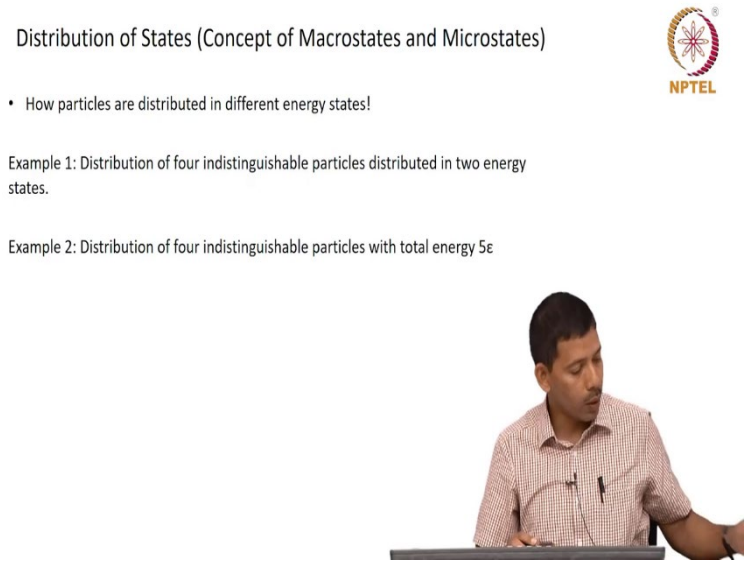
Thermodynamics for Biological Systems:
Classical and Statistical Aspects
Prof. Sanjib Senapati
Department of Biotechnology
Indian institute of Technology - Madras

Lecture – 55
Concepts of Macro and Micro States

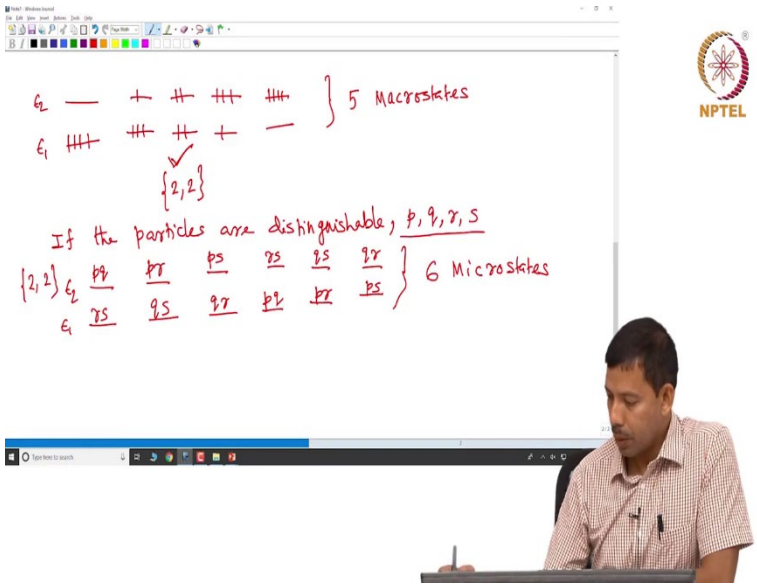
(Refer Slide Time: 00:16)



So, first we need to look at the distribution of states and that is basically to get the concept of Macro States and Micro States. So, distribution of states is nothing but we want to find out, how particles are distributed in different energy states. We will 2 examples and those 2 examples will give you clear idea what you mean by distribution of states in quantum system and that will propagate to classical system for statistical thermodynamics for biological molecules.

Now we will take the example 1: so, in example 1 we will be basically looking at distribution of 4 indistinguishable particles which are distributed in 2 energy states.

(Refer Slide Time: 01:26)



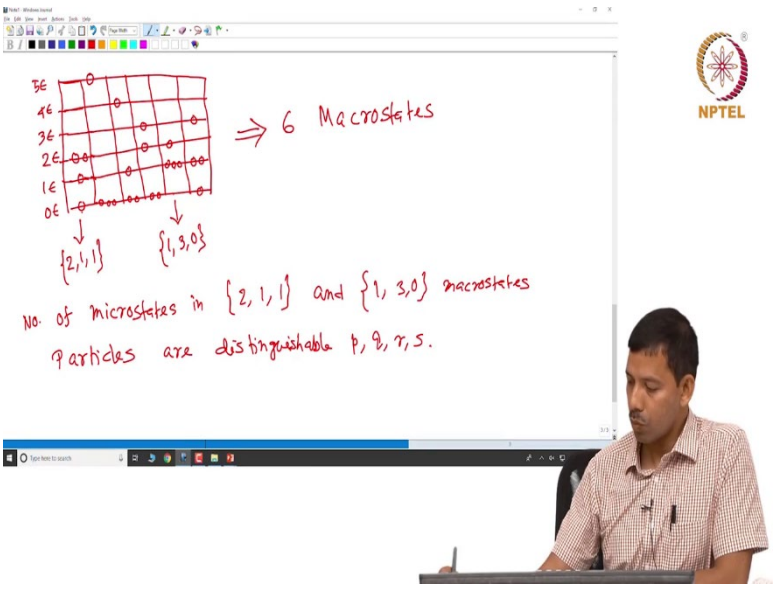
Let us write it down. So, we are looking at distribution of 2, distribution of 4 particles in 2 energy states. So, let us say energy states are epsilon 1 and epsilon 2. So, here I will be using epsilon for , for the energy and for the total energy I will be using capital E. So, epsilon 1 and epsilon 2 are basically the energy of state 1 and state 2. Now we, I said that we have 4 particles. So, how can you distribute 4 particles in these 2 energy states? So, how many distributions you got? So, you got 5 such distribution and these 5 are called Macro States.

So, for 4 particle systems with 2 energy states we can have 5 macrostates. Now, let us look at this particular macrostate which we named as 2,2 which defines that 2 particles are in epsilon 1 state and 2 particles in the epsilon 2 state. So, if now the particles if the particles are distinguishable, (by the term distinguishable I mean that these 4 particles they differ from each other and you can distinguish them.) And so, that those 4 particles are let us say P Q R and S in this case. So, if these 4 particles are distinguishable for this 2,2 macro state how many different distributions we can have? So, what you basically see here that for 2,2 macro state, we have 6 different distributions. And these 6 are called the microstates okay. So, for 2,2 macrostate, we have 6 microstates.

So, likewise for other macro state, you can have different number of microstates as you can you find it. Now, let us look at the second example which is the distribution of 4 indistinguishable particle. So, here we have the restriction is the total energy should full fill at 5 epsilon.

So, again you are talking about 4 particle system, but we are looking at the total energy 5e.

(Refer Slide Time: 06:29)



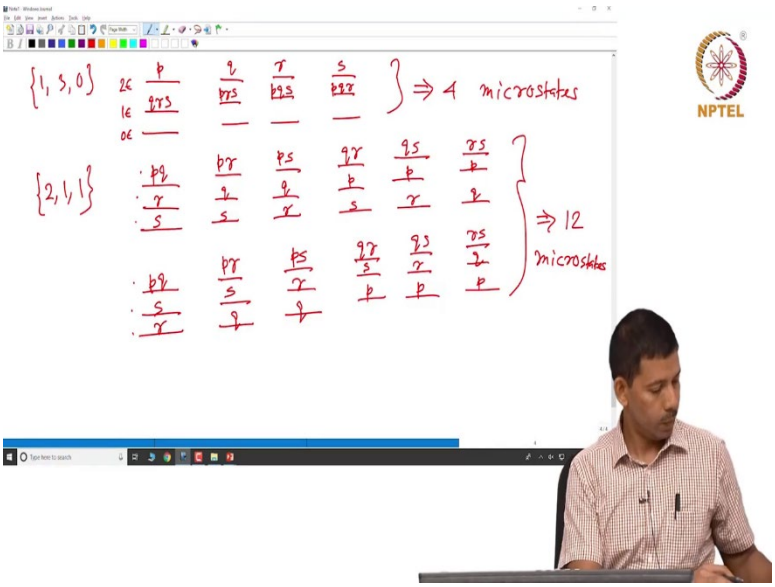
So, we let us say we have different energy states. So, you have energy straight the ground state 0E 1E, we have 2 epsilon ok epsilon naught E, 3 epsilon, 4 epsilon, 5 Epsilon. These are the different energy states and we have 4 particles and we have total energy 5e, so that we have to keep that in mind.

And we will basically counting how many macro states we have, for this particular system of 4 indistinguishable particles with total energy 5E. So these are the 6 macro states you get for this 4 particle systems with total energy 5 epsilon. Now we name this distribution as you know let us say, let us look at this particular distribution, which we name as 1,3,0 distribution. And we look at this particular distribution which we named as 2,1,1.

So, why 2, 1, 1 because you have 2 particles in 2E state we have 1 particular in 1E state, 1 particular in oE state and for 1, 3, 0 we have 1 particle in 2E state, 3 in 1E, 0 in 0E. So, now the question is what will be the number of microstates, you will have to find out. So, again so for that we say that particles are distinguishable.

So now, the particles are again distinguishable and they are sorry they are p, q, r, s. So, let us look at for 1, 3, 0 distribution, how, how many microstates we can have?

(Refer Slide Time: 13:09)



So, we have 1, 3 and 0 microstate and so you have energy state 0E, 1E and 2E. So, this particular macro state is having 4 microstate. Now, let us look at the other distribution we took as 2, 1, 1 And we got total 12 microstates.