Part 1 summary & **Part 2**

key defination

1). Macroscopic parameter: para which can be determined by large-scale measurements

2) Macrostate: state of the system described without attention to the microscopic detail.

3). Microstate: a state described in microscopic detail by the most complete specification.

4) Equilibrum: A macroscopic state which do't tend to change in time.

Equilibrum:

1. time-independent: average value of the macroscopic parameter remain C in time.
2. the equilibrum state: most random macrostate.
3. independent of its past history
4. random ⇒ can be defined with very few macroscopic parameters.

Second law of Thermodynamics (P V)

An isolated system in non-random situation
=> evolve in time so as to approach ultimately
its most random situation.(equilibrum)

Probability basics

$P_r \equiv \frac{\mathcal{N}_r}{\mathcal{N}}$ (the probality of occurrence of outcome r).

Statistical ensembles : an ensemble consisting of a very large number $\mathcal{N}$ of "similar systems"

"Tive average" & "ensemble average"

the system is in equilibrium.

Start from a "typical" point => the point of a moving system will eventually visit all parts of the space. In free motion of particle of the space ...

almost satisfy the condition. so the behavior of a particle can be equal with ensemble average.

$$\sum_{r=1}^{\Omega} P_r = 1$$

$$P(r=i \text{ or } r=j) = P_i + P_j$$

$$P_{rs} = P_r \cdot P_s$$

$$\overline{f(u)} = \sum f(u_i) P_i$$

$$\overline{f+g} = \bar{f} + \bar{g}$$

$$\overline{cf(u)} = c\overline{f(u)}$$

independent variables. $\Rightarrow$ $\overline{f(u)g(v)} = \bar{f} \cdot \bar{g}$

$P_{ij} = P_i P_j$

$$\sum\sum f(u) g(v) \cdot P_{ij}$$
$$= \sum f(u_i) P_i \sum g(v_j) P_j = \bar{f} \; \bar{g}$$

$N=4$ ideal spin $\frac{1}{2}$

$m = 1/2 \quad -1/2$

$M = m_1 + m_2 + \cdots + m_4$

$M = 2, 1, 0, -1, -2 \quad M_i \quad n = 1, 2, 3, 4, 8$

$\bar{M} = P_i M_i$

$\overline{(M - \bar{M})^2} = \overline{M^2} - (\bar{M})^2$

$= \left(\frac{C_4^0}{2^4} \cdot 4 + \frac{C_4^1}{2^4} \cdot 1\right) \cdot 2 - 0$

$= 2\left(\frac{1}{4} + \frac{1}{2}\right) = \frac{3}{4} \cdot 2 = \frac{3}{2} - 0 = \frac{3}{2}$

$D = \sqrt{\overline{(M - \bar{M})^2}} = \Delta M = \frac{\sqrt{6}}{2}$

$p, q \quad \bar{n} = ap + bq$

$\bar{M} = \sum_{i=0}^{n} C_n^i p^{n-i} q^i \{ib + (n-i)a\}$

$= \quad (b-a) \sum_{i=0}^{n} C_n^i \, i \, p^{n-i} q^i$

$i C_n^i = \frac{n!}{\ldots} = n \frac{(n-1)!}{(n-i)! \, (i-1)!}$

$(n-1)!\ \ldots$

$$= np \sum_{i=0}^{n-1} C_{n-1}^{i} p^{n-1-i} q^{i} (b-a)$$

$$+ na = n(pb + (1-p)a)$$

$$= n\bar{\mu} \Rightarrow n\bar{\mu} = \bar{M}$$

Also $Var(\mu)\,N = Var(M)$