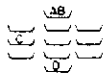
tinguishable since their positions are fixed. The statistics obeyed by *distinguishable particles* is called *MAXWELL-BOLTZMANN* (M-B) *STATISTICS* and we will call a distinguishable particle a *Boltzon*.[14]

To determine the probability of a macrostate relative to other macrostates, we must determine the number of microstates of each macrostate. In systems of distinguishable particles a microstate description contains the detail of not only which states of a degenerate level are occupied but also, precisely which particles occupy each state.

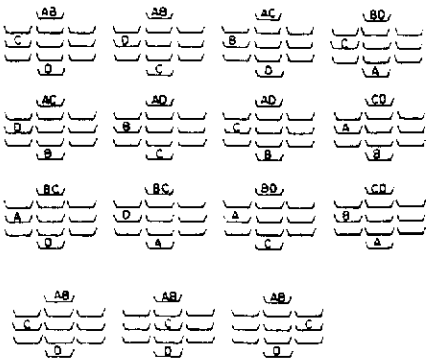
Boltzon macrostate probabilities. Any number of Boltzons can occupy a particular energy state so long as the arrangement is consistent with the system constraints, eqns. IIIA-6. To illustrate the concept of Boltzon microstates consider the 4 particle system of Exer. IIIA-6, whose macrostate distributions are listed in Table IIIA-2. What are the allowed microstates if the 4 particles are distinguishable Boltzons, designated A, B, C and D? (See Exmp. 5.)

Example 5. Consider a system of 4 Boltzons occupying the 5 levels of Fig. IIIA-1 with a total energy of 36 B_o. Determine how many microstates exist in macrostate V, Table IIIA-2.

The first arrangement of macrostate V is shown on the schematic distribution of states and levels at the right. Each distinguishable particle is designated as to which state it occupies. This is one microstate.



Other microstates are represented by simply listing all possible rearrangements among the occupied energy states (including the original in the upper-left-hand corner).



Each of the microstates generated by particle interchange has its level three particle in its (1,2,2) (left) energy state. Since this particle could just as well occupy the (2,1,2) (center) or (2,2,1) (right) energy state of the third level, each above distribution is one of three possibilities. Thus the total number of microstates of macrostate V equals 36. We designate the numbers of microstates in a macrostate as W_i where i = I,II,...; etc. This example has determined that $W_V = 36$.

In Exmp. 5 we showed that there are 36 microstates in Macrostate V of Table IIIA-2. We also found that it is tedious to determine the microstates of a macrostate by listing them. The principles involved are those of combinations and permutations. An equation that determines the number of microstates for the ith macrostate of N Boltzons distributed as $n_{j,i}$ among J levels with degeneracies g_j is (Ref. 5, Sects. 2.6 and 3.2)

$$W_i^{MB} = N! \prod_j^J \frac{g_j^{n_{j,i}}}{n_{j,i}!} = N! \left[\left(\frac{g_1^{n_{1,i}}}{n_{1,i}!}\right)\left(\frac{g_2^{n_{2,i}}}{n_{2,i}!}\right)\cdots\left(\frac{g_J^{n_{J,i}}}{n_{J,i}!}\right)\right] \qquad \text{(IIIA-7a)}$$

[14]Two indistinguishable particle statistics are considered below.