Statistical Mechanics
Lecture 5
(Revised)

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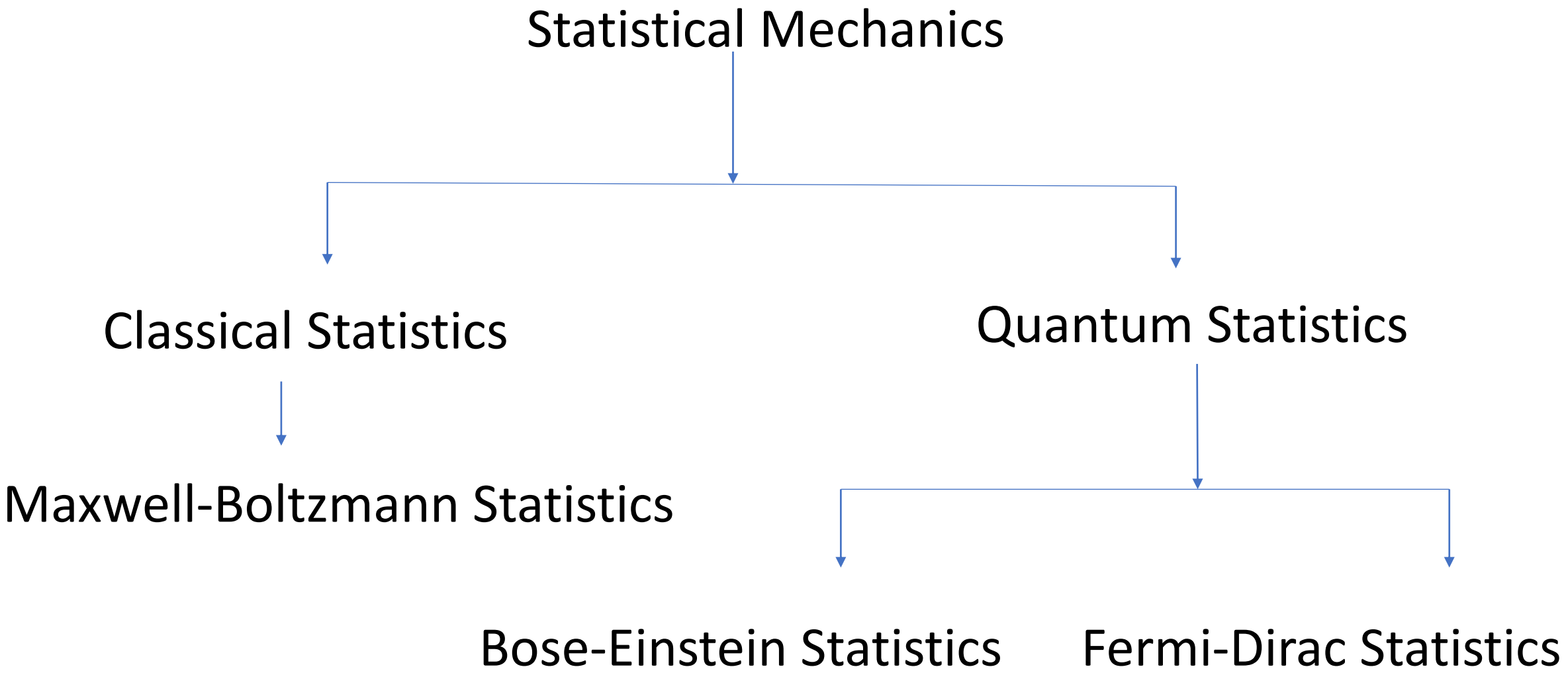
- Micro means small scale physics such as atom, nuclei.
- Macro means properties of bulk matter such as specific heat, dielectric constant.

- Macroscopic system is not concern with individual behaviour of each individual particle.

- Thermodynamics is concern with relationship with certain macroscopic properties or variables or functions of a system in equilibrium.

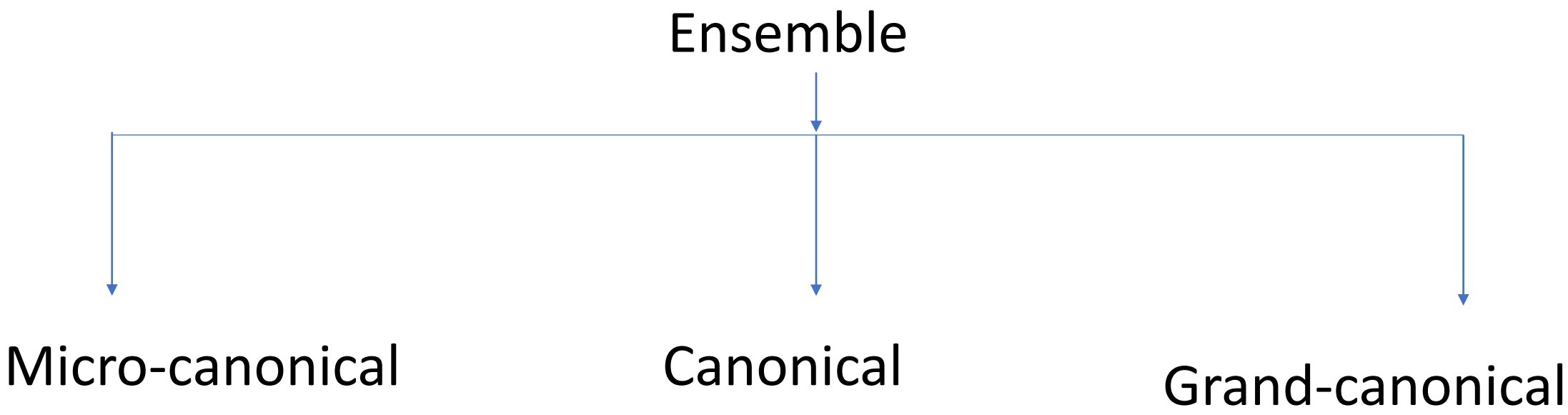
- Statistical Mechanics is one which establishes the relation between macroscopic behaviour (bulk properties) of the system in terms of microscopic behaviours (individual properties).

- Statistical Mechanics is not concern with actual motion or interaction of individual particles but it explore the most probable behaviour of assembly of particles


Statistical Mechanics
Classical Statistics
Quantum Statistics
Maxwell-Boltzmann Statistics
Bose-Einstein Statistics
Fermi-Dirac Statistics

- A single particle is called system & collection of particles called as a whole assembly. A large number of assembly is called ensemble. The number of ensemble are identical feature known as element. The element differ in their state i.e. coordinates and velocities. Thus an ensemble is defined as a collection of very large number of assemblies which are essentially independent of one another but which have been made macroscopically as identical as possible.

$$\boldsymbol{System \rightarrow Assembly \rightarrow Ensemble \rightarrow Element}$$


Ensemble
Micro-canonical
Canonical
Grand-canonical

$$Micro - canonicalEnsemble \rightarrow closed \ \& \ isolated$$
$$\rightarrow Fixed \ volume, Fixed \ energy, Fixed \ numbers \ of \ particles$$

$$Canonical \ Ensemble \rightarrow Energy \ can \ exchanged$$
$$\rightarrow Fixed \ volume, Fixed \ numbers \ of \ particles, Fixed \ mass$$

$$Grand \ Cononical \ Ensemble \rightarrow Energy \ can \ exchanged$$
$$\rightarrow Numbers \ of \ Particles \ can \ exchanged$$

Three position & three momentum coordinate together give the state of an atom in a six dimensional space called phase space.

$$H = \Delta x \Delta y \Delta z \Delta p_x \Delta p_y \Delta p_z$$

$$\Delta x \Delta y \Delta z \Delta p_x \Delta p_y \Delta p_z = h^3$$

$$H = h^3$$

Postulates of Equal a Priori Probability:

When a macroscopic system is in thermodynamical equilibrium its state is equally likely to be any state satisfying the macroscopic condition of the system. This postulate implies that in thermodynamical equilibrium the system under consideration is a member of an ensemble called microcanonical ensemble whose density function is

$$\rho(p,q) = 1 \;\; if \; E < H(p,q) < E + \Delta$$

$$\rho(p,q) = 0 \;\; otherwise$$

It is clear that all members of the ensemble have the same number of particle *N* and same volume *V* .