DISTRIBUTION FUNCTION (ρ): OR PROBABILITY DENSITY OR DENSITY OF PROBABILITY DISTRIBUTION:

In an ensemble of 'f' degrees of freedom the distribution function (ρ) is a function of f-position co-ordinates $q_1, q_2, q_3 \cdots q_f$ and f momenta co-ordinates $p_1, p_2 \cdots p_f$. It is also a function of time.

i.e $$\rho = \rho(q_1, q_2 \cdots q_f; p_1, p_2, \cdots p_f, t)$$

and in brief: $$\rho = \rho(q, p, t)$$

Obviously the density of distributions (ρ) denotes the number of systems or elements δN which are found at any given time in a given element of regions in τ space. If the regions selected is such that the position co-ordinates lie between (q_i) and ($q_i + \delta q_i$) and momenta co-ordinate between p_i and ($p_i + \delta p_i$); ($i = 1, 2, 3 \cdots f$). Then the volume of the element ($\delta \tau$) called 'Hyper-volume' will be given by,

$$\delta\tau = (\delta q_1 \cdot \delta q_2 \cdot \delta q_3 \cdots \delta q_f \; \delta p_1 \cdot \delta p_2 \cdots \delta p_f)$$

$$\delta\tau = \prod_{i=1}^{f} \delta q_i \, \delta p_i \quad \text{——} (1)$$

The no. of systems δN laying in the element of regions can be obtained by multi-plying ρ with the hyper-volume.

Thus from (1):

$$\delta N = \rho \cdot \delta \tau = \rho \prod_{i=1}^{f} \delta q_i \delta p_i \quad \text{— (2)}$$