Classical Statistical Mechanics

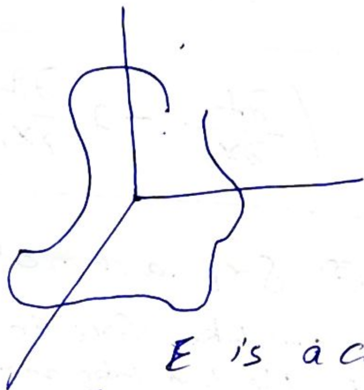
Equilibrium statistical Mechanics — Studies the properties of matter in equilibrium → Macrovariable donot change in time.

~~Postulates~~

Fundamental Postulate :- In a state of thermal equilibrium all the accessible microstate of the system are equally probable

Isolated system

$$H\{\vec{r_i}, \vec{p_i}\}_{i=1}^{N} = E$$



E is a constant of motion

Equation of motion —

$$\dot{\vec{r_i}} = \frac{\partial H}{\partial \vec{p_i}}$$

$$\dot{\vec{p_i}} = -\frac{\partial H}{\partial \vec{r_i}}$$

Phase space — For a N-particle system, e.g., a gas, the state can be described by 3N-canonical quardinate $r_1, \ldots r_{3N}$ and their conjugate momenta $p_1, \ldots, p_{3N}$. The 6N-dimensional space spanned by $\{\vec{r_i}, \vec{p_i}\}$ is called a Γ space or phase space of the system. A point in Γ space represents a state of the entire N-particle system is referred to as the representative point.

~~Gibbs ensemble :~~ — ~~Collecti~~

Gibbs ensemble :- collection of systems identical in composition and macroscopic condition but existing in different states.

This is represented by a distribution of ~~representive~~ representative point in Γ space. (mainly continuous distribution)

Density function

$$\{\vec{r}_i, \vec{p}_i\} \longrightarrow \{\vec{r}_i + d\vec{r}_i, \vec{p}_i + d\vec{p}_i\}$$

Volume element

$\rho(\vec{r}_i, \vec{p}_i, t)\, d\vec{r}_i\, d\vec{p}_i$ = number of systems lying in the small volume element $(d\vec{r}_i d\vec{p}_i)$ at time t of Γ space

→ An ensemble is completely specified by $\rho(\vec{r}_i, \vec{p}_i, t)$

Liouville's Theorem :-

"Local density of the representative points, as viewed by an observer moving with a representative point, stays constant in time."

$$\boxed{\frac{\partial \rho}{\partial t} + \sum_{i=}^{3N} \left(\frac{\partial \rho}{\partial p_i} \frac{dp_i}{dt} + \frac{\partial \rho}{\partial x_i} \frac{dx_i}{dt} \right) = 0}$$