12/1/06

$\boxed{\text{Huang}}$ → Textbook

Statistical Mechanics (Classical)

→ deal with a classical dynamical system (Hamiltonian) with large no. of degrees of freedom.

↓ in general will be described by

$$(q^1, \ldots, q^N, p_1, \ldots, p_N)$$

Example :- Gas of M-particles $\Rightarrow N = 3M$

(will be interested in the case) N: large no. $\sim 10^{23}$

In practice, it is impossible to solve the dynamics.

Initial conditions are unknown.

Even if the system has symmetry, it is impossible to know initial cnds. → e.g. non-int. ~~ka~~ gas molecules in a box

Statistical Mechanics → A way to extract certain average properties of such a system.

↳ Requires certain postulates which we shall not prove.

In principle one should be able to prove them as we have a classical dyn. system

Consider a dynamical system with large no. of degrees of freedom & let it evolve in time starting from a given ~~instant~~ initial condition.

Postulate :- After certain time, the system reaches an equilibrium state in which certain quantities $f(\vec{q}, \vec{p})$ do not change with time. → MACROSCOPIC QUANTITIES

Approximate statement (because)

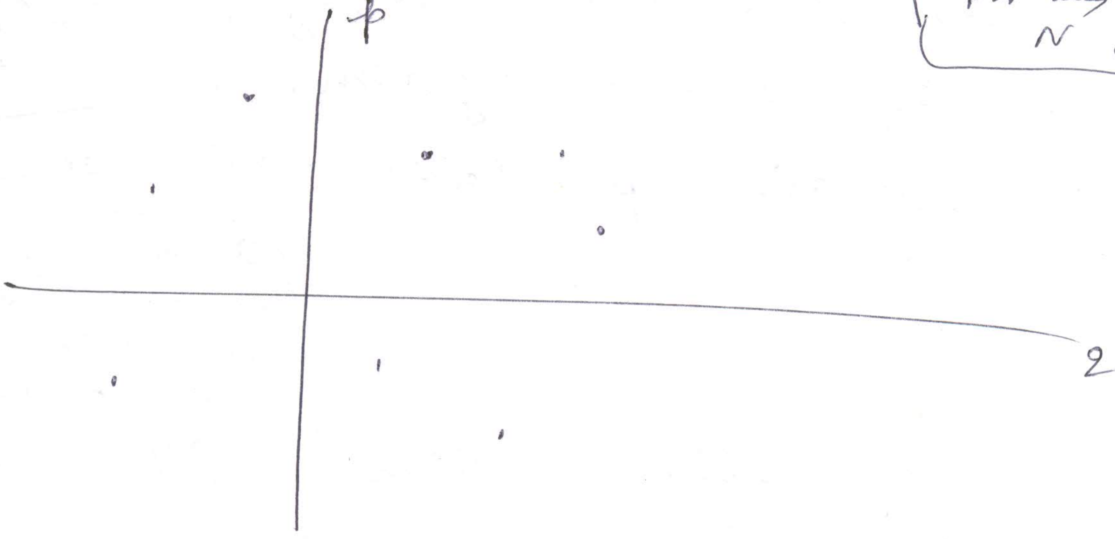
(1) F can change by small amount — (this can happen) frequently

(2) F can change by large amount — rarely

In equilibrium, F can be calculated by time average of F.

$$F = \langle F \rangle = \frac{1}{n}\Big[F(\bar{q}(t_1), \bar{p}(t_1)) + F(\bar{q}(t_2), \bar{p}(t_2)) + \dots + F(\bar{q}(t_n), \bar{p}(t_n)) \Big]$$

(there are n pts. in the phase space)



($\langle F \rangle$ is the ~~rate~~ avg. of values of F at these pts.)

$\langle F \rangle \longrightarrow$ can be regarded as an average over multiple systems at the same time but different initial conditions.

$\longrightarrow$ Statistical ensemble.

It's not that all quantities are not changing — as it is a dynamical sys.

Some quantities, like $\bar{q}, \bar{p}$ do change with time

If we take N to be large, F is almost constant

F is const. becomes true only in the $N \to \infty$ limit

For any finite N, F is not a true const. of motion — but it behaves as a const. of motion most times

$N = \infty$ isn't a dyn. system. For any dyn sys., N is finite