بسم الله الرحمن الرحيم

الدرس الثاني
Lesson 2

١٤٠٤/١/٣١

✓ * A brief History on thermodynamics & Statistical Mechanics
لمحة التاريخ

✓ * Some Keywords and Relevant terminology
الكلمات الاصلي — مصطلحات

* Thermodynamical Equilibrium التوازن الديناميكي الحراري

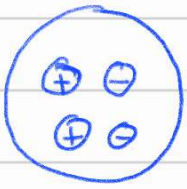
* Thermodynamical Laws قوانين الديناميكي الحراريه

the Main Reference is Greiners Book
First 4 chapter

① History : End of 19th and begining of 20th
النظرة الذريه
The atomistic view Prevailed over
Holistic view
النظرة الشاملية

② ☆ What does matter consist of?

بناء المواد



Thomson Model (1898-1904)

Bohr Model (1913)

بناء المواد

☆ What type of fundamental particles.

Constitute the matter?

تشكل

نجاح

③ The Atomistic View has Successes:

→ ☆ Clarification of Nature of matter

توضيح طبيعة المادة

→ ☆ Elementry Particles and Law governing on Matter

← الجسيمات الاولية والقانون الحاكم

معضلة

④ But we have some challenges?

لا يمكن

☆ According to Atomistic View, it is impossible to explain How and why we achieve different types of

انواع المختلفة

Matter: (Emergent Behavior)

سلوک انباشتی (ظهوری)

Emergent of New Collective behavior of Macroscopic scale from dynamics of Microscopic particles.

How Can deal with Such aspect?

کیف یمکن التعامل مع مثل واقعه

⑤ The Statistical Mechanics helps Us to Solve above Problem

تساعدنا المیکانیکا الإحصائیه علی حلها

⑥ Some Keywords:

6-1: Macroscopic Coordinates مختصات ماکروسکوپیک

They are few

They are almost related to our Sense.

V, T, P, Electric Field, Magnetic field

Volum Temperatu Pressum

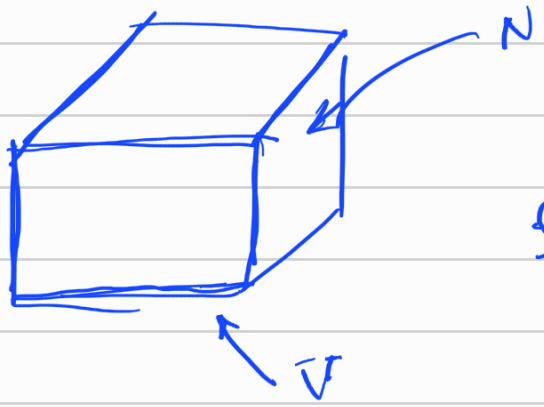
6-2 Microscopic coordinates: مختصات ماکروسکوپیک

☆ They have assumption about the Kinds of Matter

☆ We have huge Number of Microscopic Coordinates.

☆ We Can Not measure them directly,

$\rho(\vec{r})$: density of matter at posit $\vec{r}$



$$\rho = \frac{N}{V}$$

⑦ What is the thermodynamics ?

الوصف الظاهري — ماكروسكوبيك — سلوك

Phenomenological description of Macroscopic behavior

due to Microscopic Properties

ميكروسكوبيك — الخصائص

⑧ What is the Statistical Mechanics ?

Mathematical description of thermodynamics

$U(T) = \frac{3}{2} N K_B T$: We don't Know why such behavior through thermodynamics

But In Statistical Mechanics we can find the reason of this behavior.

⑨ In thermodynamics we refer to

الخصائص الداخلية

Internal Properties but It deals with Macroscopic Coordinates. V, T, N, P, ...

Without Underlying microscopic physics.

⑩ In Statistical Mechanics, We try to determine Macroscopic behavior according to Microscopic State

حالت میکروسکوپیک

⑪ Different Regime In Physics (General)

11-1: Classical versus Quantum Regimes

$n\lambda^3 \ll 1 \rightarrow$ Classical Regim

$n\lambda^3 > 1 \rightarrow$ Quantum Regime

$n\lambda^3$

$n \equiv \frac{N}{V}$ de broglie Wavelength

$$\lambda = \left(\frac{h^2}{2\pi m K_B T}\right)^{1/2}$$

11-2 Relativistic versus Non-Relativistic Regimes

$$E^2 = (PC)^2 + (m_0 c^2)^2$$

momentum ← P

$m_0 c^2$ — Light speed $c = 3\times10^5$ Km/s $= 3\times10^8$ m/s

If $PC > m_0 c^2 \rightarrow$ Relativistic

$Pc \ll m_0 c^2$ — Non-Relativ

$PC \gg m_0 c^2 \rightarrow$ Ultra-Relativistic Regm

11-3 Intractive Versus Non-Intractive Regimes

H : Hamiltonian

H = Kinetic Part + Potential Part

$= H_0 + H_I$

H_0 ↑ Free Part

H_I ↖ Intracting part

Ideal System ← $H_0 \gg H_I \rightarrow$ Non-Intractive Regm

$H_0 \sim H_I \rightarrow$ Intractn Rm

الاختام والنهاية