D II Physics Hons (Paper-IV)

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Electrostatics

Clausius Mossotti Equation:

Clausius and Mossotti tried to correlate the macroscopic properties of a dielectric with its microscopic character. They established a relation between the dielectric constant (a macroscopic parameter) and the molecular polarisability (a microscopic parameter) of a non-polar dielectric. This relation is known as 'Clausius-Mossotti Equation'.

The polarisability α of a molecule is the dipole moment p induced in the molecule per unit polarising (local) field. That is

$$p = \alpha E_{local}.$$

If there are n molecules per unit volume of the dielectric, then the polarisation P is given by

$$P = n p = n \alpha E_{local}.$$

As we know that

$$E_{local} = E + \frac{P}{3\epsilon_0},$$ where

E is the macroscopic field within the dielectric.

$$\therefore P = n\alpha\left(E + \frac{P}{3\epsilon_0}\right).$$

Now, the polarisation P is related to the dielectric constant K by the equation,

$$P = (K-1)\epsilon_0 E.$$ Then we have

$$(K-1)\epsilon_0 E = n\alpha\left[E + \frac{(K-1)\epsilon_0 E}{3\epsilon_0}\right]$$

or, $$(K-1)\epsilon_0 = n\alpha\left(1 + \frac{K-1}{3}\right) = n\alpha\left(\frac{K+2}{3}\right)$$

or, $$\alpha = \frac{3\epsilon_0}{n}\frac{(K-1)}{(K+2)}. \quad \text{(iv)}$$

This is known as Clausius-Mossotti equation.