What about when we have 2 valence e^- in same orbital?

C I $(1s^2 2s^2)\,2p^2 \Rightarrow \ell_1 = 1 \quad \ell_2 = 1 \Rightarrow L = 2, 1, 0$

$s_1 = 1/2 \quad s_2 = 1/2 \Rightarrow S = 1, 0$

$2S+1 = 3, 1$

Possible terms are:

L	S	J	Terms
0	0	0	$^1S_0$
1	0	1	$^1P_1$
2	0	2	$^1D_2$
0	1	1	$^3S_1$
1	1	2, 1, 0	$^3P_2$, $^3P_1$, $^3P_0$
2	1	3, 2, 1	$^3D_3$, $^3D_2$, $^3D_1$

However - since these $2e^-$ are in SAME ~~ORBITAL~~ SHELL we must use Pauli's exclusion principle to see which terms are allowed

For each e^- $\ell = 1 \Rightarrow m_\ell = -1, 0, +1$ and $m_s = \pm 1/2$

So there are $3 \times 2 = 6$ possible one e^- states

For $2e^-$, there are $\binom{6}{2} = \frac{6!}{2!(6-2)!} = \frac{6 \cdot 5}{2} = 15$ unique $2e^-$ states

What are they and which terms do they correspond to?

Let's make a table of possible m_ℓ & m_s

$m_s =$	m_ℓ: -1	0	$+1$	M_L	M_S	State Number
	↑↓			-2	0	1
		↑↓		0	0	2
			↑↓	$+2$	0	3
	↑	↑		-1	$+1$	4
	↑	↓		-1	0	5
	↓	↑		-1	0	6
	↓	↓		-1	-1	7
	↑		↑	0	$+1$	8
	↑		↓	0	0	9
	↓		↑	0	0	10
	↓		↓	0	-1	11
		↑	↑	$+1$	$+1$	12
		↑	↓	$+1$	0	13
		↓	↑	$+1$	0	14
		↓	↓	$+1$	-1	15

These are the 15 states!

Now let's make a table that adds up all the M_L's and M_S's:

$M_L \backslash M_S$	1	0	-1
$+2$	0	1	0
$+1$	1	2	1
0	1	3	1
-1	1	2	1
-2	0	1	0

Now let's check for terms in this table.
For istance

$$^3D_J \Rightarrow \begin{matrix} L=2 \\ S=1 \end{matrix} \Rightarrow \begin{matrix} M_L=2 \\ M_S=1 \end{matrix}$$ should appear in our table

It does <u>NOT</u>! Therefore ^3D_J term is disallowed by Pauli's exclusion principle.

Lets try $^1D \Rightarrow \begin{matrix} L=2 \\ S=0 \end{matrix} \Rightarrow \begin{matrix} M_L = -2, 1, 0, 1, 2 \\ M_S = 0 \end{matrix}$

Let's subtract those 5 states from our table

$M_L \backslash M_S$	1	0	-1
+2	0	0	0
+1	1	1	1
0	1	2	1
-1	1	1	1
-2	0	0	0

$\Rightarrow$ A ^1D term exists!

Lets try $3P \Rightarrow \begin{matrix} L=1 \\ S=1 \end{matrix} \Rightarrow \begin{matrix} M_L = -1, 0, +1 \\ M_S = -1, 0, +1 \end{matrix}$

There are 9 combinations of M_L and M_S - let's subtract those:

$M_L \backslash M_S$	1	0	-1
+2	0	0	0
+1	0	0	0
0	0	1	0
-1	0	0	0
-2	0	0	0

$\Rightarrow$ The ^3P_J terms exist!

The ONE remaining state has $M_L = 0$ and $M_S = 0$
There is only one term which has those as the only projections $\Rightarrow L = 0$ and $S = 0$
$2S+1 = 1$

$\Rightarrow$ A ^1S term.

So the allowed terms for CI $(1s^2 2s^2)2p^2$ are:

^1D, $3P_J$, and ^1S

The rest are NOT allowed by Pauli exclusion principle!