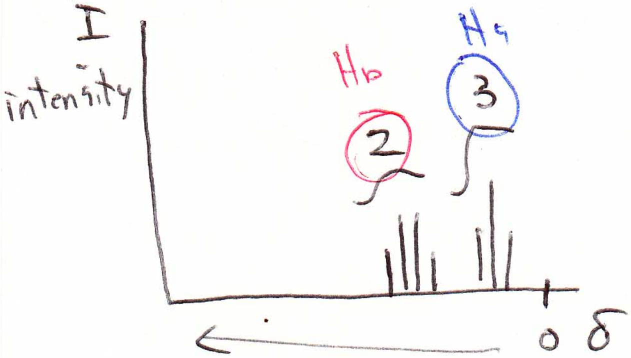


If a photon with the correct energy (which corresponds to light of a particular frequency) is absorbed by the nucleus, the nucleus can flip from the low- to high-energy spin state. The energy released when the nucleus returns to the lower state is measured by an NMR spectrometer.

If a nucleus has an electronegative neighbor, that neighbor will pull electron density away from the nucleus (deshield), exposing the nucleus more greatly to the magnetic field. This causes a larger energy gap, which means a higher frequency of light would be needed.

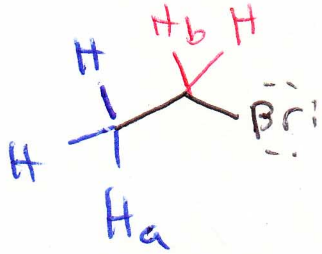
$$\delta \equiv \frac{\text{observed frequency} - \text{machine } f}{\text{machine } f} \times 1{,}000{,}000$$

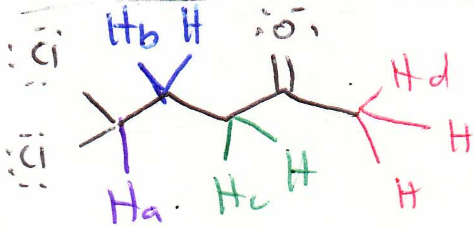
For ^1H and ^{13}C, the machine frequency is determined by using the reference standard TMS (tetramethylsilane).



C_2H_5-Br

- chemical shift → functional group
- integration → proportion to the # of H's.
- splitting → gives information about neighbors





δ 2.0, s, 3H
δ 2.3, t, 2H
δ 2.5, dt, 2H
δ 5.3, t, 1H

If $J_{ab} \ll J_{bc}$