If spin multiplicity $(2S+1)$ is shown with spectroscopic - Symbol 'L', then term is obtained

Now Term = $^{2S+1}L = {}^{2S+1}L$

Total orbital angular momentum 'L' and Total spin angular momentum 'S' these L and S interact to give the resultant angular momenta This resultant angular momentum is denoted by symbol 'J'.

And such interaction i.e. Total orbital angular momentum with Total spin angular momentum is known as (L - S) Coupling or (R-S) Coupling.

The 'J' can have all values from (L-S) to (L+S)

i.e. $J = (L-S)$ to $(L+S)$

For more than half filled orbital,

'J' can have [L+S] values

and for less than half filled orbitals,

'J' can have [L-S] values in ground state.

Since 'J' is the total angular momenta (i.e. resultant of angular momentums, L & S)

The value of 'J' can have only positive value.

or we can say the value of J is always positive but never negative.

If 'J' values is shown 'term', it is called spectroscopic. Energy -energy state or simply state.

Energy state or state = $^{2S+1}L_J$

Find All the possible state for a system in $p^2$ and $d^2$ systems.

A system can have many sets of quantum or Russel - Saunder's states.

Out of which, some are singlets and rest are triplets.

In a singlet state, spins are paired. It means the magnetic quantum numbers are the same for two electrons. It is given below.

For an orbital [↑↓], $S = \frac{1}{2} - \frac{1}{2} = 0$ (Total spin of orbital)

Hence spin multiplicity $(2S+1)$.

$= 2 \times 0 + 1$
$= 0 + 1$
$= 1$ (Singlet)

But, in a triplet state,
spins are parallel
i.e magnetic quantum numbers are different for two electrons
e.g.

For [↑] and [↑] orbitals

$S = \frac{1}{2} + \frac{1}{2} = 1$

$\therefore 2S+1 = 2 \times 1 + 1 = 3$ (Triplet)

To calculate all possible states of a system, then first such set the arrangement of electrons in orbitals is selected for which the L value is the maximum.

It is then followed in decreasing order of L values are corresponding spin multiplets are calculated.

In order to calculate all possible states of a system, firstly one such set i.e. the arrangement of electrons in orbitals is selected for which the L value is the maximum. It is then followed in decreasing order of L values and corresponding spin multiplets are calculated.

Examples:- The $p^2$ system has 15 states:-

Now $\frac{6!}{2!\,(6-2)!} = \frac{6!}{2!\,4!} = \frac{6 \cdot 5 \cdot 4!}{2 \cdot 1 \cdot 4!} = 15$ states

The set with the highest L value is given as:-

| -1 | 0 | +1 |
|---|---|---|
| ↑↓ | | |

$\therefore L = 2\ (D),$

$S = 0$

$\therefore 2S+1 = 2 \times 0 + 1 = 0 + 1 = 1$ (Singlet)

$\therefore$ Term $= {}^1D$

Similarly, ${}^3P$ & ${}^1S$ are other terms for the $p^2$ system:-

| Term | Set (-1, 0, +1) | L | S | 2S+1 | Term | No. of states |
|---|---|---|---|---|---|---|
| ${}^1D$ | [↑↓][ ][ ] | 2 | 0 | 1 | ${}^1D$ | 1x5 = 5 |
| ${}^3P$ | [↑][↑][ ] | 1 | 1 | 3 | ${}^3P$ | 3 x 3 = 9 |
| ${}^1S$ | [ ][↑↓][ ] | 0 | 0 | 1 | ${}^1S$ | 1 x 1 = 1 |