Micro and macro states

Consider a system consisting of N structureless identical weakly interacting particles, occupying , a fixed volume V. let the internal energy of the system be U. The state of the system is completely determined by 6N coordinates ; 3N position coordinates and 3N momentum coordinates. Since there are 6N coordinates this phase space is 6N dimensional. Let the phase space be divided into allowed discrete energy levels. Let there be n_1 particles in the energy state $E_1, n_2 in\ E_2$and soon.

$$n_1 + n_2 + n_3 + \ldots = \sum_i n_i = N \quad \ldots\ldots\ldots\ldots (1)$$

$$n_1E_1 + n_2E_2 + n_3E_3 + \ldots = \sum_i n_i E_i = U \quad \ldots\ldots\ldots\ldots (2)$$

The set of numbers n_1, n_2, n_3 of the particles represents one set of distribution of N particles corresponding to the same macrostate of the system. We can have different sets of numbers of particles in the energy levels satisfying equations (1) and (2). These different sets of numbers of particles give different distributions corresponding to the microstate. Thus a macrostate is specified by just giving the number of particles in each energy state. Macrostate is a state of a system which represented by the macro properties like pressure, volume, temperature, density etc in the equilibrium state.

For defining a microstate we should specify to which energy state each particle of the system belongs at a particular instant. The number of microstates corresponding to the given macrostate of the system is called thermodynamic probability or thermodynamic frequency.

For indistinguishable particles, each distribution of the particles among the energy levels, corresponding to the same microstate of the system is called a microstate, or the state of a system represented by the instant positions and momenta of all the particles is called the microstate. The microstate may change continuously with time.