LEVEL - (Energy Level): In general, an allowed discrete energy magnitude. Level, when associated with the integer, j, implies an ordering of energy magnitudes. Thus, there are (j-1) levels with discrete energy magnitudes less than the magnitude of the jth level. The first energy level is ε_1, the second ε_2, etc. The notation ε_j represents any energy level, j = 1,2,.... With each energy level there is associated at least one, and frequently many energy states, i.e., distinct sets of the numbers ℓ,m, and n.

DEGENERACY - (The Degeneracy of an Energy Level): The number, g, of energy states, all of which possess equal discrete energies, i.e., the number of states at a given level is called the degeneracy of that level. Thus, g_j for a fixed integer, j, implies the number of energy states in the jth level.

Thus far our introduction to quantum mechanics has been limited to systems composed of only one particle. Since the particles we have in mind are molecules, atoms, electrons, etc., we realize that the concepts developed must be extended to systems with more than one, indeed, very large numbers of particles. In the following paragraphs we discuss some of the complications that such systems present to our theory.

II. GROUP PARTICLE BEHAVIOR

The macroscopic properties of systems result from individual particle behaviors. These behaviors cannot be considered individually since the particles experience continuous interactions (collisions) among themselves. In this section, we explain why it is that even while the distribution of particles among states and levels changes continually under the agitation of collisions (i.e., as the particles exchange energies), their macroscopic properties in equilibrium remain constant. To reconcile constant properties with incessantly changing particle distributions, we must study the possible and probable distributions of the particles within the available energy states and levels under prescribed system conditions.

A. Macrostate Distributions

We will consider the properties of systems with certain fixed conditions or constraints. Basically, these conditions ensure that the systems do not exchange mass or energy with the surroundings, i.e., the systems are isolated. In terms of the particles of a system, isolation requires that:

(i) the space occupied by the particles be permanently fixed in shape and size—the volume, V, of the system is constant;

(ii) the system contains a fixed group of particles (number and identity). For convenience we will consider only systems with a single type of particle, N in number.

(iii) there are no energy transfers to these particles from sources outside of the system. Therefore, the internal energy, U, of the system is constant.[10]

[10]We are considering an isolated system in a fixed stationary position. Hence, the kinetic and potential energy terms need not be included.