Only one configuration remains $M_L=0$, $M_S=0$ which can give only a ^1S term ($L=0$, $S=0$).

be

$$\left.\begin{array}{l} M_L = 0 \\ M_S = 0 \end{array}\right\} {}^1S.$$

Thus two equivalent p-electrons give rise to ^1D, ^3P and ^1S terms; and no others. The fine-structure levels are $^1D_2$, $^3P_{0,1,2}$ and $^1S_0$.

The same terms are readily calculated from Breit's scheme. In this scheme we write in a table all the possible values of M_L which can be formed by the combination of m_{l_1} and m_{l_2} of the two electrons. For this we write the values of m_{l_1} and m_{l_2} in a row and column respectively. The sums M_L are written below m_{l_1} and to the left of m_{l_2}. These nine values of M_L form three sets divided by the L-shaped (dotted) lines. These sets are:

m_{l_1} =	1	0	−1	
M_L =	2	1	0	1
M_L =	1	0	−1	0
M_L =	0	−1	−2	−1
	S	P	D	m_{l_2}

(two equivalent p-electrons)

$l_1=1$; $l_2=1$

2 1 0 −1 −2 (I set)

1 0 −1 (II set)

0 (III set)

These sets of M_L-values correspond to $L=2$, 1 and 0 respectively *i.e.* to one D, one P, and one S term.

The spins of the two electrons can be combined to form either $S=0$ (singlets) or $S=1$ (triplets). For $S=1$, both electrons have the same spin quantum number m_s and hence they must differ in their values of m_l. We cannot, therefore, combine any of the M_L-values lying on the diagonal of the above table with $S=1$ (because the diagonal corresponds to equal values of m_{l_1} and m_{l_2}). Also, we can use only the M_L-values from one side of the diagonal, as those on the other side merely correspond to a different numbering of the electrons (otherwise they are identical with, and are a mirror image of those on the first side). Thus, with $S=1$ (triplets), we are limited to the following M_L-values.

$$1, 0, -1 \quad \text{(II set)}$$

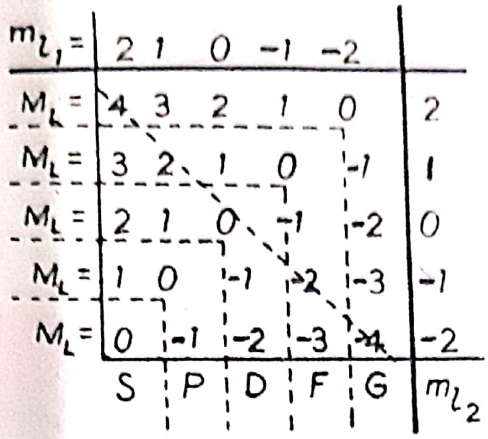
which are the components of a term with $L=1$. This corresponds to a ^3P term or a $^3P_{0,1,2}$ multiplet.

When $S=0$, the electrons differ in their spin quantum numbers and there is no restriction on the values of M_L which may be combined with this value of S. As the II set of M_L values has already been used to form the ^3P term, we have only the remaining I and III sets to combine with $S=0$ (singlets). These sets are the components of terms with $L=2$ and $L=0$ respectively. Hence they correspond to ^1D and ^1S terms.

Thus two equivalent p-electrons give ^1S, ^1D and ^3P terms or $^1S_0$, $^1D_2$ and $^3P_{0,1,2}$ multiplets.

These will also be the terms for p^4 configuration.

Let us now consider two equivalent d-electrons *i.e.* $(nd)^2$ configuration. The Breit's scheme for the possible M_L-values is :



(two equivalent d-electrons)

$l_1=2$; $l_2=2$.

There are 5 sets of M_L-values :

4	3	2	1	0	−1	−2	−3	−4	(I set)
	3	2	1	0	−1	−2	−3		(II set)
		2	1	0	−1	−2			(III set)
			1	0	−1				(IV set)
				0					(V set)

These sets correspond to $L=4, 3, 2, 1, 0$ respectively *i.e.* to G, F, D, P, S terms respectively.

The spins of the two electrons can be combined to form either $S=0$ (singlets) or $S=1$ (triplets). For $S=1$, we are limited to the M_L values from one side of the diagonal *i.e.* to the following sets :

3	2	1	0	−1	−2	−3	(II set)
		1	0	−1			(IV set)

These sets correspond to $L=3$ and $L=1$ and give ^3F and ^3P terms or $^3F_{2,3,4}$ and $^3P_{0,1,2}$ multiplets.

The remaining I, III, and V sets of M_L-values are to be combined with $S=0$ (singlets). They yield ^1G, ^1D and ^1S terms Thus two equivalent d-electrons give

$$^1S_0,\ ^1D_2,\ ^1G_4,\ ^3P_{0,1,2},\ ^3F_{2,3,4}.$$

These will also be the terms for d^8 configuration.

As a final example, we now calculate the spectral terms arising from p^3 configuration. The six possible states for a single p-electron in a very strong field are

$$m_l = \quad 1 \quad 0 \quad -1 \qquad 1 \quad 0 \quad -1$$

$$m_s = \quad \tfrac{1}{2} \quad \tfrac{1}{2} \quad \tfrac{1}{2} \quad -\tfrac{1}{2} \quad -\tfrac{1}{2} \quad -\tfrac{1}{2}$$

(*a*) (*b*) (*c*) (*d*) (*e*) (*f*)

The possible states for three (equivalent) electrons can be obtained by taking all possible combinations of the above six states taken three at a time, with no two alike There will be 20 such combinations $\left({}^6C_3 = \frac{6\,!}{3\,!\,(6-3)\,!} = 20\right)$. They are

abc abd abe abf acd ace acf ade adf aef

bcd bce bcf bde bdf bef cde cdf cef def

For each of these 20 combinations we obtain $M_L\ (= \Sigma\, m_l)$ and $M_S\ (= \Sigma\, m_s)$. This leads to the following tabulation :

	abc	abd*	abe*	abf*	acd**	ace**	acf*	ade*	adf*	aef*
$M_L =$	0	2	1	0	1	0	−1	2	1	0
$M_S =$	$\frac{3}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$-\frac{1}{2}$	$-\frac{1}{2}$	$-\frac{1}{2}$

	bcd	bce**	bcf*	bde**	bdf**	bef*	cde	cdf**	cef*	def
$M_L =$	0	−1	−2	1	0	−1	0	−1	−2	0
$M_S =$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$-\frac{1}{2}$	$-\frac{1}{2}$	$-\frac{1}{2}$	$-\frac{1}{2}$	$-\frac{1}{2}$	$-\frac{1}{2}$	$-\frac{3}{2}$

The highest values of M_L are 2 which indicate a *D*-term ($L=2$). Since they occur with $M_S = \frac{1}{2}$ and $M_S = -\frac{1}{2}$, which are the magnetic field components of $S = \frac{1}{2}$, the term is ${}^2D$. Apart from $M_L = 2$; $M_L = 1, 0, -1, -2$ and each with $M_S = \frac{1}{2}$ and $M_S = -\frac{1}{2}$ also belong to this term. Thus out of the above 20 combinations those marked as* go to form the ${}^2D$ term.

Of the remaining combinations, the highest M_L are 1, and again they occur with $M_S = \frac{1}{2}$ and $M_S = -\frac{1}{2}$. They indicate, therefore, a ${}^2P$ term ($L = 1$, $S = \frac{1}{2}$). Apart from $M_L = 1$; $M_L = 0, -1$ and each with $M_S = \frac{1}{2}$ and $M_S = -\frac{1}{2}$ also belong to this term. Hence the combinations marked** belong to the ${}^2P$ term.

The remaining four combinations are :

$$M_L = 0 \quad 0 \quad 0 \quad 0$$

$$M_S = \tfrac{3}{2} \quad \tfrac{1}{2} \quad -\tfrac{1}{2} \quad -\tfrac{3}{2}$$

These M_L and M_S values are the components of $L = 0$ and $S = \frac{3}{2}$ which correspond to a ${}^4S$ term. Thus the terms of p^3 are

$${}^2P^\circ,\ {}^2D^\circ,\ {}^4S^\circ$$

or

$${}^2P^\circ_{1/2\,,\,3/2}\ ;\ {}^2D^\circ_{3/2\,,\,5/2}\ ;\ {}^4S^\circ_{3/2}.$$