Ising Model

Total Magnetic moment

$$M = \mu (N_+ - N_-) \quad \text{---} (6)$$

and $N = N_+ + N_- \quad \text{---} (7)$

$$M = \mu (N_+ - N + N_+)$$

$$\frac{M}{N\mu} = \frac{2N_+}{N} - 1 = m \text{ (say)} \quad \text{---} (8)$$

$$\frac{N_+}{N} = \frac{1}{2}\left(1 + \frac{M}{N\mu}\right) = \frac{1}{2}(1+m) \quad \text{---} (9)$$

and similarly $\frac{N_-}{N} = \frac{1}{2}(1-m) \quad \text{---} (10)$

Also $\frac{2N_+N_-}{N^2} = 2\frac{N_+}{N}\frac{N_-}{N} = 2\frac{1}{2}(1+m)\frac{1}{2}(1-m) \quad \text{---} (11)$

From (6) we get

$$\frac{M}{\mu N} = \frac{N_+}{N} - \frac{N_-}{N} = m \text{ So } N_+ - N_- = mN \quad \text{---} (12)$$

using (9), (10), (11) and (12) into eq^n (5) (-1 we get)

$$E_I = -\frac{1}{2}\nu\epsilon N m^2 - \mu H m N \quad \text{---} (13)$$

$-1 \leq m \leq 1$ (long range order parameter)

and used in ferromagnetic system and dielectric polarisation

No of arrangement of spin

$$W = \frac{\lfloor N}{\lfloor N_+ \lfloor N_-} = \frac{\lfloor N}{\lfloor N_+ \lfloor N_-}$$

$$\log_e \lfloor N = N \log N - N$$

and using $N = N_+ + N_-$

and $\frac{M}{N\mu} = m$

$$E_I = -\frac{1}{2} \nu N \epsilon \left(\frac{N_+}{N} - \frac{N_-}{N}\right)^2 - \mu H (N_+ - N_-)$$

$$S = k \log W$$

and then Helmholtz energy

$$F = E - TS$$

$$= -\frac{1}{2} \nu \epsilon N m^2 - \mu H m N$$

$$- NKT\left[-\log 2 + \frac{1}{2}(1+m)\log(1+m) + \frac{1}{2}(1-m)\log(1-m)\right]$$

~~For small:~~