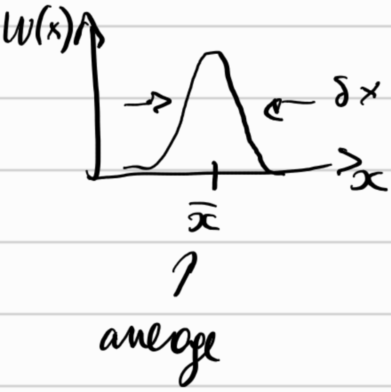
Part 1 : "Thermodynamic limit"
Part 2 : The closed system



δx : width distribut°

degree of freedom

As $N \to \infty$, $\frac{\delta x}{x} \to 0$

$\frac{\text{(std deviat°)}}{\text{average}} \to 0$

System appears to chose macrostate with greatest stat weight

The closed system

internal energy :

$$\left.\begin{array}{l} U_0 = U_1 + U_2 \\ V_0 = V_1 + V_2 \\ N_0 = N_1 - N_2 \\ \text{(particle n°)} \end{array}\right\} \text{fixed}$$

$U_1 \leftrightarrow U_2$
$V_1 \leftrightarrow V_2$
$N_1 \leftrightarrow N_2$

Allow the exchange of energy (heat), volume, particles btw n sub systems

Entropy

→ Thermodynamics : $\boxed{dS = \frac{\delta Q}{T}}$

→ Stat Mech
consider stat weight
$W_1(U_1, V_1, N_1)$

n° (accessible) macrostates

extensive quantity : depends size system = sum subsystems

$S_{tot} = S_1 + S_i$

$W_2(U_2, V_2, N_2)$

stat weight $\propto$ size syst but not $\sum$ subsystems ← they multiply

NOT extensive

Intensive

$W_0 = W_1 \times W_2$

$\underbrace{\ln(W_0) = \ln(W_1) + \ln(W_2)}$

we look at this extensive quantity ← we need to work with extensive quant

$S_0 = S_1 + S_2$

$\ln(W_0) = \ln(W_1) + \ln(W_2)$

Boltzmann const

$$\boxed{S = k_B \ln(W)}$$

entropy S $\propto$ stat weight W

→ $\ln W$ is extensive

→ $\ln W$ is maximized for closed system in eq^{m}

$$\left(\frac{\partial W}{\partial x} = 0 \Rightarrow \frac{\partial \ln W}{\partial x} = \frac{1}{W} \frac{\partial W}{\partial x} = 0 \right)$$

Thermodynamic principles:

$$\frac{\partial \ln(W_0)}{\partial x} = 0 \qquad x = U_2, V_2, N_2 \text{ (for subsystem 2)}$$

(1) $x = U_2$

$$\left(\frac{\partial \ln(W_0)}{\partial U_2} \right)_{V_2, N_2} = 0$$

$$\ln(W_0) = \ln(\omega_1) + \ln(\omega_2)$$

$$U_0 = U_1 + U_2 \Rightarrow 0 = dU_1 + dU_2$$

$$0 = \frac{\partial \ln(\omega_1)}{\partial(U_2)} + \frac{\partial \ln(W_2)}{\partial(U_2)}$$

$$\boxed{\frac{dU_1}{dU_2} = -1}$$

$$= \frac{\partial \ln(\omega_1)}{\partial U_2} = -\frac{\partial \ln(\omega_1)}{\partial U_1} \Leftarrow$$

$$0 = -\frac{\partial \ln \omega_1}{\partial U_1} + \frac{\partial \ln W_2}{\partial U_2}$$

1

$$\boxed{\frac{\partial \ln W_1}{\partial U_1} = \frac{\partial \ln W_2}{\partial U_2}}$$

← only works under the assumpt° of eq^m
equilibrium

$$\beta = \frac{1}{k_B T} = \frac{\partial \ln(\omega)}{\partial U} \qquad \frac{1}{T} = \frac{\partial S}{\partial U} = \frac{\partial k_B \ln W}{\partial U}$$

$$\left(T = \left(\frac{\partial U}{\partial S}\right)_{V,N} \right.$$: 0^{th} law of thermodynamics (Temperature exists)

2

$$\frac{\partial \ln W_0}{\partial V_2} = 0 \;, \quad x = V_2$$

$$\frac{\partial \ln W}{\partial V_2} = \frac{\partial \ln W_1}{\partial V_1}$$ (same as before)

$$= k_B T \left(\frac{\partial \ln W}{\partial V}\right)_{U,N}$$ ← ?sugg+ = pressure → no exchange Vol

$$\boxed{P = T\left(\frac{\partial S}{\partial V}\right)_{U,N}}$$

IF $P_1 = P_2 \Rightarrow$ mechanical equilibrium

3 $\quad x = N_2 \quad \frac{\partial \ln(W)}{\partial N_2} = 0 \qquad \frac{\partial \ln(W_2)}{\partial N_2} = \frac{\partial \ln(W_1)}{\partial N_1}$

Chemical potential

$$\left(\frac{\partial S}{\ }\right) \qquad k_B T\left(\frac{\partial \ln W}{\ }\right)$$

$$\mu = -T\left(\frac{\partial S}{\partial N}\right)_{U,V} = -k_B T\left(\frac{\partial \ln \Omega}{\partial N}\right)_{U,V}$$

If $\mu_1 = \mu_2 \Rightarrow$ difusive $eq^{\underline{m}}$