The stark effect:-

Observed stark effect of Hydrogen:-

In 1913 J. Stark discovered the Balmer lines emitted by Hydrogen atoms placed in an electric field of the order of 10^5 volts/cm are split into a number of polarised components. When viewed perpendicular to the field, some of the components of each line are plane-polarised with the electric vector parallel to the field (π components) and the others polarised with electric vector perpendicular to the field (σ components).
When viewed parallel to the field only the σ components appear which are now unpolarised.
This splitting of spectral lines in an electric field is known as stark effect.

It plays an important role part in the theories of molecule formation from atoms, of the broadening of spectral lines and of dielectric constants.

→ The main features of the observed stark effect:

(I) All hydrogen lines form symmetrical patterns but the pattern depends markedly on the quantum no. n of the terms involved. The no. of stark lines and the total width of the pattern increase with n. The line H_β shows a large no. of stark components than H_α, the line H_γ showing still more larger no.

(II) The wave no. shifts are integral multiples of a unit which is proportional to the strength of the electric field and is the same for all hydrogen

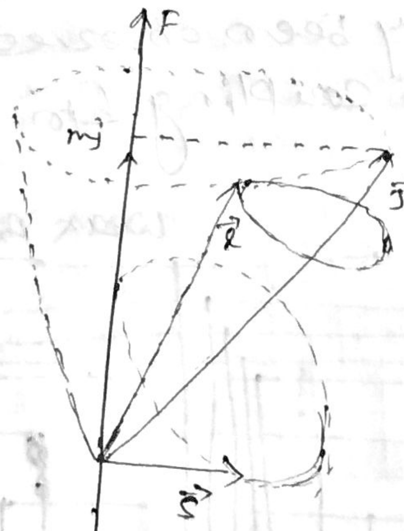
(III) except for the absence of circular polarisation in longitudinal observation, the polarisation properties of stark lines resemble those of the Zeeman lines. But, in contrast to the latter, the π-components show greater shifts than

6 components.

(iv) The Hydrogen lines involving the lower energy states (n small), such as H_α, H_β, show only a symmetrical splitting proportional to the strength about their field - free positions. This is known as the **first order or linear stark effect**. For the lines involving the higher states, such as H_γ, H_δ, the stark components show unidirectional displacements proportional to the square of the field strength. This is known as second order stark effect.

First-order stark effect is restricted to Hydrogen like atoms, and occurs in those only in fields large enough for the fine structure to become negligible. Other atoms show a second order or quadratic effect which is generally very small.

(2) Weak-field stark Effect in Hydrogen



A weak electric field for Hydrogen is one for which the interaction energy b/w the electron total angular momentum $\vec{J}$ and the field F is less than the magnetic interaction energy b/w orbital momentum $\vec{L}$ and spin momentum $\vec{S}$ i.e for which the stark splitting is small compared with the fine structure splitting

The selection rules for the weak field Stark effect are the same as those for the Zeeman effect.

$\Delta m_j = 0$ gives π components.
$\Delta m_j = \pm 1$ gives σ components.

The weak field Stark pattern has never been observed.

Strong-field Stark effect in Hydrogen:

A strong electric field for hydrogen is one which the interaction energy b/w the electron and the field F is greater than the interaction energy b/w the electron orbit and spin, i.e. for which the splitting of the energy levels due to the field is greater than the fine structure splitting. It is strong field for which the 1st order Stark effect in hydrogen has actually been observed. In such a field the magnetic coupling b/w $\vec{l}$ & $\vec{s}$ is broken and