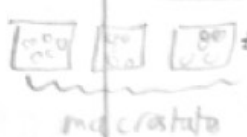


Lecture 17 review:

states of a system



microstate

microstate: know all coordinates and momenta $x_i + p_i$ of each particle i .

same system, different macrostate; low T.

p_i = probability of being in state j .

$p(x_i, p_i)$ or $|ψ(x_i)|^2$ if system specified by $ψ(x)$

Know only the state functions like E, V, N, \dots , which are measurable.

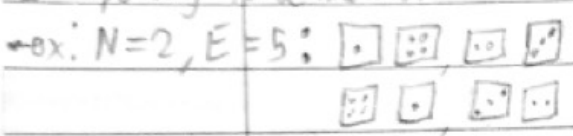
$$\sum p_i = 1$$

Lecture 18: The postulates of statistical Mechanics

• Example system: N dice, total roll "E"

(think of each die as molecule "i" with energy E_i , so $\sum E_i = E$.)

• Ensemble: all microstates of a system corresponding to a macrostate with state functions E, V, N, \dots



• Postulates

I: Microscopic laws (e.g. $F=ma, pV=E$) also apply to an isolated macroscopic system

specified by extensive state functions E, V, N, \dots

II: Principle of equal probabilities:

(i) weak form: All the W microstates $j=1, 2, 3, \dots$ have equal probability (microcanonical ensemble)

ex: p_j for state $\square \square = p_j$ for state $\square \square$

$p_j = \frac{1}{W} = \frac{1}{4}$ for $N=2, E=5$

weak form

• Partition Function: # of microstates accessible to the system in the macrostate with E, V, N, \dots

ex: $W=4$ for dice system $N=2, E=5$

• Extensive state function: scales linearly with size

ex: \square $E=2, N=1, T=2$

\downarrow
 $\square \square$ $E=4, N=2, T=2$

(ii) strong form: $\langle p_j \rangle_N = \langle p_j \rangle_E$

ex of average: $N=1$, allow all E

$$\langle \text{roll} \rangle = \frac{1}{6} \cdot 1 + \frac{1}{6} \cdot 2 + \dots + \frac{1}{6} \cdot 6 = \sum_i \frac{1}{6} p_i E_i = 3.5$$

$$= \sum_{j=1}^6 \frac{1}{W} E_j = \frac{1}{W} \sum E_j$$

• Intensive state functions; independent of system size

ex: $T = E/N$

• Goal in stat mech: for a given system, calculate

average of any observable "A"

$$\langle A \rangle = \bar{A} = A = \sum p_j A_j \quad (\text{analogous to QM } \langle A \rangle = \int dx \psi^* A \psi)$$

S2.2: How many ways to distinguish

3 distinguishable molecules in a box of size 3. $\square \square \square$

