

12/1/06

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

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

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.

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

↳ Requires certain postulates which we shall not prove.

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

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. \rightarrow MACROSCOPIC QUANTITIES

Approximate statement (because)

(1) F can change by small amount

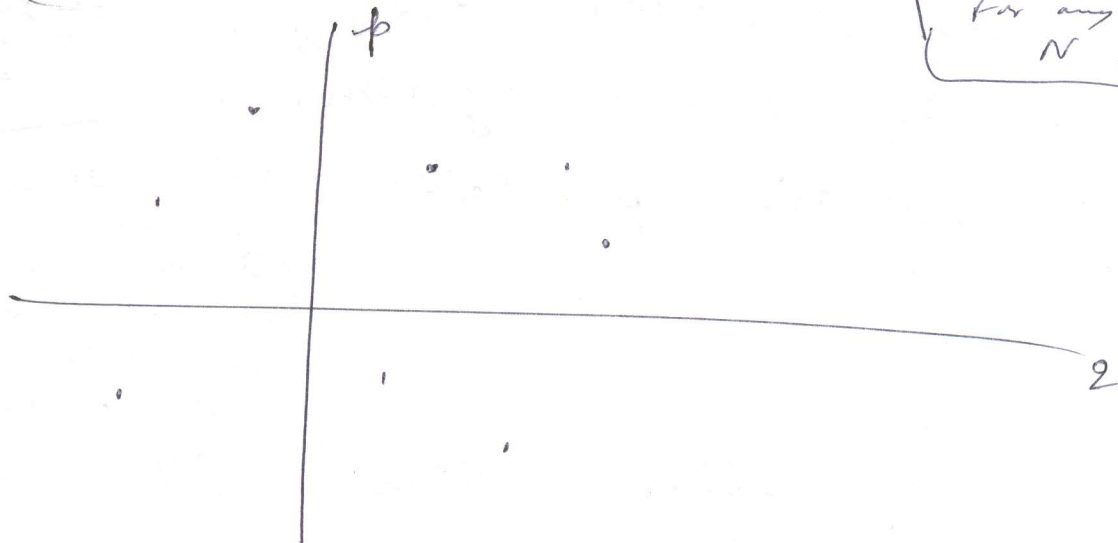
— (this can happen) frequently

(2) F can change by large amount — rarely

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

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

(these are n pts. in the phase space)



($\langle F \rangle$ is the ~~time~~ avg. of values of F at these pts.)
 $\langle F \rangle \rightarrow$ can be regarded as an average over multiple systems at the same time but different initial conditions.

\rightarrow 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 $N \rightarrow \infty$ 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

