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B.Sc (Part-II) Hons

Weiss Molecular Field theory of paramagnetism.

In 1907, Weiss introduced the concept of internal molecular field in a bid to explain the above point. Weiss assumed that, since in a real gas the molecules are mutually influenced by their magnetic moments, there should exist within the gas a molecular field, produced at any point by all molecules. This molecular field is produced to and acting in the same sense as the magnetisation vector $\vec{M}$. Thus, we may write.

$$\text{Molecular field} \propto \text{Magnetisation} (\vec{M})$$

$$\text{or Molecular field} = \gamma \vec{M}$$

where γ is a constant known as molecular field co-efficient. The effective field may be regarded as the vector sum of the external applied magnetic field and internal molecular field. that is

$$\vec{B}_{eff} = \vec{B} + \gamma \vec{M} \quad \text{——— (1)}$$

putting B_{eff} in place of B in the expression for

$$M = \frac{P_m^2}{3KT} B$$

We get

$$M = \frac{P_m^2}{3KT} B_{eff}$$

$$= \frac{P_m^2}{3KT}(B + \gamma M)$$

The magnetic moment of a gram molecule

$$M = \frac{N_m P_m^2}{3KT}(B + \gamma M)$$

Where N_m is the number of molecules in gram-molecule.

We may also write

$$M = \left(1 - \frac{N_m P_m^2 \gamma}{3KT}\right)$$

$$= \frac{N_m P_m^2 B}{3KT}$$

or, $$M = \frac{N_m P_m^2 B}{3K\left(T - \frac{N_m P_m^2 \gamma}{3K}\right)}$$

But $B = \mu H$, therefore

$$M = \frac{N_m P_m^2 \mu H}{3K\left(T - \frac{N_m P_m^2 \gamma}{3K}\right)}$$

Molecular susceptibility

$$\chi_m = \frac{M}{H}$$

$$= \frac{N_m P_m^2 \mu}{3K\left(T - \frac{N_m P_m^2 \gamma}{3K}\right)}$$

$$= \frac{N_m^2 P_m^2 \mu}{3R\left(T - \frac{N_m^2 P_m^2 \gamma}{R}\right)} \qquad \left(\because \frac{R}{N_m} = K\right)$$

$$\therefore \chi_m = \frac{C_m}{(T-\theta)} \quad \text{--- (2)}$$

where

$$C_m = \frac{N_m^2 P_m^2 \mu}{3R} \quad (\text{Curie's Constant})$$

and $$\theta = \frac{N_m^2 P_m^2 \gamma}{3R}$$

Equation (2) is known as Curie-weiss law.

According to Curie-weiss law; the Susceptibility of a paramagnetic Substance having molecular field, varies inversely as the excess of temprature not from absolute zero but from a certain Critical temprature which is known as Curie's point. Curie point explain the relation observed between para and ferromagnetism. Below Curie point θ, the ferromagnetism exists, but above Curie point, ferromagnetic properties disappear and the Substance becomes paramagnetic.