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The RS coupling scheme for g^n configurations using partial terms

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ABSTRACT

The partial terms for the hypothetical complex g^n configurations have been derived by the numerical algorithm. These have been utilized to derive the RS terms of g^n configurations. A multiplication table has been developed to facilitate the derivation of RS terms of such complex configurations. Furthermore, a symmetry relationship for the multiplication of partial terms of 'square' spin set configurations has been discerned which also greatly simplifies the derivation of RS terms of complex configurations.

Key words: RS Coupling scheme, g^n configuration, partial terms.

INTRODUCTION

The Russell-Saunders coupling (L-S) scheme is of great importance in understanding the atomic and electronic spectra. Just as the complexity of the shapes of orbitals increases as the value of *l* (angular momentum quantum number) increases, the complexity of Russell-Saunders coupling scheme increases in the same manner. In this connection, the derivation of RS terms is usually restricted to simple configurations[1] such as p^2 and d^2.

The ease and versatility of using partial terms in deriving RS terms has been amply explained in previous publications[2-5] for the configurations p^n, d^n and f^n whose block of elements are already known. Many inorganic textbooks provide tables of RS terms for d^n configurations but not those of complex f^n or g^n configurations. Due to lack of easy and simple methods of deriving RS terms, such tables tend to induce fear among learners. By applying the simple Partial Terms Method of deriving RS terms, the fright at the sight of such tables including those of RS terms of f^n and g^n will no longer exist. Although, there is no atom with a g^n configuration discovered yet, it will be interesting to see the type RS terms of g^n configurations look like using the simple Partial Terms method. This paper therefore takes a step further to illustrate the use of partial terms concept to derive the RS terms of very complex hypothetical g^n configurations.

The g^n partial terms

The concept of Hole Formalism greatly simplifies the derivation of partial and RS terms. Hole formalism based on half-filled shell links the partial terms whereas the hole formalism based on a filled shell links the RS terms[2]. Thus, the partial terms for the trivial configurations g^0 and g^1 are S and G respectively whereas those of the rest have to be derived. Our aim therefore is to generate the Partial Terms of the configurations in question below:

$g^0 = g^9 \rightarrow$ S (trivial case)
$g^1 = g^8 \rightarrow$ G (trivial case)
$g^2 = g^7 \rightarrow$?
$g^3 = g^6 \rightarrow$?
$g^4 = g^5 \rightarrow$?

Clearly, in order for us to derive the RS terms of g^n configurations, all we have to do is to first derive the partial terms for g^2, g^3 and g^4 only.

The partial terms of g^2 configuration

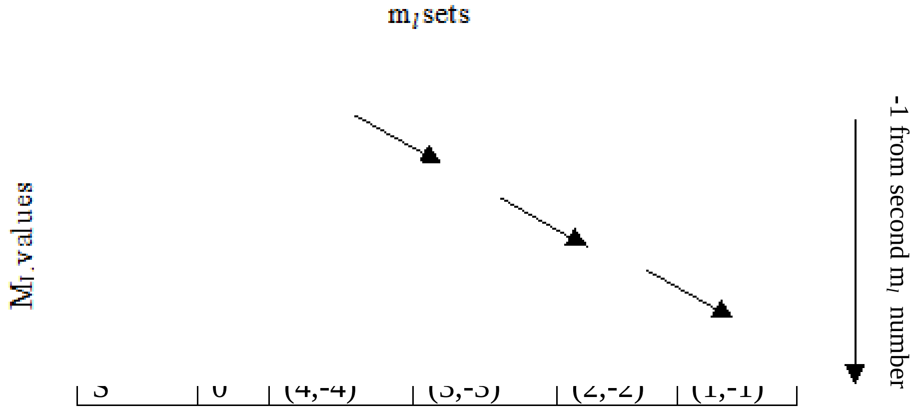
The numerical algorithm method that has been applied to d^n and f^n is utilized[3-5].

The lead m_l values are obtained from the first set (4,3) by subtracting a total of -2 (one from each m_l number) to obtain the successive lead m_l sets. These are :

$$(4,3) \xrightarrow{-2} (3,2) \xrightarrow{-2} (2,1) \xrightarrow{-2} (1,0)$$

Using the lead m_l values, the rest of m_l values can be generated by subtracting one from the second m_l number. A complete set of m_l values needed to obtain the partial terms of g^2 is given in table - 1.

Table-1: The Numerical Method for Deriving the Partial terms of g^2 configuration



The column starting with the m_l set (4,3) has the M_L values [7,6,5, 4,3,2,1,0> and it can be extended to generate a complete set of M_L values [7,6,5,4,3,2,1,0,-1,-2,-3,-4,-5,-6,-7] giving rise to a resultant L-value of 7 corresponding to the partial term K. Since there is a symmetry of numbers centered around 0, there is no need to generate the m_l sets and the M_L values of negative values as it may be cumbersome. This numerical approach method only generates the m_l sets and the M_L values which are positive starting with the m_l set of the highest value for electrons of the same spin arranged singly in the orbitals.

The rest of L values that can be obtained from the table as follows:

[5, 4,3,2,1,0> $\rightarrow$ H , [3,2,1,0> $\rightarrow$ F and [1,0> $\rightarrow$ P.

Hence, the partial terms of g^2 are K, H, F and P. Following a similar procedure, the partial terms of g^3 can be obtained. This is summed up in table 2.

Table - 2: The lead m_l sets of g^3 configuration

-3

-2

$$
\begin{tikzcd}
(4,3,2) \arrow[r] \arrow[d] & (3,2,1) \arrow[r] \arrow[d] & (2,1,0) \arrow[r] \arrow[d] & (1,0,-1) \\
(4,2,1) \arrow[r] \arrow[d] & (3,1,0) \arrow[r] \arrow[d] & (2,0,-1) & \\
(4,1,0) \arrow[r] \arrow[d] & (3,0-1) \arrow[d] & & \\
(4,0,-1) \arrow[r] \arrow[d] & (3,-1,-2) & & \\
(4,-1,-2) & & &
\end{tikzcd}
$$

From the lead m_l sets, the complete m_l sets needed to derive the partial terms can be generated. This is shown in table 3.Table-3: Complete list of g^3 m_l sets

Table - 3: Complete list of g^3 m_l sets

-1 from the last m_l number

(4,3,2) → (4,3,1) → (4,3,0) → (4,3,-1) → (4,3,-2) → (4,3,-3) → (4,3,-4)

(4,2,1) → (4,2,0) → (4,2,-1) → (4,2,-2) → (4,2,-3) → (4,2,-4)

(4,1,0) → (4,1,-1) → (4,1,-2) → (4,1,-3) → (4,1,-4)

(4,0-1) → (4,0,-2) → (4,0,-3) → (4,0,-4)

(4,-1,-2) → (4,0,-3)

(3,2,1) → (3,2,0) → (3,2,-1) → (3,2,-2) → (3,2,-3) → (3,2,-4)

(3,1,0) → (3,1,-1) → (3,1,-2) → (3,1,-3) → (3,1,-4)

(3,0,-1) → (3,0,-2) → (3,0,-3)

(3,-1,-2)

(2,1,0) → (2,1,-1) ? (2,1,-2) → (2,1,-3)

(2,0,-1) → (2,0,-2)

(1,0,-1)

The total number of microstates is 46. These microstates can be cast into a microstates array diagram shown in table 4.

Table - 4: Microstate Array of g^3 Partial Terms

M	9	*											
L	8	*											
K	7	*	*										
I	6	*	*				*						
H	5	*	*	*			*						
G	4	*	*	*			*	*					
F	3	*	*	*	*		*	*			*		
D	2		*	*	*		*	*	*		*		
P	1			*	*	*	*	*	*		*	*	
S	0				*	*		*	*	*	*	*	*

The microstates array diagram can be re-arranged in such away that each column has elements starting from zero. This will give us a final microstates array diagram shown in table 5.

Table-5: Partial Terms Microstate Array Diagram for g^3

M	9	*							
L	8	*							
K	7	*	*						
I	6	*	*				*		
H	5	*	*	*			*		
G	4	*	*	*			*	*	
F	3	*	*	*	*		*	*	*
D	2	*	*	*	*		*	*	*
P	1	*	*	*	*	*	*	*	*
S	0	*	*	*	*	*	*	*	*
Number of microstates	10	8	6	4	2	7	5	4	

As can be seen from table 5, the total number of microstates is 46 from which the following partial terms can readily be extracted as

$$g^3 \rightarrow \text{MKIHGF(2)P}.$$

Using a similar approach for g^4, we can generate the following numerical sequence. This is shown in table 6.

Further development of table 6 gives rise to the m_l sets which are shown in table 7.

Table-6: The m_l sets of g^4 Partial Terms

-4 one from each m_l number →

-3 one from each of the last three m_l numbers ↓

(4, 3,2,1)	→	(3,2,1,0)	→	(2,1,0,-1)
↓		↓		
(4, 2, 1, 0)	→	(3,1, 0,-1)		
↓		↓		
(4, 1, 0,-1)	→	(3,0,-1,-2)		
↓				
(4, 0, -1, -2)				

Table-7: The lead m_l sets of g^4

-3 one from each of the last m_l number →

-2 one from each of the last three m_l numbers ↓

(4, 3, 2,1)	→	(4,2,1,0)	→	(4,1,0,-1)	→	(4, 0, -1, -2)
↓		↓		↓		
(4,3,1,0)	→	(4,2,0,-1)	→	(4,1,-1,-2)		
↓		↓		↓		
(4,3,0,-1)	→	(4,2,-1,-2)	→	(4,1,-2,-3)		
↓		↓		↓		
(4,3,-1,-2)	→	(4,2,-2,-3)				
↓						
(4,3,-2,-3)						
↓						
(4,3,-3,-4)						

(3,2,1,0)	(3,1, 0,-1)	(3,0,-1,-2)
(3,2,0,-1)	(3,1,-1,-2)	
(3,2,-1,-2)		
(3,2,-2,-3)		

(2,1,0,-1)
(2,1,-1,-2)

Subtracting one from the last m_l number

By subtracting ONE from the last m_l number we generate the final sets of m_l values that will give us the partial of g^4 configuration. For instance, let us take the m_l set (4, 3, 2,1) as an illustration. The resulting m_l sets will be (4,3,2,0), (4,3,2,-1), (4,3,2,-2), (4,3,2,-3) and (4,3,2,-4). The corresponding M_L values are 10, 9,8, 7,6,and 5 respectively. Each of these M_L values represents a microstate. If we use symbol (*) to represent a microstate similarly generated from the m_l sets in table 7 then we can re-arrange them to obtain a microstate array diagram shown in table 8. Rearrangement of table 8 produces table 9.

Table-8: Microstate Array Diagram of g^4.

M_L																							
10	*																						
9	*																						
8	*	*																					
7	*	*					*																
6	*	*	*				*							*									
5	*	*	*				*	*						*									
4		*	*	*			*	*			*			*	*								
3			*	*			*	*	*		*			*	*			*					
2				*	*			*	*		*	*		*	*	*		*		*			
1					*				*	*	*	*			*	*		*	*	*		*	
0						*				*		*	*			*	*	*	*	*	*	*	*

Table - 9: Microstate Array Diagram of g^4

N	10	*											
M	9	*											
L	8	*	*										
K	7	*	*				*						
I	6	*	*	*			*			*			
H	5	*	*	*			*	*		*			
G	4	*	*	*	*		*	*		*	*		
F	3	*	*	*	*		*	*	*	*	*		
D	2	*	*	*	*	*	*	*	*	*	*	*	
P	1	*	*	*	*	*	*	*	*	*	*	*	
S	0	*	*	*	*	*	*	*	*	*	*	*	*

g^4 = NLKI(2)HG(2)FD(2)S

The partial terms of g^4 given above are readily extracted from table 9.

A table of partial terms for g^n configurations can now readily be set up. It is constructed on the knowledge of hoe formalism based on half filled shell. This is shown in table 10.

Table-10: Equivalence Relationship of Partial Terms of g^n Configurations

g^n	g^{9-n}	PARTIAL TERMS
g^0	g^9	S
g^1	g^8	G
g^2	g^7	KHFP
g^3	g^6	MKIHGF(2)P
g^4	g^5	NLKI(2)HG(2)FD(2)S

Derivation of Russell-Saunders terms for g^n configurations

Using partial terms

The procedures utilized in the derivations of RS terms for the p^n, d^n and f^n configurations will be applied to the complex g^n configurations. A Partial Terms Multiplication table has been developed to highly simplify the derivation of RS terms and is shown in table 11.

Table-11: Multiplication Table of Partial Terms

		S	P	D	F	G	H	I	K	L	M	N
		0	1	2	3	4	5	6	7	8	9	10
S	0	0	1	2	3	4	5	6	7	8	9	10
P	1	1	0,2	1,3	2,4	3,5	4,6	5,7	6,8	7,9	8,10	9,11
D	2	2	1,3	0,4	1,5	2,6	3,7	4,8	5,9	6,10	7,11	8,12
F	3	3	2,4	1,5	0,6	1,7	2,8	3,9	4,10	5,11	6,12	7,13
G	4	4	3,5	2,6	1,7	0,8	1,9	2,10	3,11	4,12	5,13	6,14
H	5	5	4,6	3,7	2,8	1,9	0,10	1,11	2,12	3,13	4,14	5,15
I	6	6	5,7	4,8	3,9	2,10	1,11	0,12	1,13	2,14	3,15	4,16
K	7	7	6,8	5,9	4,10	3,11	2,12	1,13	0,14	1,15	2,16	3,17
L	8	8	7,9	6,10	5,11	4,12	3,13	2,14	1,15	0,16	1,17	2,18
M	9	9	8,10	7,11	6,12	5,13	4,14	3,15	2,16	1,17	0,18	1,19
N	10	10	9,11	8,12	7,13	6,14	5,15	4,16	3,17	2,18	1,19	0,20

The sets of paired numbers are based on the multiplication principle of terms discussed in the earlier paper[4-5]. For example, the product of GxF terms with corresponding L values of 4 and 3 will have a minimum resultant L value of $|4-3| = 1$ and the maximum resultant L value of $|4+3| = 7$. The entire set of resultant L values will be {1,2,3,4,5,6,7}. However, the multiplication table only indicates the set {1,7} in the intersection box.

Let us start with a g^2 configuration. The procedure is summarised in table 12.

Table - 12: The Derivation of g^2 RS Terms using the Partial Terms

g^n	Spin type	Partial Terms	S, 2S+1	RS Terms
g^2	↑↑	KHFP	1, 3	^{3}[KHFP]

	Spin	Partial Terms Product									
			S	P	D	F	G	H	I	K	L
g^1g^1	↑↓	GG	0	1	2	3	4	5	6	7	8
			S	P	D	F	G	H	I	K	L
g^2		Subtract (-)		P		F		H		K	
Net			S		D		G		I		L

$g^2 \rightarrow$ ^{3}[KHFP] + ^{1}[SDGIL]

The number of microstates is 3[15+11+7+3] +[1+5+9+13+17] = 153

This number can be checked using the factorial formula (F) as follows:

F =18!/2!16! = 18.17/2 =153.

Derivation of rs terms of g^3 configuration Using partial terms

The procedure for the derivation of RS terms using partial terms is based on factoring the spin sets and then manipulating their corresponding partial terms.

The RS terms of the highest spin multiplicity are easily obtained by immediately inserting the appropriate spin multiplicity to the corresponding partial terms. In the case of g^3, the partial terms set is MKIHGF(2)P from which the RS terms of the highest spin multiplicity are directly obtained as follows:

$g^3 \rightarrow$ MKIHGF(2)P $\rightarrow$ ^{4}[MKIHGF(2)P]

Spin set: ↑↑↑ S=3/2 , 2S+1 = 4

For the Spin set ↑↑↑ (S =1/2 and 2S+1 =2) means that it consists two electrons of one spin type and the other of one electron. Hence, we must use the partial terms of a g^2 configuration and that of a g^1 configuration from table 10 as follows:-

g^2g^1 $\rightarrow$ [KHFP][G] = GK+GH+GF+GP

These terms can readily be evaluated from the partial terms multiplication table 11. The results are tabulated in table 12.

Table-12: The Derivation of the Partial Terms of g^2g^1 Spin Set.

		S	P	D	F	G	H	I	K	L	M	N	O
	L	0	1	2	3	4	5	6	7	8	9	10	11
GK					3	4	5	6	7	8	9	10	11
GH			1	2	3	4	5	6	7	8	9		
GF			1	2	3	4	5	6	7				
GP					3	4	5						
Total	G2G1		P(2)	D(2)	F(4)	G(4)	H(4)	I(3)	K(3)	L(2)	M(2)	N	O
Subtract	G3	-	P		F(2)	G	H	I	K		M		
NET			P	D(2)	F(2)	G(3)	H(3)	I(2)	K(2)	L(2)	M	N	O

The partial terms of the spin sets are interlinked. Thus, in order to get genuine doublet RS terms, we must 'filter off' from the partial terms of g^2g^1 spin set the partial terms of g^3 spin set as summed up in table 12.
Hence, the RS terms of g^3 are:

$$g^3 \rightarrow {}^4[MKIHGF(2)P] + {}^2[ONML(2)K(2)I(2)H(3)G(3)F(2)D(2)P]$$

Number of microstates = 4[19+15+13+11+9+7x2+3] +
23+21+19+17x2+15X2+13X2+11x3+9x3+7X2+5X2+3]
= 4. 84 + 2. 240 = 336 +480 = 816
F = 18!/3!15! = 18.17.16/3.2 = 3.17.16 = 816

The RS terms of a g^4 electron configurations

The derivation of g^4 RS terms follows a similar procedure as that of g^3 illustrated above.

Steps 1 ↑↑↑↓ → g^4 '! NLKI(2)HG(2)FD(2)S → ^{5}[NLKI(2)HG(2)FD(2)S]
S =2, 2S+1 =5

2\. ↑↑↑↓ → g^3. g^1 '![MKIHGF(2)P]G =GM+GK+GI+GH+GG+2GF+GP
s= 1, 2s+1 =3

The partial terms products arising from the multiplication are readily evaluated using the multiplication table 10. The procedure is summarised in table 13.

Table-13: The Partial Terms of g^3g^1 spin set

2L+1		1	3	5	7	9	11	13	15	17	19	21	23	25	27
L		0	1	2	3	4	5	6	7	8	9	10	11	12	13
		S	P	D	F	G	H	I	K	L	M	N	O	Q	R
GM							5	6	7	8	9	10	11	12	13
GK					3	4	5	6	7	8	9	10	11		
GI				2	3	4	5	6	7	8	9	10			
GH			1	2	3	4	5	6	7	8	9				
GG		0	1	2	3	4	5	6	7	8					
GF			1	2	3	4	5	6	7						
GF			1	2	3	4	5	6	7						
GP					3	4	5								
Total	G3G1	S	P(4)	D(5)	F(7)	G(7)	H(8)	I(7)	K(7)	L(5)	M(4)	N(3)	O(2)	Q	R
-	G4	S		D(2)	F	G(2)	H	I(2)	K	L		N			
Net			P(4)	D(3)	F(6)	G(5)	H(7)	I(5)	K(6)	L(4)	M(4)	N(2)	O(2)	Q	R

Triplets = ^{3}[P(4)D(3)F(6)G(5)H(7)I(5)K(6)L(4)M(4)N(2)O(2)QR]

Spin set ↑↑↑↓ → $g^2.g^2$ =[KHFP] [KHFP]
S=0, 2S+ 1 =1

The products of the multiplication of the partial terms can readily be obtained from table 14.

Table - 14: The Products of Partial Terms of g^2g^2 'square' Configuration

	K	H	F	P
K	KK	KH	KF	KP
H	HK	HH	HF	HP
F	FK	FH	FF	FP
P	PK	PH	PF	PP

The multiplication of the same set of terms from a 'square' configuration in this case {KHFP}{KHFP} produces very interesting symmetry properties in the table 14.

For instance, along the top left-bottom right diagonal, you find the products, KK, HH, FF and PP. Reading across this diagonal you find duplicate terms such as HK and HK giving rise to 2HK. Hence, the entire set of term for this square multiplication is {KK,HH,FF,PP,2HK,2FK,2PK,2FH,2PH,2PF}.

Table 14 greatly helps in writing down the product of a square multiplication. All is needed is to square the symbols at the corners and obtain KK, HH, FF, and PP. Then multiply the symbols to give products, KH, KF, KP, HF and FP which are then doubled to give 2[KH+KF+KP+HF+ HP+FP]. Also from the diagonal an identity symmetry (vertical-horizontal) of terms is readily discernible. For instance, on vertical axis we can easily see the products PK, FK and HK and then on the horizontal line, we have HK, FK and PK. Similarly, other sets of product terms are discernible, namely, PH, FH and FH , PH. There is a final set of terms PF and PF. The above product terms are then evaluated using the multiplication table 10. The result is shown in table 15.

Table - 15: The evaluation of partial terms of g^2g^2 spin set

2L+1	1	3	5	7	9	11	13	15	17	19	21	23	25	27	29
L	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	S	P	D	F	G	H	I	K	L	M	N	O	Q	R	T
KK	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
HH	0	1	2	3	4	5	6	7	8	9	10				
FF	0	1	2	3	4	5	6								
PP	0	1	2												
2KH			2	3	4	5	6	7	8	9	10	11	12		
			2	3	4	5	6	7	8	9	10	11	12		
2KF					4	5	6	7	8	9	10				
					4	5	6	7	8	9	10				
2KP							6	7	8						
							6	7	8						
2HF			2	3	4	5	6	7	8						
			2	3	4	5	6	7	8						
2HP					4	5	6								
					4	5	6								
2FP			2	3	4										
			2	3	4										
Total	S(4)	P(4)	D(10)	F(9)	G(13)	H(11)	I(13)	K(10)	L(10)	M(6)	N(6)	O(3)	Q(3)	R	T
-	S	P(4)	D(5)	F(7)	G(7)	H(8)	I(7)	K(7)	L(5)	M(4)	N(3)	O(2)	Q	R	
Net	S(3)		D(5)	F(2)	G(6)	H(3)	I(6)	K(3)	L(5)	M(2)	N(3)	O	Q(2)		T

The product of the partial terms of g3g1 are then subtracted from the total terms obtained from the multiplication of g^2g^2 partial terms to obtain the singlet terms.

Singlets =
^{1}[S(3)D(5)F(2)G(6)H(3)I(6)K(3)L(5)M(2)N(3)OQ(2)T]

RS Terms of g^4 $\rightarrow$ ^{5}[NLKI(2)HG(2)FD(2)S] + ^{3}[P(4)D(3)F(6)G(5)H(7)I(5)K(6)L(4)M(4)N(2)O(2)QR] +^{1}[S(3)D(5)F(2)G(6)H(3)I(6)K(3)L(5)M(2)N(3)OQ(2)T]

RS Terms of g^4 $\rightarrow$ ^{5}[NLKI(2)HG(2)FD(2)S] +

^{3}[P(4)D(3)F(6)G(5)H(7)I(5)K(6)L(4)M(4)N(2)O(2)QR]

+^{1}[S(3)D(5)F(2)G(6)H(3)I(6)K(3)L(5)M(2)N(3)OQ(2)T]

Number of microstates

Quintets =
5[21+17+15+13x2+11+9x2+7+5x2+1] =
5[21+17+15+26+11+18+7+10+1]=5.126 =630

Triplets =
3[3x4+5x3+7x6+9x5+11x7+13x5+15x6+17x4+19x4+21x2+23x2+25+27]
=
3[12+15+42+45+77+65+90+68+76+42+46+25+27]
= 3.630 = 1890

Singlets =
3+5x5+7x2+9x6+11x3+13x6+15x3+17x5+19x2+21x3+23+25x2+29
=
3+25+14+54+33+78+45+85+38+63+23+50+29
=540

Total = 630+1890+540 =3060
F = 18!/4!14! = 18.17.16.15/4.3.2 =3060

Tables 16 and 17 give the spin sets and the ‘raw’ expressions of partial terms for g^6 out of which the RS terms can be derived.

Table - 16: The g^6 spin sets

g^n		Electron arragements	S	2S+1(or n +1)
g^6	1	↑↑↑↑↑↑	3	7
g^5g^1	2	↑↑↑↑↑↓	2	5
g^4g^2	3	↑↑↑↑↓↓	1	3
g^3g^3	4	↑↑↑↓↓↓	0	1

S – Total spin, n – number of unpaired electrons

Table - 17: The Partial Terms Expressions of g^6 Spin Sets

g^n		Partial Term Expressions
g^6	1	PF(2)GHIKM
g^5g^1	2	S(2)P(4)D(8)F(9)G(11)H(10)I(11)K(9)L(8)M(6)N(5)O(3)Q(2)RT
g^4g^2	3	S(3)P(17)D(21)F(32)G(32)H(38)I(34)K(35)L(28)M(26)N(9)O(16)Q(10)R(8)T(4)U(3)VW
g^3g^3	4	S(10)P(20)D(34)F(43)G(51)H(51)I(55)K(49)L(45)M(38)N(32)O(23)Q(19)R(12)T(8) U(5)V(3)WX

This method was applied to the rest of the configurations, g^5 to g^9 and the RS terms were obtained. These are presented in table 18.

Table - 18: The RS Terms of g^n Configurations

G^n conf.	Number of microstates	RS Terms
g^1 ,g^{17}	18	^{2}G
g^2 ,g^{16}	153	^{3}[KHFP] + ^{1}[SDGIL]
g^3 ,g^{15}	816	^{4}[MKIHGF(2)P] + ^{2}[ONML(2)K(2)I(2)H(3)G(3)F(2)D(2)P]
g^4 ,g^{14}	3060	^{5}[NLKI(2)HG(2)FD(2)S] + ^{3}[P(4)D(3)F(6)G(5)H(7)I(5)K(6)L(4)M(4)N(2)O(2)QR] +^{1}[S(3)D(5)F(2)G(6)H(3)I(6)K(3)L(5)M(2)N(3)OQ(2)T]
g^5 ,g^{13}	8,568	^{6}[NLKI(2)HG(2)FD(2)S] +^{4}[SP(4)D(6)F(8)G(9)H(9)I(9)K(8)L(7)M(6)N(4)O(3)Q(2)RT]+^{2}[S(3)P(5)D(10)F(11)G(15)H(14)I(15)K(13)L(13)M(10)N(9)0(6)Q(5)R(3)T(2)UV]
g^6 ,g^{12}	18,564	^{7}[MKIHGF(2)P]+5[S(2)P(3)D(8)F(7)G(10)H(9)I(10)K(8)L(8)M(5)N(5)O(3)Q(2)RT] +3[SP(13)D(13)F(23)G(21)H(28)I(23)K(26)L(20)M(20)N(14)O(13)Q(8)R(7)T(3)U(3)VW]+1[S(7)P(3)D(13)F(11)G(19) H(13)I(21)K(14)L(17)M(12)N(13)O(7)Q(9)R(4)T(4)U(2)V(2)X]
g^7,g^{11}	31,824	^{8}[KHFP]+^{6}[SP(3)D(5)F(6)G(7)H(8)I(7)K(7)L(5)M(4)N(3)O(2)QR]+^{4}[S(2)P(13)D(16)F(25)G(25)H(30)I(27)K(28)L(23)M(22)N(16)O(14)Q(9)R(7)T(4)U(3)VW] +^{2}[S(5)P(15)D(24)F(31)G(37)H(39)I(40)K(39)L(36)M(32)N(27)O(22)Q(17)R(13)T(9)U(6)V(4)W(2)XY]
g^8 ,g^{10}	43,758	^{9}G +^{7}[P(2)D(2)F(4)G(3)H(4)I(3)K(3)L(2)M(2)NO]+^{5}[S(5)P(7)D(16)F(16)G(22)H(20)I(23)K(19)L(19)M(14)N(13)O(8)Q(7)R(4)T(3)UV] +^{3}[S(3)P(23)D(27)F(43)H(53)I(48)K(52)L(43)M(42)N(32)O(29)Q(20)R(17)T(10)U(8)V(4)W(3)XY]^{1}[S(10)P(7)D(24)F(20)G(34)H(28)I(37)K(28)L(34)M(24)N(26)O(17)Q(18)R(10)T(10)U(5)V(5)W(2)X(2)Z]
g^9	48,620	^{10}S + ^{8}[PDFGHIKL]+^{6}[S(3)P(3)D(9)F(8)G(12)H(10)I(12)K(9)L(9)M(6)N(6)O(3)Q(3)RT] +^{4}[S(6)P(16)D(24)F(34)G(38)H(40)I(42)K(39)L(35)M(32)N(26)O(20)Q(16)R(11)T(8)U(5)V(3)WX] + ^{2}[S(8)P(19)D(35)F(40)G(52)H(54)I(56)K(53)L(53)M(44)N(40)O(32)Q(26)R(19)T(14)U(9)V(7)W(4)X(2)YZ)

Conclusion

The use of a numerical algorithm method to derive partial terms and their applications to derive RS terms will greatly enhance the ease of understanding atomic and electronic spectra. With the concepts developed in this method, the RS terms of configurations simple configurations such as p^n and d^n, and complex ones such f^n, g^n , h^n, etc can readily be generated.

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REFERENCES

1. Cotton, F. A., "*Chemical Applications of Group Theory*" 3rd Edition, John Willey and Sons, 257(1990).
2. Kiremire, E.M.R., *Journal of Chemical Education*, **66**(6), 479, (1989).
3. Kiremire E.M.R., *Journal of Chemical Education*, **64**(11), 951 (1987).
4. Kiremire, E.M.R., *Orient. J. Chem.*, **21**(3), (2005).
5. Kiremire, E.M.R., *Orient. J. Chem.,* **22**(1), (2006).