- ***Russell Saunders coupling.***
- ***Orgel diagram.***

Russell Saunders coupling

- In atomic spectroscopy, **Russell–Saunders coupling**, also known as LS **coupling**, specifies a **coupling** scheme of electronic spin- and orbital-angular momenta.
- In light atoms, the interactions between the orbital angular momenta of individual electrons is stronger than the spin-orbit **coupling** between the spin and orbital angular momenta. These cases are described by **L-S coupling.**
- The interactions that can occur are of three types.
- spin-spin coupling
- orbit-orbit coupling
- spin-orbit coupling

- There are two principal coupling schemes used:
    i. Russell-Saunders (or L - S) coupling
    ii. jj coupling.
- In the Russell Saunders scheme it is assumed that: spin-spin coupling > orbit-orbit coupling > spin-orbit coupling.
- This is found to give a good approximation for first row transition series where spin-orbit (J) coupling can generally be ignored, however for elements with atomic number greater than thirty, spin-orbit coupling becomes more significant and the j-j coupling scheme is used.

Spin-Spin Coupling

- S - the resultant spin quantum number for a system of electrons. The overall spin S arises from adding the individual m_s together and is as a result of coupling of spin quantum numbers for the separate electrons

Orbit-Orbit Coupling

- L - the total orbital angular momentum quantum number defines the energy state for a system of electrons. These states or term letters are represented as in later.

Spin-Orbit Coupling

- Coupling occurs between the resultant spin and orbital momenta of an electron which gives rise to J the total angular momentum quantum number. Multiplicity occurs when several levels are close together and is given by the formula (2S+1). The Russell Saunders term symbol that results from these considerations is given by: $^{(2S+1)}L$
- S= + ½ , hence (2S+1) = 2

For L=2 , the Ground Term is written as ^2D

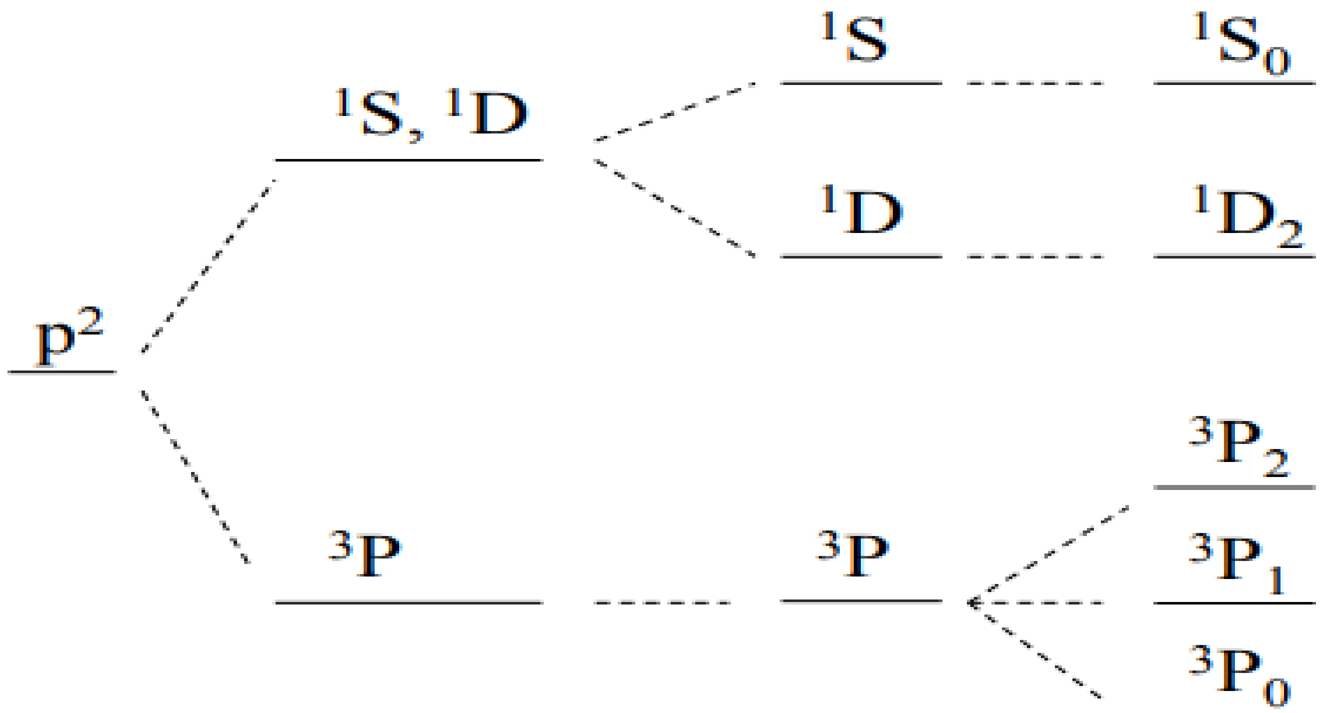
The Russell Saunders term symbols for the other free ion configurations are given in the Table below.

Terms for $3d^n$ free ion configurations

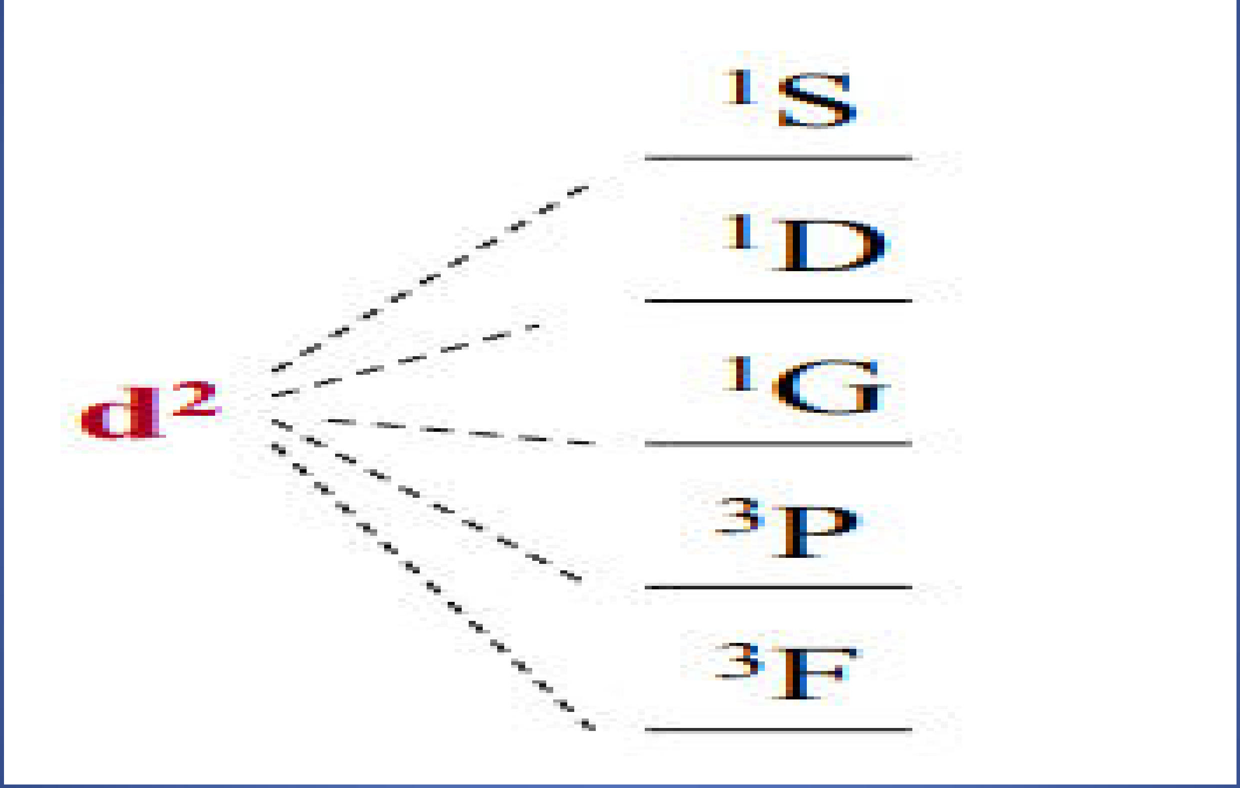
Configuration	# of energy levels	Ground Term	Excited Terms
d^1,d^9	1	**^2D**	-
d^2,d^8	5	**^3F**	**^3P**, ^1G,^1D,^1S
d^3,d^7	8	**^4F**	**^4P**, ^2H, ^2G, ^2F, 2 x ^2D, ^2P
d^4,d^6	16	**^5D**	^3H, ^3G, 2 x ^3F, ^3D, 2 x ^3P, ^1I, 2 x ^1G, ^1F, 2 x ^1D, 2 x ^1S
d^5	16	**^6S**	^4G, ^4F, ^4D, ^4P, ^2I, ^2H, 2 x ^2G, 2 x ^2F, 3 x ^2D, ^2P, ^2S

- **Hund's Rules**
  The Ground Terms are deduced by using Hund's Rules.
  The two rules are:
  1) The Ground Term will have the maximum multiplicity
  2) If there is more than 1 Term with maximum multiplicity, then the Ground Term will have the largest value of L.

d^n	2	1	0	-1	-2	L	S	Ground Term
d^1	↑					2	1/2	^2D
d^2	↑	↑				3	1	^3F
d^3	↑	↑	↑			3	3/2	^4F
d^4	↑	↑	↑	↑		2	2	^5D
d^5	↑	↑	↑	↑	↑	0	5/2	^6S
d^6	↑↓	↑	↑	↑	↑	2	2	^5D
d^7	↑↓	↑↓	↑	↑	↑	3	3/2	^4F
d^8	↑↓	↑↓	↑↓	↑	↑	3	1	^3F
d^9	↑↓	↑↓	↑↓	↑↓	↑	2	1/2	^2D

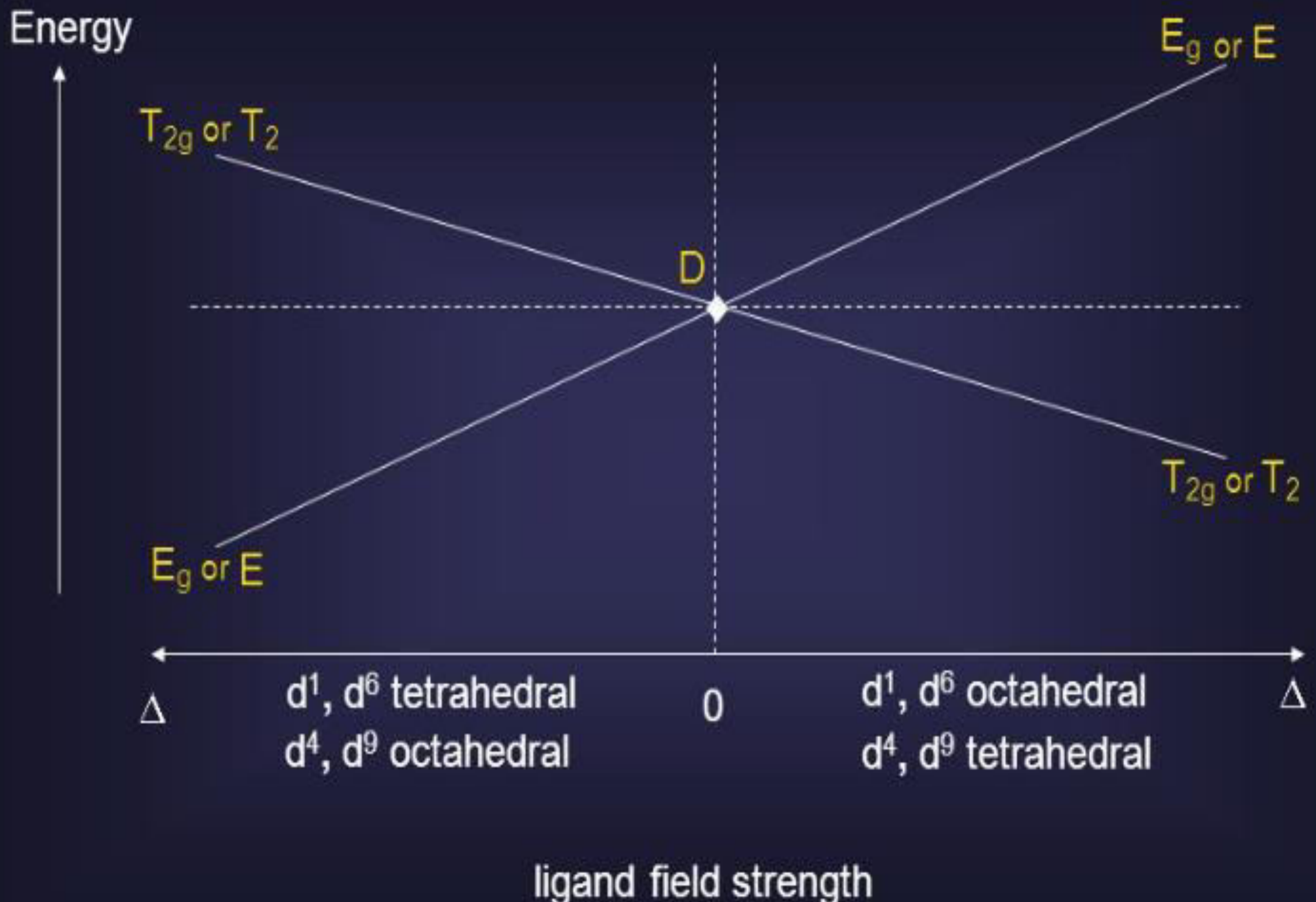


p^2
$^1S, ^1D$
^3P
^1S
^1D
^3P
$^1S_0$
$^1D_2$
$^3P_2$
$^3P_1$
$^3P_0$

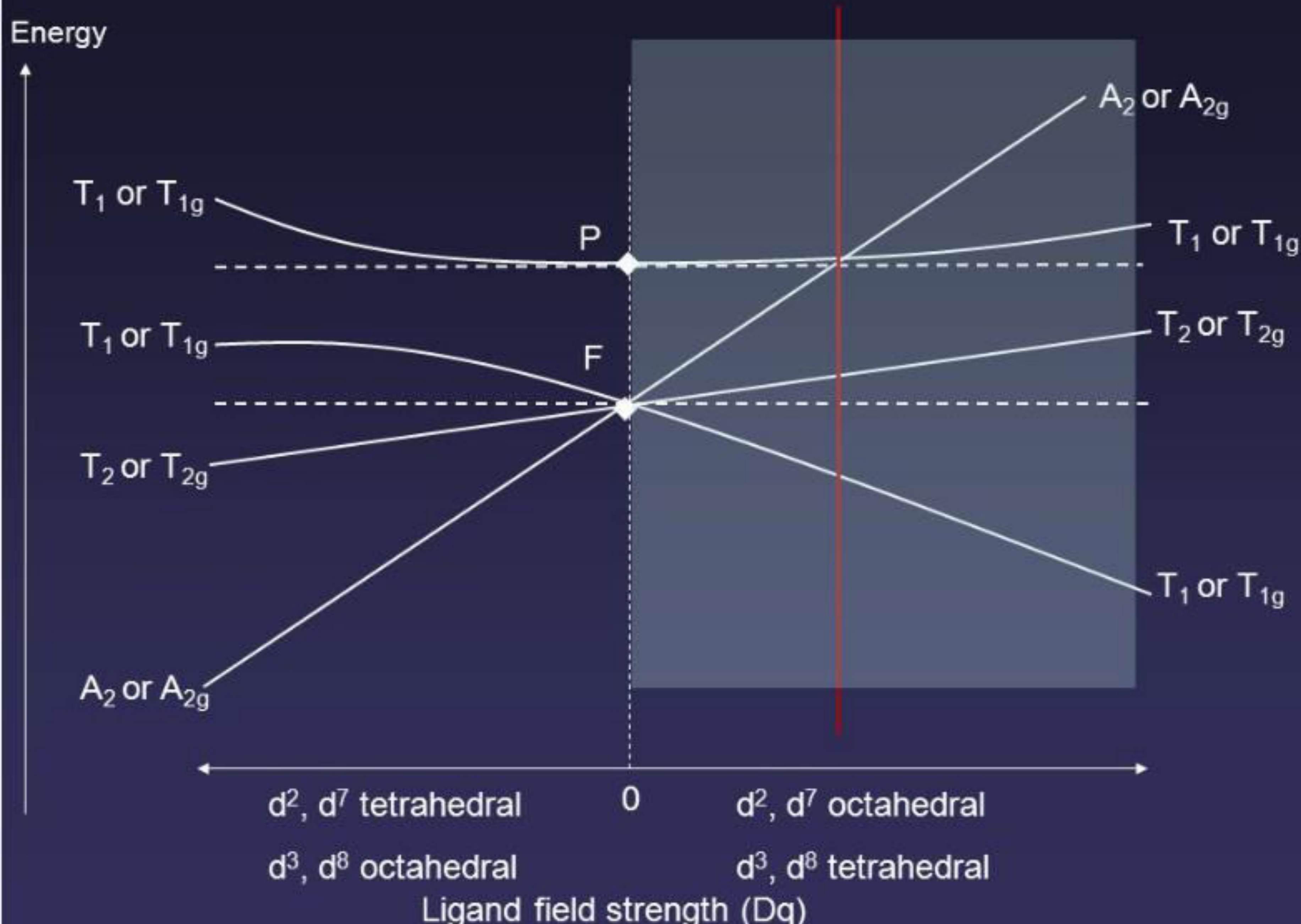


d^2
^1S
^1D
^1G
^3P
^3F

Orgel diagram for d^1, d^4, d^6, d^9



Orgel diagram for d^2, d^3, d^7, d^8 ions



- For a d^7 configuration :
- in the +2 box are 2 electrons, so **L** for that box is 2*2= 4
- in the +1 box are 2 electrons, so **L** for that box is 1*2= 2
- in the 0 box is 1 electron, **L** is 0
- in the -1 box is 1 electron, **L** is -1*1= -1
- in the -2 box is 1 electron, **L** is -2*1= -2
- Total value of **L** is therefore +4 +2 +0 -1 -2 or **L**=3. Note that for 5 electrons with 1 electron in each box then the total value of **L** is 0. This is why **L** for a d^1 configuration is the same as for a d^6.

- The other thing to note is the idea of the "hole" approach. A d^1 configuration can be treated as similar to a d^9 configuration. In the first case there is 1 electron and in the latter there is an absence of an electron i.e., a hole.
- The overall result shown in the Table above is that:
- 4 configurations (d^1, d^4, d^6, d^9) give rise to D ground terms,
- 4 configurations (d^2, d^3, d^7, d^8) give rise to F ground terms
- and the d5 configuration gives an S ground term.