

# Model for “MoS2”

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## General Condition

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- Basis type: 1g
- SAMB selection:
  - Type: [Q, G]
  - Rank: [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11]
  - Irrep.: [ $A'_1, A'_2, A''_1, A''_2, E', E''$ ]
  - Spin (s): [0, 1]
- Max. neighbor: 10
- Search cell range: (-2, 3), (-2, 3), (-2, 3)
- Toroidal priority: false

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## Group and Unit Cell

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- Group: SG No. 187  $D_{3h}^1$   $P\bar{6}m2$  [ hexagonal ]
- Associated point group: PG No. 187  $D_{3h}$   $\bar{6}m2$  (-6m2 setting) [ hexagonal ]
- Unit cell:  
 $a = 3.16610, b = 3.16610, c = 20.00000, \alpha = 90.0, \beta = 90.0, \gamma = 120.0$
- Lattice vectors (conventional cell):  
 $a_1 = [3.16610, 0.00000, 0.00000]$   
 $a_2 = [-1.58305, 2.74192, 0.00000]$   
 $a_3 = [0.00000, 0.00000, 20.00000]$

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## Symmetry Operation

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Table 1: Symmetry operation

#	SO	#	SO	#	SO	#	SO	#	SO
1	{1 0}	2	{3 <sup>+</sup> <sub>001</sub>  0}	3	{3 <sup>-</sup> <sub>001</sub>  0}	4	{m <sub>001</sub>  0}	5	{-6 <sup>-</sup> <sub>001</sub>  0}

*continued ...*

Table 1

#	SO	#	SO	#	SO	#	SO	#	SO
6	$\{-6^+_{001} 0\}$	7	$\{m_{110} 0\}$	8	$\{m_{100} 0\}$	9	$\{m_{010} 0\}$	10	$\{2_{1-10} 0\}$
11	$\{2_{120} 0\}$	12	$\{2_{210} 0\}$						

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— Harmonics —

Table 2: Harmonics

#	symbol	irrep.	rank	X	multiplicity	component	symmetry
1	$\mathbb{Q}_0(A'_1)$	$A'_1$	0	$Q, T$	-	-	1
2	$\mathbb{Q}_2(A'_1)$	$A'_1$	2	$Q, T$	-	-	$-\frac{x^2}{2} - \frac{y^2}{2} + z^2$
3	$\mathbb{Q}_3(A'_1)$	$A'_1$	3	$Q, T$	-	-	$\frac{\sqrt{10}y(3x^2-y^2)}{4}$
4	$\mathbb{Q}_4(A'_1)$	$A'_1$	4	$Q, T$	-	-	$\frac{3x^4}{8} + \frac{3x^2y^2}{4} - 3x^2z^2 + \frac{3y^4}{8} - 3y^2z^2 + z^4$
5	$\mathbb{Q}_5(A'_1)$	$A'_1$	5	$Q, T$	-	-	$-\frac{\sqrt{70}y(3x^2-y^2)(x^2+y^2-8z^2)}{16}$
6	$\mathbb{G}_0(A''_1)$	$A''_1$	0	$G, M$	-	-	1
7	$\mathbb{G}_2(A''_1)$	$A''_1$	2	$G, M$	-	-	$-\frac{x^2}{2} - \frac{y^2}{2} + z^2$
8	$\mathbb{G}_3(A''_1)$	$A''_1$	3	$G, M$	-	-	$\frac{\sqrt{10}y(3x^2-y^2)}{4}$
9	$\mathbb{G}_4(A''_1)$	$A''_1$	4	$G, M$	-	-	$\frac{3x^4}{8} + \frac{3x^2y^2}{4} - 3x^2z^2 + \frac{3y^4}{8} - 3y^2z^2 + z^4$
10	$\mathbb{Q}_4(A''_1)$	$A''_1$	4	$Q, T$	-	-	$\frac{\sqrt{70}xz(x^2-3y^2)}{4}$

continued ...

Table 2

#	symbol	irrep.	rank	X	multiplicity	component	symmetry
11	$\mathbb{G}_1(A'_2)$	$A'_2$	1	$G, M$	-	-	$z$
12	$\mathbb{G}_3(A'_2)$	$A'_2$	3	$G, M$	-	-	$-\frac{z(3x^2+3y^2-2z^2)}{2}$
13	$\mathbb{Q}_3(A'_2)$	$A'_2$	3	$Q, T$	-	-	$\frac{\sqrt{10}x(x^2-3y^2)}{4}$
14	$\mathbb{Q}_5(A'_2)$	$A'_2$	5	$Q, T$	-	-	$-\frac{\sqrt{70}x(x^2-3y^2)(x^2+y^2-8z^2)}{16}$
15	$\mathbb{Q}_1(A''_2)$	$A''_2$	1	$Q, T$	-	-	$z$
16	$\mathbb{G}_3(A''_2)$	$A''_2$	3	$G, M$	-	-	$\frac{\sqrt{10}x(x^2-3y^2)}{4}$
17	$\mathbb{Q}_3(A''_2)$	$A''_2$	3	$Q, T$	-	-	$-\frac{z(3x^2+3y^2-2z^2)}{2}$
18	$\mathbb{Q}_4(A''_2)$	$A''_2$	4	$Q, T$	-	-	$\frac{\sqrt{70}yz(3x^2-y^2)}{4}$
19	$\mathbb{Q}_{1,1}(E')$	$E'$	1	$Q, T$	-	1	$x$
20	$\mathbb{Q}_{1,2}(E')$					2	$y$
21	$\mathbb{G}_{2,1}(E')$	$E'$	2	$G, M$	-	1	$\sqrt{3}yz$
22	$\mathbb{G}_{2,2}(E')$					2	$-\sqrt{3}xz$
23	$\mathbb{Q}_{2,1}(E')$	$E'$	2	$Q, T$	-	1	$\sqrt{3}xy$
24	$\mathbb{Q}_{2,2}(E')$					2	$\frac{\sqrt{3}(x-y)(x+y)}{2}$
25	$\mathbb{G}_{3,1}(E')$	$E'$	3	$G, M$	-	1	$-\frac{\sqrt{15}z(x-y)(x+y)}{2}$
26	$\mathbb{G}_{3,2}(E')$					2	$\sqrt{15}xyz$
27	$\mathbb{Q}_{3,1}(E')$	$E'$	3	$Q, T$	-	1	$-\frac{\sqrt{6}x(x^2+y^2-4z^2)}{4}$
28	$\mathbb{Q}_{3,2}(E')$					2	$-\frac{\sqrt{6}y(x^2+y^2-4z^2)}{4}$
29	$\mathbb{Q}_{4,1}(E', 1)$	$E'$	4	$Q, T$	1	1	$-\frac{\sqrt{35}xy(x-y)(x+y)}{2}$
30	$\mathbb{Q}_{4,2}(E', 1)$					2	$\frac{\sqrt{35}(x^2-2xy-y^2)(x^2+2xy-y^2)}{8}$
31	$\mathbb{Q}_{4,1}(E', 2)$	$E'$	4	$Q, T$	2	1	$-\frac{\sqrt{5}xy(x^2+y^2-6z^2)}{2}$

*continued ...*

Table 2

#	symbol	irrep.	rank	X	multiplicity	component	symmetry
32	$\mathbb{Q}_{4,2}(E', 2)$					2	$-\frac{\sqrt{5}(x-y)(x+y)(x^2+y^2-6z^2)}{4}$
33	$\mathbb{Q}_{5,1}(E', 1)$	$E'$	5	$Q, T$	1	1	$\frac{3\sqrt{14}x(x^4-10x^2y^2+5y^4)}{16}$
34	$\mathbb{Q}_{5,2}(E', 1)$					2	$-\frac{3\sqrt{14}y(5x^4-10x^2y^2+y^4)}{16}$
35	$\mathbb{Q}_{5,1}(E', 2)$	$E'$	5	$Q, T$	2	1	$\frac{\sqrt{15}x(x^4+2x^2y^2-12x^2z^2+y^4-12y^2z^2+8z^4)}{8}$
36	$\mathbb{Q}_{5,2}(E', 2)$					2	$\frac{\sqrt{15}y(x^4+2x^2y^2-12x^2z^2+y^4-12y^2z^2+8z^4)}{8}$
37	$\mathbb{G}_{1,1}(E'')$	$E''$	1	$G, M$	-	1	$x$
38	$\mathbb{G}_{1,2}(E'')$					2	$y$
39	$\mathbb{G}_{2,1}(E'')$	$E''$	2	$G, M$	-	1	$\sqrt{3}xy$
40	$\mathbb{G}_{2,2}(E'')$					2	$\frac{\sqrt{3}(x-y)(x+y)}{2}$
41	$\mathbb{Q}_{2,1}(E'')$	$E''$	2	$Q, T$	-	1	$\sqrt{3}yz$
42	$\mathbb{Q}_{2,2}(E'')$					2	$-\sqrt{3}xz$
43	$\mathbb{G}_{3,1}(E'')$	$E''$	3	$G, M$	-	1	$-\frac{\sqrt{6}x(x^2+y^2-4z^2)}{4}$
44	$\mathbb{G}_{3,2}(E'')$					2	$-\frac{\sqrt{6}y(x^2+y^2-4z^2)}{4}$
45	$\mathbb{Q}_{3,1}(E'')$	$E''$	3	$Q, T$	-	1	$-\frac{\sqrt{15}z(x-y)(x+y)}{2}$
46	$\mathbb{Q}_{3,2}(E'')$					2	$\sqrt{15}xyz$
47	$\mathbb{G}_{4,1}(E'', 1)$	$E''$	4	$G, M$	1	1	$-\frac{\sqrt{35}xy(x-y)(x+y)}{2}$
48	$\mathbb{G}_{4,2}(E'', 1)$					2	$\frac{\sqrt{35}(x^2-2xy-y^2)(x^2+2xy-y^2)}{8}$
49	$\mathbb{Q}_{4,1}(E'')$	$E''$	4	$Q, T$	-	1	$-\frac{\sqrt{10}yz(3x^2+3y^2-4z^2)}{4}$
50	$\mathbb{Q}_{4,2}(E'')$					2	$\frac{\sqrt{10}xz(3x^2+3y^2-4z^2)}{4}$
51	$\mathbb{Q}_{5,1}(E'', 1)$	$E''$	5	$Q, T$	1	1	$-\frac{3\sqrt{35}z(x^2-2xy-y^2)(x^2+2xy-y^2)}{8}$
52	$\mathbb{Q}_{5,2}(E'', 1)$					2	$-\frac{3\sqrt{35}xyz(x-y)(x+y)}{2}$

continued ...

Table 2

#	symbol	irrep.	rank	X	multiplicity	component	symmetry
53	$\mathbb{Q}_{5,1}(E'', 2)$	$E''$	5	$Q, T$	2	1	$\frac{\sqrt{105}z(x-y)(x+y)(x^2+y^2-2z^2)}{4}$
54	$\mathbb{Q}_{5,2}(E'', 2)$					2	$-\frac{\sqrt{105}xyz(x^2+y^2-2z^2)}{2}$

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Basis in full matrix

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Table 3: dimension = 11

#	orbital@atom(SL)	#	orbital@atom(SL)	#	orbital@atom(SL)	#	orbital@atom(SL)	#	orbital@atom(SL)
1	$ d_u\rangle @\text{Mo}(1)$	2	$ d_{xz}\rangle @\text{Mo}(1)$	3	$ d_{yz}\rangle @\text{Mo}(1)$	4	$ d_{xy}\rangle @\text{Mo}(1)$	5	$ d_v\rangle @\text{Mo}(1)$
6	$ p_x\rangle @\text{S}(1)$	7	$ p_y\rangle @\text{S}(1)$	8	$ p_z\rangle @\text{S}(1)$	9	$ p_x\rangle @\text{S}(2)$	10	$ p_y\rangle @\text{S}(2)$
11	$ p_z\rangle @\text{S}(2)$								

Table 4: Atomic basis (orbital part only)

orbital	definition
$ p_x\rangle$	$x$

*continued ...*

Table 4

orbital	definition
$ p_y\rangle$	$y$
$ p_z\rangle$	$z$
$ d_u\rangle$	$-\frac{x^2}{2} - \frac{y^2}{2} + z^2$
$ d_{xz}\rangle$	$\sqrt{3}xz$
$ d_{yz}\rangle$	$\sqrt{3}yz$
$ d_{xy}\rangle$	$\sqrt{3}xy$
$ d_v\rangle$	$\frac{\sqrt{3}(x^2-y^2)}{2}$

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SAMB

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164 (all 246) SAMBs

- 'Mo' site-cluster
  - \* bra:  $\langle d_u |$ ,  $\langle d_{xz} |$ ,  $\langle d_{yz} |$ ,  $\langle d_{xy} |$ ,  $\langle d_v |$
  - \* ket:  $|d_u \rangle$ ,  $|d_{xz} \rangle$ ,  $|d_{yz} \rangle$ ,  $|d_{xy} \rangle$ ,  $|d_v \rangle$
  - \* wyckoff: **1a**

[z1]  $\mathbb{Q}_0^{(c)}(A'_1) = \mathbb{Q}_0^{(a)}(A'_1)\mathbb{Q}_0^{(s)}(A'_1)$

[z2]  $\mathbb{Q}_2^{(c)}(A'_1) = \mathbb{Q}_2^{(a)}(A'_1)\mathbb{Q}_0^{(s)}(A'_1)$

[z3]  $\mathbb{Q}_4^{(c)}(A'_1) = \mathbb{Q}_4^{(a)}(A'_1)\mathbb{Q}_0^{(s)}(A'_1)$

[z43]  $\mathbb{Q}_4^{(c)}(A''_1) = \mathbb{Q}_4^{(a)}(A''_1)\mathbb{Q}_0^{(s)}(A'_1)$

[z60]  $\mathbb{Q}_4^{(c)}(A''_2) = \mathbb{Q}_4^{(a)}(A''_2)\mathbb{Q}_0^{(s)}(A'_1)$

$$\boxed{\text{z83}} \quad \mathbb{Q}_{2,1}^{(c)}(E') = \frac{\sqrt{2}\mathbb{Q}_{2,1}^{(a)}(E')\mathbb{Q}_0^{(s)}(A'_1)}{2}$$

$$\boxed{\text{z84}} \quad \mathbb{Q}_{2,2}^{(c)}(E') = \frac{\sqrt{2}\mathbb{Q}_{2,2}^{(a)}(E')\mathbb{Q}_0^{(s)}(A'_1)}{2}$$

$$\boxed{\text{z85}} \quad \mathbb{Q}_{4,1}^{(c)}(E', 1) = \frac{\sqrt{2}\mathbb{Q}_{4,1}^{(a)}(E', 1)\mathbb{Q}_0^{(s)}(A'_1)}{2}$$

$$\boxed{\text{z86}} \quad \mathbb{Q}_{4,2}^{(c)}(E', 1) = \frac{\sqrt{2}\mathbb{Q}_{4,2}^{(a)}(E', 1)\mathbb{Q}_0^{(s)}(A'_1)}{2}$$

$$\boxed{\text{z87}} \quad \mathbb{Q}_{4,1}^{(c)}(E', 2) = \frac{\sqrt{2}\mathbb{Q}_{4,1}^{(a)}(E', 2)\mathbb{Q}_0^{(s)}(A'_1)}{2}$$

$$\boxed{\text{z88}} \quad \mathbb{Q}_{4,2}^{(c)}(E', 2) = \frac{\sqrt{2}\mathbb{Q}_{4,2}^{(a)}(E', 2)\mathbb{Q}_0^{(s)}(A'_1)}{2}$$

$$\boxed{\text{z167}} \quad \mathbb{Q}_{2,1}^{(c)}(E'') = \frac{\sqrt{2}\mathbb{Q}_{2,1}^{(a)}(E'')\mathbb{Q}_0^{(s)}(A'_1)}{2}$$

$$\boxed{\text{z168}} \quad \mathbb{Q}_{2,2}^{(c)}(E'') = \frac{\sqrt{2}\mathbb{Q}_{2,2}^{(a)}(E'')\mathbb{Q}_0^{(s)}(A'_1)}{2}$$

$$\boxed{\text{z169}} \quad \mathbb{Q}_{4,1}^{(c)}(E'') = \frac{\sqrt{2}\mathbb{Q}_{4,1}^{(a)}(E'')\mathbb{Q}_0^{(s)}(A'_1)}{2}$$

$$\boxed{\text{z170}} \quad \mathbb{Q}_{4,2}^{(c)}(E'') = \frac{\sqrt{2}\mathbb{Q}_{4,2}^{(a)}(E'')\mathbb{Q}_0^{(s)}(A'_1)}{2}$$

• 'S' site-cluster

\* bra:  $\langle p_x |, \langle p_y |, \langle p_z |$

\* ket:  $|p_x \rangle, |p_y \rangle, |p_z \rangle$

\* wyckoff: 2i

$$\boxed{\text{z4}} \quad \mathbb{Q}_0^{(c)}(A'_1) = \mathbb{Q}_0^{(a)}(A'_1)\mathbb{Q}_0^{(s)}(A'_1)$$

$$\boxed{\text{z5}} \quad \mathbb{Q}_2^{(c)}(A'_1) = \mathbb{Q}_2^{(a)}(A'_1)\mathbb{Q}_0^{(s)}(A'_1)$$

$$\boxed{\text{z61}} \quad \mathbb{Q}_1^{(c)}(A_2'', a) = \mathbb{Q}_0^{(a)}(A'_1)\mathbb{Q}_1^{(s)}(A_2'')$$

$$\boxed{\text{z62}} \quad \mathbb{Q}_1^{(c)}(A_2'', b) = \mathbb{Q}_2^{(a)}(A'_1)\mathbb{Q}_1^{(s)}(A_2'')$$

$$\boxed{\text{z89}} \quad \mathbb{Q}_{1,1}^{(c)}(E') = -\frac{\sqrt{2}\mathbb{Q}_{2,2}^{(a)}(E'')\mathbb{Q}_1^{(s)}(A_2'')}{2}$$

$$\boxed{\text{z90}} \quad \mathbb{Q}_{1,2}^{(c)}(E') = \frac{\sqrt{2}\mathbb{Q}_{2,1}^{(a)}(E'')\mathbb{Q}_1^{(s)}(A_2'')}{2}$$

$$\boxed{\text{z91}} \quad \mathbb{Q}_{2,1}^{(c)}(E') = \frac{\sqrt{2}\mathbb{Q}_{2,1}^{(a)}(E')\mathbb{Q}_0^{(s)}(A'_1)}{2}$$

$$\boxed{\text{z92}} \quad \mathbb{Q}_{2,2}^{(c)}(E') = \frac{\sqrt{2}\mathbb{Q}_{2,2}^{(a)}(E')\mathbb{Q}_0^{(s)}(A'_1)}{2}$$

$$\boxed{\text{z171}} \quad \mathbb{Q}_{2,1}^{(c)}(E'') = \frac{\sqrt{2}\mathbb{Q}_{2,1}^{(a)}(E'')\mathbb{Q}_0^{(s)}(A'_1)}{2}$$

$$\boxed{\text{z172}} \quad \mathbb{Q}_{2,2}^{(c)}(E'') = \frac{\sqrt{2}\mathbb{Q}_{2,2}^{(a)}(E'')\mathbb{Q}_0^{(s)}(A'_1)}{2}$$

$$\boxed{\text{z173}} \quad \mathbb{Q}_{3,1}^{(c)}(E'') = -\frac{\sqrt{2}\mathbb{Q}_{2,2}^{(a)}(E')\mathbb{Q}_1^{(s)}(A_2'')}{2}$$

$$\boxed{\text{z174}} \quad \mathbb{Q}_{3,2}^{(c)}(E'') = \frac{\sqrt{2}\mathbb{Q}_{2,1}^{(a)}(E')\mathbb{Q}_1^{(s)}(A_2'')}{2}$$

• 'Mo'-'Mo' bond-cluster

\* bra:  $\langle d_u |, \langle d_{xz} |, \langle d_{yz} |, \langle d_{xy} |, \langle d_v |$

\* ket:  $|d_u \rangle, |d_{xz} \rangle, |d_{yz} \rangle, |d_{xy} \rangle, |d_v \rangle$

\* wyckoff: 3b03j

$$\boxed{\text{z6}} \quad \mathbb{Q}_0^{(c)}(A'_1, a) = \mathbb{Q}_0^{(a)}(A'_1)\mathbb{Q}_0^{(b)}(A'_1)$$

$$\boxed{\text{z7}} \quad \mathbb{Q}_0^{(c)}(A'_1, b) = \mathbb{M}_1^{(a)}(A'_2)\mathbb{M}_1^{(b)}(A'_2)$$

$$\boxed{\text{z8}} \quad \mathbb{Q}_2^{(c)}(A'_1, a) = \mathbb{Q}_2^{(a)}(A'_1)\mathbb{Q}_0^{(b)}(A'_1)$$

$$\boxed{\text{z9}} \quad \mathbb{Q}_2^{(c)}(A'_1, b) = \mathbb{M}_3^{(a)}(A'_2)\mathbb{M}_1^{(b)}(A'_2)$$

$$\boxed{\text{z10}} \quad \mathbb{Q}_3^{(c)}(A'_1, a) = \frac{\sqrt{2}\mathbb{Q}_{2,1}^{(a)}(E')\mathbb{Q}_{1,1}^{(b)}(E')}{2} + \frac{\sqrt{2}\mathbb{Q}_{2,2}^{(a)}(E')\mathbb{Q}_{1,2}^{(b)}(E')}{2}$$

$$\boxed{\text{z11}} \quad \mathbb{Q}_3^{(c)}(A'_1, b) = -\frac{\sqrt{406}\mathbb{Q}_{4,1}^{(a)}(E', 1)\mathbb{Q}_{1,1}^{(b)}(E')}{29} - \frac{\sqrt{58}\mathbb{Q}_{4,1}^{(a)}(E', 2)\mathbb{Q}_{1,1}^{(b)}(E')}{58} - \frac{\sqrt{406}\mathbb{Q}_{4,2}^{(a)}(E', 1)\mathbb{Q}_{1,2}^{(b)}(E')}{29} - \frac{\sqrt{58}\mathbb{Q}_{4,2}^{(a)}(E', 2)\mathbb{Q}_{1,2}^{(b)}(E')}{58}$$

$$\boxed{\text{z12}} \quad \mathbb{Q}_3^{(c)}(A'_1, c) = -\frac{\sqrt{2}\mathbb{M}_{3,1}^{(a)}(E')\mathbb{T}_{1,1}^{(b)}(E')}{2} - \frac{\sqrt{2}\mathbb{M}_{3,2}^{(a)}(E')\mathbb{T}_{1,2}^{(b)}(E')}{2}$$

$$\boxed{\text{z13}} \quad \mathbb{Q}_4^{(c)}(A'_1) = \mathbb{Q}_4^{(a)}(A'_1)\mathbb{Q}_0^{(b)}(A'_1)$$

$$\boxed{\text{z14}} \quad \mathbb{Q}_5^{(c)}(A'_1) = -\frac{\sqrt{58}\mathbb{Q}_{4,1}^{(a)}(E', 1)\mathbb{Q}_{1,1}^{(b)}(E')}{58} + \frac{\sqrt{406}\mathbb{Q}_{4,1}^{(a)}(E', 2)\mathbb{Q}_{1,1}^{(b)}(E')}{29} - \frac{\sqrt{58}\mathbb{Q}_{4,2}^{(a)}(E', 1)\mathbb{Q}_{1,2}^{(b)}(E')}{58} + \frac{\sqrt{406}\mathbb{Q}_{4,2}^{(a)}(E', 2)\mathbb{Q}_{1,2}^{(b)}(E')}{29}$$

$$\boxed{\text{z29}} \quad \mathbb{Q}_4^{(c)}(A''_1, a) = \mathbb{Q}_4^{(a)}(A''_1)\mathbb{Q}_0^{(b)}(A'_1)$$

$$\boxed{\text{z30}} \quad \mathbb{Q}_4^{(c)}(A''_1, b) = \mathbb{M}_3^{(a)}(A''_2)\mathbb{M}_1^{(b)}(A'_2)$$

$$\boxed{\text{z31}} \quad \mathbb{Q}_3^{(c)}(A'_2, a) = -\frac{\sqrt{2}\mathbb{Q}_{2,1}^{(a)}(E')\mathbb{Q}_{1,2}^{(b)}(E')}{2} + \frac{\sqrt{2}\mathbb{Q}_{2,2}^{(a)}(E')\mathbb{Q}_{1,1}^{(b)}(E')}{2}$$

$$\boxed{\text{z32}} \quad \mathbb{Q}_3^{(c)}(A'_2, b) = -\frac{\sqrt{406}\mathbb{Q}_{4,1}^{(a)}(E', 1)\mathbb{Q}_{1,2}^{(b)}(E')}{29} + \frac{\sqrt{58}\mathbb{Q}_{4,1}^{(a)}(E', 2)\mathbb{Q}_{1,2}^{(b)}(E')}{58} + \frac{\sqrt{406}\mathbb{Q}_{4,2}^{(a)}(E', 1)\mathbb{Q}_{1,1}^{(b)}(E')}{29} - \frac{\sqrt{58}\mathbb{Q}_{4,2}^{(a)}(E', 2)\mathbb{Q}_{1,1}^{(b)}(E')}{58}$$

$$\boxed{\text{z44}} \quad \mathbb{Q}_3^{(c)}(A'_2, c) = \frac{\sqrt{2}\mathbb{M}_{3,1}^{(a)}(E')\mathbb{T}_{1,2}^{(b)}(E')}{2} - \frac{\sqrt{2}\mathbb{M}_{3,2}^{(a)}(E')\mathbb{T}_{1,1}^{(b)}(E')}{2}$$

$$\boxed{\text{z45}} \quad \mathbb{Q}_5^{(c)}(A'_2) = -\frac{\sqrt{58}\mathbb{Q}_{4,1}^{(a)}(E', 1)\mathbb{Q}_{1,2}^{(b)}(E')}{58} - \frac{\sqrt{406}\mathbb{Q}_{4,1}^{(a)}(E', 2)\mathbb{Q}_{1,2}^{(b)}(E')}{29} + \frac{\sqrt{58}\mathbb{Q}_{4,2}^{(a)}(E', 1)\mathbb{Q}_{1,1}^{(b)}(E')}{58} + \frac{\sqrt{406}\mathbb{Q}_{4,2}^{(a)}(E', 2)\mathbb{Q}_{1,1}^{(b)}(E')}{29}$$

$$\boxed{\text{z46}} \quad \mathbb{Q}_1^{(c)}(A''_2, a) = \frac{\sqrt{2}\mathbb{Q}_{2,1}^{(a)}(E'')\mathbb{Q}_{1,2}^{(b)}(E')}{2} - \frac{\sqrt{2}\mathbb{Q}_{2,2}^{(a)}(E'')\mathbb{Q}_{1,1}^{(b)}(E')}{2}$$

$$\boxed{\text{z47}} \quad \mathbb{Q}_1^{(c)}(A''_2, b) = \frac{\sqrt{2}\mathbb{M}_{1,1}^{(a)}(E'')\mathbb{T}_{1,2}^{(b)}(E')}{2} - \frac{\sqrt{2}\mathbb{M}_{1,2}^{(a)}(E'')\mathbb{T}_{1,1}^{(b)}(E')}{2}$$

$$\boxed{\text{z48}} \quad \mathbb{Q}_3^{(c)}(A''_2, a) = \frac{\sqrt{2}\mathbb{Q}_{4,1}^{(a)}(E'')\mathbb{Q}_{1,2}^{(b)}(E')}{2} - \frac{\sqrt{2}\mathbb{Q}_{4,2}^{(a)}(E'')\mathbb{Q}_{1,1}^{(b)}(E')}{2}$$

$$\boxed{\text{z49}} \quad \mathbb{Q}_3^{(c)}(A_2'', b) = \frac{\sqrt{2}\mathbb{M}_{3,1}^{(a)}(E'')\mathbb{T}_{1,2}^{(b)}(E')}{2} - \frac{\sqrt{2}\mathbb{M}_{3,2}^{(a)}(E'')\mathbb{T}_{1,1}^{(b)}(E')}{2}$$

$$\boxed{\text{z63}} \quad \mathbb{Q}_4^{(c)}(A_2'', a) = \mathbb{Q}_4^{(a)}(A_2'')\mathbb{Q}_0^{(b)}(A_1')$$

$$\boxed{\text{z64}} \quad \mathbb{Q}_4^{(c)}(A_2'', b) = \mathbb{M}_3^{(a)}(A_1'')\mathbb{M}_1^{(b)}(A_2')$$

$$\boxed{\text{z65}} \quad \mathbb{Q}_{1,1}^{(c)}(E', a) = \frac{\sqrt{2}\mathbb{Q}_0^{(a)}(A_1')\mathbb{Q}_{1,1}^{(b)}(E')}{2}$$

$$\boxed{\text{z66}} \quad \mathbb{Q}_{1,2}^{(c)}(E', a) = \frac{\sqrt{2}\mathbb{Q}_0^{(a)}(A_1')\mathbb{Q}_{1,2}^{(b)}(E')}{2}$$

$$\boxed{\text{z67}} \quad \mathbb{Q}_{1,1}^{(c)}(E', b) = \frac{\sqrt{42}\mathbb{Q}_{2,1}^{(a)}(E')\mathbb{Q}_{1,2}^{(b)}(E')}{14} + \frac{\sqrt{42}\mathbb{Q}_{2,2}^{(a)}(E')\mathbb{Q}_{1,1}^{(b)}(E')}{14} - \frac{\sqrt{14}\mathbb{Q}_2^{(a)}(A_1')\mathbb{Q}_{1,1}^{(b)}(E')}{14}$$

$$\boxed{\text{z68}} \quad \mathbb{Q}_{1,2}^{(c)}(E', b) = \frac{\sqrt{42}\mathbb{Q}_{2,1}^{(a)}(E')\mathbb{Q}_{1,1}^{(b)}(E')}{14} - \frac{\sqrt{42}\mathbb{Q}_{2,2}^{(a)}(E')\mathbb{Q}_{1,2}^{(b)}(E')}{14} - \frac{\sqrt{14}\mathbb{Q}_2^{(a)}(A_1')\mathbb{Q}_{1,2}^{(b)}(E')}{14}$$

$$\boxed{\text{z93}} \quad \mathbb{Q}_{1,1}^{(c)}(E', c) = -\frac{\sqrt{2}\mathbb{M}_1^{(a)}(A_2')\mathbb{T}_{1,2}^{(b)}(E')}{2}$$

$$\boxed{\text{z94}} \quad \mathbb{Q}_{1,2}^{(c)}(E', c) = \frac{\sqrt{2}\mathbb{M}_1^{(a)}(A_2')\mathbb{T}_{1,1}^{(b)}(E')}{2}$$

$$\boxed{\text{z95}} \quad \mathbb{Q}_{2,1}^{(c)}(E', a) = \frac{\sqrt{2}\mathbb{Q}_{2,1}^{(a)}(E')\mathbb{Q}_0^{(b)}(A_1')}{2}$$

$$\boxed{\text{z96}} \quad \mathbb{Q}_{2,2}^{(c)}(E', a) = \frac{\sqrt{2}\mathbb{Q}_{2,2}^{(a)}(E')\mathbb{Q}_0^{(b)}(A_1')}{2}$$

$$\boxed{\text{z97}} \quad \mathbb{Q}_{2,1}^{(c)}(E', b) = \frac{\sqrt{2}\mathbb{M}_{3,2}^{(a)}(E')\mathbb{M}_1^{(b)}(A_2')}{2}$$

$$\boxed{\text{z98}} \quad \mathbb{Q}_{2,2}^{(c)}(E', b) = -\frac{\sqrt{2}\mathbb{M}_{3,1}^{(a)}(E')\mathbb{M}_1^{(b)}(A_2')}{2}$$

$$\boxed{\text{z99}} \quad \mathbb{Q}_{3,1}^{(c)}(E', a) = \frac{\sqrt{7}\mathbb{Q}_{2,1}^{(a)}(E')\mathbb{Q}_{1,2}^{(b)}(E')}{14} + \frac{\sqrt{7}\mathbb{Q}_{2,2}^{(a)}(E')\mathbb{Q}_{1,1}^{(b)}(E')}{14} + \frac{\sqrt{21}\mathbb{Q}_2^{(a)}(A_1')\mathbb{Q}_{1,1}^{(b)}(E')}{7}$$

$$\boxed{\text{z100}} \quad \mathbb{Q}_{3,2}^{(c)}(E', a) = \frac{\sqrt{7}\mathbb{Q}_{2,1}^{(a)}(E')\mathbb{Q}_{1,1}^{(b)}(E')}{14} - \frac{\sqrt{7}\mathbb{Q}_{2,2}^{(a)}(E')\mathbb{Q}_{1,2}^{(b)}(E')}{14} + \frac{\sqrt{21}\mathbb{Q}_2^{(a)}(A'_1)\mathbb{Q}_{1,2}^{(b)}(E')}{7}$$

$$\boxed{\text{z101}} \quad \mathbb{Q}_{3,1}^{(c)}(E', b) = \frac{\sqrt{35}\mathbb{Q}_{4,1}^{(a)}(E', 2)\mathbb{Q}_{1,2}^{(b)}(E')}{14} + \frac{\sqrt{35}\mathbb{Q}_{4,2}^{(a)}(E', 2)\mathbb{Q}_{1,1}^{(b)}(E')}{14} - \frac{\sqrt{7}\mathbb{Q}_4^{(a)}(A'_1)\mathbb{Q}_{1,1}^{(b)}(E')}{7}$$

$$\boxed{\text{z102}} \quad \mathbb{Q}_{3,2}^{(c)}(E', b) = \frac{\sqrt{35}\mathbb{Q}_{4,1}^{(a)}(E', 2)\mathbb{Q}_{1,1}^{(b)}(E')}{14} - \frac{\sqrt{35}\mathbb{Q}_{4,2}^{(a)}(E', 2)\mathbb{Q}_{1,2}^{(b)}(E')}{14} - \frac{\sqrt{7}\mathbb{Q}_4^{(a)}(A'_1)\mathbb{Q}_{1,2}^{(b)}(E')}{7}$$

$$\boxed{\text{z103}} \quad \mathbb{Q}_{3,1}^{(c)}(E', c) = -\frac{\sqrt{55}\mathbb{M}_{3,1}^{(a)}(E')\mathbb{T}_{1,2}^{(b)}(E')}{22} - \frac{\sqrt{55}\mathbb{M}_{3,2}^{(a)}(E')\mathbb{T}_{1,1}^{(b)}(E')}{22} - \frac{\sqrt{33}\mathbb{M}_3^{(a)}(A'_2)\mathbb{T}_{1,2}^{(b)}(E')}{11}$$

$$\boxed{\text{z104}} \quad \mathbb{Q}_{3,2}^{(c)}(E', c) = -\frac{\sqrt{55}\mathbb{M}_{3,1}^{(a)}(E')\mathbb{T}_{1,1}^{(b)}(E')}{22} + \frac{\sqrt{55}\mathbb{M}_{3,2}^{(a)}(E')\mathbb{T}_{1,2}^{(b)}(E')}{22} + \frac{\sqrt{33}\mathbb{M}_3^{(a)}(A'_2)\mathbb{T}_{1,1}^{(b)}(E')}{11}$$

$$\boxed{\text{z105}} \quad \mathbb{Q}_{4,1}^{(c)}(E', 1) = \frac{\sqrt{2}\mathbb{Q}_{4,1}^{(a)}(E', 1)\mathbb{Q}_0^{(b)}(A'_1)}{2}$$

$$\boxed{\text{z106}} \quad \mathbb{Q}_{4,2}^{(c)}(E', 1) = \frac{\sqrt{2}\mathbb{Q}_{4,2}^{(a)}(E', 1)\mathbb{Q}_0^{(b)}(A'_1)}{2}$$

$$\boxed{\text{z107}} \quad \mathbb{Q}_{4,1}^{(c)}(E', 2) = \frac{\sqrt{2}\mathbb{Q}_{4,1}^{(a)}(E', 2)\mathbb{Q}_0^{(b)}(A'_1)}{2}$$

$$\boxed{\text{z108}} \quad \mathbb{Q}_{4,2}^{(c)}(E', 2) = \frac{\sqrt{2}\mathbb{Q}_{4,2}^{(a)}(E', 2)\mathbb{Q}_0^{(b)}(A'_1)}{2}$$

$$\boxed{\text{z109}} \quad \mathbb{Q}_{5,1}^{(c)}(E', 1) = \frac{\mathbb{Q}_{4,1}^{(a)}(E', 1)\mathbb{Q}_{1,2}^{(b)}(E')}{2} + \frac{\mathbb{Q}_{4,2}^{(a)}(E', 1)\mathbb{Q}_{1,1}^{(b)}(E')}{2}$$

$$\boxed{\text{z110}} \quad \mathbb{Q}_{5,2}^{(c)}(E', 1) = \frac{\mathbb{Q}_{4,1}^{(a)}(E', 1)\mathbb{Q}_{1,1}^{(b)}(E')}{2} - \frac{\mathbb{Q}_{4,2}^{(a)}(E', 1)\mathbb{Q}_{1,2}^{(b)}(E')}{2}$$

$$\boxed{\text{z111}} \quad \mathbb{Q}_{5,1}^{(c)}(E', 2) = \frac{\sqrt{14}\mathbb{Q}_{4,1}^{(a)}(E', 2)\mathbb{Q}_{1,2}^{(b)}(E')}{14} + \frac{\sqrt{14}\mathbb{Q}_{4,2}^{(a)}(E', 2)\mathbb{Q}_{1,1}^{(b)}(E')}{14} + \frac{\sqrt{70}\mathbb{Q}_4^{(a)}(A'_1)\mathbb{Q}_{1,1}^{(b)}(E')}{14}$$

$$\boxed{\text{z112}} \quad \mathbb{Q}_{5,2}^{(c)}(E', 2) = \frac{\sqrt{14}\mathbb{Q}_{4,1}^{(a)}(E', 2)\mathbb{Q}_{1,1}^{(b)}(E')}{14} - \frac{\sqrt{14}\mathbb{Q}_{4,2}^{(a)}(E', 2)\mathbb{Q}_{1,2}^{(b)}(E')}{14} + \frac{\sqrt{70}\mathbb{Q}_4^{(a)}(A'_1)\mathbb{Q}_{1,2}^{(b)}(E')}{14}$$

$$\boxed{\text{z113}} \quad \mathbb{Q}_{2,1}^{(c)}(E'', a) = \frac{\sqrt{2}\mathbb{Q}_{2,1}^{(a)}(E'')\mathbb{Q}_0^{(b)}(A'_1)}{2}$$

$$\boxed{\text{z114}} \quad \mathbb{Q}_{2,2}^{(c)}(E'', a) = \frac{\sqrt{2}\mathbb{Q}_{2,2}^{(a)}(E'')\mathbb{Q}_0^{(b)}(A'_1)}{2}$$

$$\boxed{\text{z115}} \quad \mathbb{Q}_{2,1}^{(c)}(E'', b) = \frac{\sqrt{2}\mathbb{M}_{3,2}^{(a)}(E'')\mathbb{M}_1^{(b)}(A'_2)}{2}$$

$$\boxed{\text{z116}} \quad \mathbb{Q}_{2,2}^{(c)}(E'', b) = -\frac{\sqrt{2}\mathbb{M}_{3,1}^{(a)}(E'')\mathbb{M}_1^{(b)}(A'_2)}{2}$$

$$\boxed{\text{z117}} \quad \mathbb{Q}_{2,1}^{(c)}(E'', c) = \frac{\sqrt{2}\mathbb{M}_{1,2}^{(a)}(E'')\mathbb{M}_1^{(b)}(A'_2)}{2}$$

$$\boxed{\text{z118}} \quad \mathbb{Q}_{2,2}^{(c)}(E'', c) = -\frac{\sqrt{2}\mathbb{M}_{1,1}^{(a)}(E'')\mathbb{M}_1^{(b)}(A'_2)}{2}$$

$$\boxed{\text{z175}} \quad \mathbb{Q}_{3,1}^{(c)}(E'', a) = \frac{\mathbb{Q}_{2,1}^{(a)}(E'')\mathbb{Q}_{1,2}^{(b)}(E')}{2} + \frac{\mathbb{Q}_{2,2}^{(a)}(E'')\mathbb{Q}_{1,1}^{(b)}(E')}{2}$$

$$\boxed{\text{z176}} \quad \mathbb{Q}_{3,2}^{(c)}(E'', a) = \frac{\mathbb{Q}_{2,1}^{(a)}(E'')\mathbb{Q}_{1,1}^{(b)}(E')}{2} - \frac{\mathbb{Q}_{2,2}^{(a)}(E'')\mathbb{Q}_{1,2}^{(b)}(E')}{2}$$

$$\boxed{\text{z177}} \quad \mathbb{Q}_{3,1}^{(c)}(E'', b) = -\frac{\sqrt{2}\mathbb{Q}_{4,1}^{(a)}(E'')\mathbb{Q}_{1,2}^{(b)}(E')}{8} - \frac{\sqrt{2}\mathbb{Q}_{4,2}^{(a)}(E'')\mathbb{Q}_{1,1}^{(b)}(E')}{8} - \frac{\sqrt{14}\mathbb{Q}_4^{(a)}(A''_1)\mathbb{Q}_{1,1}^{(b)}(E')}{8} - \frac{\sqrt{14}\mathbb{Q}_4^{(a)}(A''_2)\mathbb{Q}_{1,2}^{(b)}(E')}{8}$$

$$\boxed{\text{z178}} \quad \mathbb{Q}_{3,2}^{(c)}(E'', b) = -\frac{\sqrt{2}\mathbb{Q}_{4,1}^{(a)}(E'')\mathbb{Q}_{1,1}^{(b)}(E')}{8} + \frac{\sqrt{2}\mathbb{Q}_{4,2}^{(a)}(E'')\mathbb{Q}_{1,2}^{(b)}(E')}{8} - \frac{\sqrt{14}\mathbb{Q}_4^{(a)}(A''_1)\mathbb{Q}_{1,2}^{(b)}(E')}{8} + \frac{\sqrt{14}\mathbb{Q}_4^{(a)}(A''_2)\mathbb{Q}_{1,1}^{(b)}(E')}{8}$$

$$\boxed{\text{z179}} \quad \mathbb{Q}_{3,1}^{(c)}(E'', c) = \frac{\sqrt{10}\mathbb{M}_{3,1}^{(a)}(E'')\mathbb{T}_{1,2}^{(b)}(E')}{8} + \frac{\sqrt{10}\mathbb{M}_{3,2}^{(a)}(E'')\mathbb{T}_{1,1}^{(b)}(E')}{8} + \frac{\sqrt{6}\mathbb{M}_3^{(a)}(A''_1)\mathbb{T}_{1,1}^{(b)}(E')}{8} - \frac{\sqrt{6}\mathbb{M}_3^{(a)}(A''_2)\mathbb{T}_{1,2}^{(b)}(E')}{8}$$

$$\boxed{\text{z180}} \quad \mathbb{Q}_{3,2}^{(c)}(E'', c) = \frac{\sqrt{10}\mathbb{M}_{3,1}^{(a)}(E'')\mathbb{T}_{1,1}^{(b)}(E')}{8} - \frac{\sqrt{10}\mathbb{M}_{3,2}^{(a)}(E'')\mathbb{T}_{1,2}^{(b)}(E')}{8} + \frac{\sqrt{6}\mathbb{M}_3^{(a)}(A''_1)\mathbb{T}_{1,2}^{(b)}(E')}{8} + \frac{\sqrt{6}\mathbb{M}_3^{(a)}(A''_2)\mathbb{T}_{1,1}^{(b)}(E')}{8}$$

$$\boxed{\text{z181}} \quad \mathbb{Q}_{4,1}^{(c)}(E'') = \frac{\sqrt{2}\mathbb{Q}_{4,1}^{(a)}(E'')\mathbb{Q}_0^{(b)}(A'_1)}{2}$$

$$\boxed{\text{z182}} \quad \mathbb{Q}_{4,2}^{(c)}(E'') = \frac{\sqrt{2}\mathbb{Q}_{4,2}^{(a)}(E'')\mathbb{Q}_0^{(b)}(A'_1)}{2}$$

$$\boxed{\text{z183}} \quad \mathbb{Q}_{5,1}^{(c)}(E'', 1) = -\frac{\mathbb{Q}_4^{(a)}(A''_1)\mathbb{Q}_{1,1}^{(b)}(E')}{2} + \frac{\mathbb{Q}_4^{(a)}(A''_2)\mathbb{Q}_{1,2}^{(b)}(E')}{2}$$

$$\boxed{\text{z184}} \quad \mathbb{Q}_{5,2}^{(c)}(E'', 1) = -\frac{\mathbb{Q}_4^{(a)}(A''_1)\mathbb{Q}_{1,2}^{(b)}(E')}{2} - \frac{\mathbb{Q}_4^{(a)}(A''_2)\mathbb{Q}_{1,1}^{(b)}(E')}{2}$$

$$\boxed{\text{z185}} \quad \mathbb{Q}_{5,1}^{(c)}(E'', 2) = \frac{\sqrt{14}\mathbb{Q}_{4,1}^{(a)}(E'')\mathbb{Q}_{1,2}^{(b)}(E')}{8} + \frac{\sqrt{14}\mathbb{Q}_{4,2}^{(a)}(E'')\mathbb{Q}_{1,1}^{(b)}(E')}{8} - \frac{\sqrt{2}\mathbb{Q}_4^{(a)}(A''_1)\mathbb{Q}_{1,1}^{(b)}(E')}{8} - \frac{\sqrt{2}\mathbb{Q}_4^{(a)}(A''_2)\mathbb{Q}_{1,2}^{(b)}(E')}{8}$$

$$\boxed{\text{z186}} \quad \mathbb{Q}_{5,2}^{(c)}(E'', 2) = \frac{\sqrt{14}\mathbb{Q}_{4,1}^{(a)}(E'')\mathbb{Q}_{1,1}^{(b)}(E')}{8} - \frac{\sqrt{14}\mathbb{Q}_{4,2}^{(a)}(E'')\mathbb{Q}_{1,2}^{(b)}(E')}{8} - \frac{\sqrt{2}\mathbb{Q}_4^{(a)}(A''_1)\mathbb{Q}_{1,2}^{(b)}(E')}{8} + \frac{\sqrt{2}\mathbb{Q}_4^{(a)}(A''_2)\mathbb{Q}_{1,1}^{(b)}(E')}{8}$$

$$\boxed{\text{z187}} \quad \mathbb{G}_0^{(c)}(A''_1) = \frac{\sqrt{2}\mathbb{M}_{1,1}^{(a)}(E'')\mathbb{T}_{1,1}^{(b)}(E')}{2} + \frac{\sqrt{2}\mathbb{M}_{1,2}^{(a)}(E'')\mathbb{T}_{1,2}^{(b)}(E')}{2}$$

$$\boxed{\text{z188}} \quad \mathbb{G}_2^{(c)}(A''_1, a) = -\frac{\sqrt{2}\mathbb{Q}_{2,1}^{(a)}(E'')\mathbb{Q}_{1,1}^{(b)}(E')}{2} - \frac{\sqrt{2}\mathbb{Q}_{2,2}^{(a)}(E'')\mathbb{Q}_{1,2}^{(b)}(E')}{2}$$

$$\boxed{\text{z189}} \quad \mathbb{G}_2^{(c)}(A''_1, b) = \frac{\sqrt{2}\mathbb{M}_{3,1}^{(a)}(E'')\mathbb{T}_{1,1}^{(b)}(E')}{2} + \frac{\sqrt{2}\mathbb{M}_{3,2}^{(a)}(E'')\mathbb{T}_{1,2}^{(b)}(E')}{2}$$

$$\boxed{\text{z190}} \quad \mathbb{G}_4^{(c)}(A''_1) = -\frac{\sqrt{2}\mathbb{Q}_{4,1}^{(a)}(E'')\mathbb{Q}_{1,1}^{(b)}(E')}{2} - \frac{\sqrt{2}\mathbb{Q}_{4,2}^{(a)}(E'')\mathbb{Q}_{1,2}^{(b)}(E')}{2}$$

$$\boxed{\text{z191}} \quad \mathbb{G}_{2,1}^{(c)}(E') = \frac{\sqrt{66}\mathbb{M}_{3,1}^{(a)}(E')\mathbb{T}_{1,2}^{(b)}(E')}{22} + \frac{\sqrt{66}\mathbb{M}_{3,2}^{(a)}(E')\mathbb{T}_{1,1}^{(b)}(E')}{22} - \frac{\sqrt{110}\mathbb{M}_3^{(a)}(A'_2)\mathbb{T}_{1,2}^{(b)}(E')}{22}$$

$$\boxed{\text{z192}} \quad \mathbb{G}_{2,2}^{(c)}(E') = \frac{\sqrt{66}\mathbb{M}_{3,1}^{(a)}(E')\mathbb{T}_{1,1}^{(b)}(E')}{22} - \frac{\sqrt{66}\mathbb{M}_{3,2}^{(a)}(E')\mathbb{T}_{1,2}^{(b)}(E')}{22} + \frac{\sqrt{110}\mathbb{M}_3^{(a)}(A'_2)\mathbb{T}_{1,1}^{(b)}(E')}{22}$$

$$\boxed{\text{z193}} \quad \mathbb{G}_{2,1}^{(c)}(E'', a) = -\frac{\sqrt{6}\mathbb{M}_{3,1}^{(a)}(E'')\mathbb{T}_{1,2}^{(b)}(E')}{8} - \frac{\sqrt{6}\mathbb{M}_{3,2}^{(a)}(E'')\mathbb{T}_{1,1}^{(b)}(E')}{8} + \frac{\sqrt{10}\mathbb{M}_3^{(a)}(A''_1)\mathbb{T}_{1,2}^{(b)}(E')}{8} - \frac{\sqrt{10}\mathbb{M}_3^{(a)}(A''_2)\mathbb{T}_{1,1}^{(b)}(E')}{8}$$

$$\boxed{\text{z194}} \quad \mathbb{G}_{2,2}^{(c)}(E'', a) = -\frac{\sqrt{6}\mathbb{M}_{3,1}^{(a)}(E'')\mathbb{T}_{1,1}^{(b)}(E')}{8} + \frac{\sqrt{6}\mathbb{M}_{3,2}^{(a)}(E'')\mathbb{T}_{1,2}^{(b)}(E')}{8} + \frac{\sqrt{10}\mathbb{M}_3^{(a)}(A''_1)\mathbb{T}_{1,2}^{(b)}(E')}{8} + \frac{\sqrt{10}\mathbb{M}_3^{(a)}(A''_2)\mathbb{T}_{1,1}^{(b)}(E')}{8}$$

$$\boxed{\text{z195}} \quad \mathbb{G}_{2,1}^{(c)}(E'', b) = \frac{\mathbb{M}_{1,1}^{(a)}(E'')\mathbb{T}_{1,2}^{(b)}(E')}{2} + \frac{\mathbb{M}_{1,2}^{(a)}(E'')\mathbb{T}_{1,1}^{(b)}(E')}{2}$$

$$\boxed{\text{z196}} \quad \mathbb{G}_{2,2}^{(c)}(E'', b) = \frac{\mathbb{M}_{1,1}^{(a)}(E'')\mathbb{T}_{1,1}^{(b)}(E')}{2} - \frac{\mathbb{M}_{1,2}^{(a)}(E'')\mathbb{T}_{1,2}^{(b)}(E')}{2}$$

$$\boxed{\text{z197}} \quad \mathbb{G}_{4,1}^{(c)}(E'', 1) = -\frac{\mathbb{M}_3^{(a)}(A''_1)\mathbb{T}_{1,1}^{(b)}(E')}{2} - \frac{\mathbb{M}_3^{(a)}(A''_2)\mathbb{T}_{1,2}^{(b)}(E')}{2}$$

$$\boxed{\text{z198}} \quad \mathbb{G}_{4,2}^{(c)}(E'', 1) = -\frac{\mathbb{M}_3^{(a)}(A''_1)\mathbb{T}_{1,2}^{(b)}(E')}{2} + \frac{\mathbb{M}_3^{(a)}(A''_2)\mathbb{T}_{1,1}^{(b)}(E')}{2}$$

• 'Mo'-'S' bond-cluster

\* bra:  $\langle d_u |, \langle d_{xz} |, \langle d_{yz} |, \langle d_{xy} |, \langle d_v |$

\* ket:  $|p_x\rangle, |p_y\rangle, |p_z\rangle$

\* wyckoff: **6a@6n**

$$\boxed{\text{z15}} \quad \mathbb{Q}_0^{(c)}(A'_1) = \frac{\sqrt{3}\mathbb{Q}_{1,1}^{(a)}(E')\mathbb{Q}_{1,1}^{(b)}(E')}{3} + \frac{\sqrt{3}\mathbb{Q}_{1,2}^{(a)}(E')\mathbb{Q}_{1,2}^{(b)}(E')}{3} + \frac{\sqrt{3}\mathbb{Q}_1^{(a)}(A''_2)\mathbb{Q}_1^{(b)}(A''_2)}{3}$$

$$\boxed{\text{z16}} \quad \mathbb{Q}_2^{(c)}(A'_1, a) = \frac{\sqrt{14}\mathbb{Q}_{3,1}^{(a)}(E')\mathbb{Q}_{1,1}^{(b)}(E')}{7} + \frac{\sqrt{14}\mathbb{Q}_{3,2}^{(a)}(E')\mathbb{Q}_{1,2}^{(b)}(E')}{7} + \frac{\sqrt{21}\mathbb{Q}_3^{(a)}(A''_2)\mathbb{Q}_1^{(b)}(A''_2)}{7}$$

$$\boxed{\text{z17}} \quad \mathbb{Q}_2^{(c)}(A'_1, b) = -\frac{\sqrt{6}\mathbb{Q}_{1,1}^{(a)}(E')\mathbb{Q}_{1,1}^{(b)}(E')}{6} - \frac{\sqrt{6}\mathbb{Q}_{1,2}^{(a)}(E')\mathbb{Q}_{1,2}^{(b)}(E')}{6} + \frac{\sqrt{6}\mathbb{Q}_1^{(a)}(A''_2)\mathbb{Q}_1^{(b)}(A''_2)}{3}$$

$$\boxed{\text{z18}} \quad \mathbb{Q}_2^{(c)}(A'_1, c) = -\frac{\sqrt{2}\mathbb{G}_{2,1}^{(a)}(E')\mathbb{Q}_{1,1}^{(b)}(E')}{2} - \frac{\sqrt{2}\mathbb{G}_{2,2}^{(a)}(E')\mathbb{Q}_{1,2}^{(b)}(E')}{2}$$

$$\boxed{\text{z19}} \quad \mathbb{Q}_3^{(c)}(A'_1, a) = \mathbb{Q}_3^{(a)}(A'_1)\mathbb{Q}_0^{(b)}(A'_1)$$

$$\boxed{\text{z20}} \quad \mathbb{Q}_3^{(c)}(A'_1, b) = -\frac{\sqrt{2}\mathbb{Q}_{3,1}^{(a)}(E'')\mathbb{Q}_{2,1}^{(b)}(E'')}{2} - \frac{\sqrt{2}\mathbb{Q}_{3,2}^{(a)}(E'')\mathbb{Q}_{2,2}^{(b)}(E'')}{2}$$

$$\boxed{\text{z21}} \quad \mathbb{Q}_3^{(c)}(A'_1, c) = \frac{\sqrt{2}\mathbb{G}_{2,1}^{(a)}(E'')\mathbb{Q}_{2,1}^{(b)}(E'')}{2} + \frac{\sqrt{2}\mathbb{G}_{2,2}^{(a)}(E'')\mathbb{Q}_{2,2}^{(b)}(E'')}{2}$$

$$\boxed{\text{z22}} \quad \mathbb{Q}_4^{(c)}(A'_1) = -\frac{\sqrt{42}\mathbb{Q}_{3,1}^{(a)}(E')\mathbb{Q}_{1,1}^{(b)}(E')}{14} - \frac{\sqrt{42}\mathbb{Q}_{3,2}^{(a)}(E')\mathbb{Q}_{1,2}^{(b)}(E')}{14} + \frac{2\sqrt{7}\mathbb{Q}_3^{(a)}(A''_2)\mathbb{Q}_1^{(b)}(A''_2)}{7}$$

$$\boxed{\text{z33}} \quad \mathbb{Q}_4^{(c)}(A''_1) = -\frac{\sqrt{6}\mathbb{Q}_{3,1}^{(a)}(E'')\mathbb{Q}_{1,1}^{(b)}(E')}{4} - \frac{\sqrt{6}\mathbb{Q}_{3,2}^{(a)}(E'')\mathbb{Q}_{1,2}^{(b)}(E')}{4} + \frac{\mathbb{Q}_3^{(a)}(A''_2)\mathbb{Q}_1^{(b)}(A''_2)}{2}$$

$$\boxed{\text{z34}} \quad \mathbb{Q}_3^{(c)}(A'_2, a) = \mathbb{Q}_3^{(a)}(A'_2)\mathbb{Q}_0^{(b)}(A'_1)$$

$$\boxed{\text{z35}} \quad \mathbb{Q}_3^{(c)}(A'_2, b) = \frac{\sqrt{2}\mathbb{Q}_{3,1}^{(a)}(E'')\mathbb{Q}_{2,2}^{(b)}(E'')}{2} - \frac{\sqrt{2}\mathbb{Q}_{3,2}^{(a)}(E'')\mathbb{Q}_{2,1}^{(b)}(E'')}{2}$$

$$\boxed{\text{z36}} \quad \mathbb{Q}_3^{(c)}(A'_2, c) = -\frac{\sqrt{2}\mathbb{G}_{2,1}^{(a)}(E'')\mathbb{Q}_{2,2}^{(b)}(E'')}{2} + \frac{\sqrt{2}\mathbb{G}_{2,2}^{(a)}(E'')\mathbb{Q}_{2,1}^{(b)}(E'')}{2}$$

$$\boxed{\text{z37}} \quad \mathbb{Q}_1^{(c)}(A''_2, a) = -\frac{\sqrt{2}\mathbb{Q}_{3,1}^{(a)}(E')\mathbb{Q}_{2,2}^{(b)}(E'')}{2} + \frac{\sqrt{2}\mathbb{Q}_{3,2}^{(a)}(E')\mathbb{Q}_{2,1}^{(b)}(E'')}{2}$$

$$\boxed{\text{z38}} \quad \mathbb{Q}_1^{(c)}(A''_2, b) = \mathbb{Q}_1^{(a)}(A''_2)\mathbb{Q}_0^{(b)}(A'_1)$$

$$\boxed{\text{z39}} \quad \mathbb{Q}_1^{(c)}(A''_2, c) = -\frac{\sqrt{2}\mathbb{Q}_{1,1}^{(a)}(E')\mathbb{Q}_{2,2}^{(b)}(E'')}{2} + \frac{\sqrt{2}\mathbb{Q}_{1,2}^{(a)}(E')\mathbb{Q}_{2,1}^{(b)}(E'')}{2}$$

$$\boxed{\text{z50}} \quad \mathbb{Q}_1^{(c)}(A''_2, d) = \frac{\sqrt{2}\mathbb{G}_{2,1}^{(a)}(E')\mathbb{Q}_{2,2}^{(b)}(E'')}{2} - \frac{\sqrt{2}\mathbb{G}_{2,2}^{(a)}(E')\mathbb{Q}_{2,1}^{(b)}(E'')}{2}$$

$$\boxed{\text{z51}} \quad \mathbb{Q}_3^{(c)}(A''_2) = \mathbb{Q}_3^{(a)}(A''_2)\mathbb{Q}_0^{(b)}(A'_1)$$

$$\boxed{\text{z52}} \quad \mathbb{Q}_4^{(c)}(A''_2) = -\frac{\sqrt{6}\mathbb{Q}_{3,1}^{(a)}(E'')\mathbb{Q}_{1,2}^{(b)}(E')}{4} + \frac{\sqrt{6}\mathbb{Q}_{3,2}^{(a)}(E'')\mathbb{Q}_{1,1}^{(b)}(E')}{4} + \frac{\mathbb{Q}_3^{(a)}(A'_1)\mathbb{Q}_1^{(b)}(A''_2)}{2}$$

$$\boxed{\text{z53}} \quad \mathbb{Q}_{1,1}^{(c)}(E', a) = \frac{\sqrt{130}\mathbb{Q}_{3,1}^{(a)}(E'')\mathbb{Q}_{2,2}^{(b)}(E'')}{26} + \frac{\sqrt{130}\mathbb{Q}_{3,2}^{(a)}(E'')\mathbb{Q}_{2,1}^{(b)}(E'')}{26} + \frac{\sqrt{78}\mathbb{Q}_3^{(a)}(A''_2)\mathbb{Q}_{2,2}^{(b)}(E'')}{26}$$

$$\boxed{\text{z54}} \quad \mathbb{Q}_{1,2}^{(c)}(E', a) = \frac{\sqrt{130}\mathbb{Q}_{3,1}^{(a)}(E'')\mathbb{Q}_{2,1}^{(b)}(E'')}{26} - \frac{\sqrt{130}\mathbb{Q}_{3,2}^{(a)}(E'')\mathbb{Q}_{2,2}^{(b)}(E'')}{26} - \frac{\sqrt{78}\mathbb{Q}_3^{(a)}(A''_2)\mathbb{Q}_{2,1}^{(b)}(E'')}{26}$$

$$\boxed{\text{z55}} \quad \mathbb{Q}_{1,1}^{(c)}(E', b) = \frac{\sqrt{2}\mathbb{Q}_{1,1}^{(a)}(E')\mathbb{Q}_0^{(b)}(A'_1)}{2}$$

$$\boxed{\text{z56}} \quad \mathbb{Q}_{1,2}^{(c)}(E', b) = \frac{\sqrt{2}\mathbb{Q}_{1,2}^{(a)}(E')\mathbb{Q}_0^{(b)}(A'_1)}{2}$$

$$\boxed{\text{z69}} \quad \mathbb{Q}_{1,1}^{(c)}(E', c) = -\frac{\sqrt{2}\mathbb{Q}_1^{(a)}(A''_2)\mathbb{Q}_{2,2}^{(b)}(E'')}{2}$$

$$\boxed{\text{z70}} \quad \mathbb{Q}_{1,2}^{(c)}(E', c) = \frac{\sqrt{2}\mathbb{Q}_1^{(a)}(A''_2)\mathbb{Q}_{2,1}^{(b)}(E'')}{2}$$

$$\boxed{\text{z71}} \quad \mathbb{Q}_{1,1}^{(c)}(E', d) = -\frac{\sqrt{10}\mathbb{G}_{2,1}^{(a)}(E'')\mathbb{Q}_{2,2}^{(b)}(E'')}{10} - \frac{\sqrt{10}\mathbb{G}_{2,2}^{(a)}(E'')\mathbb{Q}_{2,1}^{(b)}(E'')}{10} - \frac{\sqrt{30}\mathbb{G}_2^{(a)}(A''_1)\mathbb{Q}_{2,1}^{(b)}(E'')}{10}$$

$$\boxed{\text{z72}} \quad \mathbb{Q}_{1,2}^{(c)}(E', d) = -\frac{\sqrt{10}\mathbb{G}_{2,1}^{(a)}(E'')\mathbb{Q}_{2,1}^{(b)}(E'')}{10} + \frac{\sqrt{10}\mathbb{G}_{2,2}^{(a)}(E'')\mathbb{Q}_{2,2}^{(b)}(E'')}{10} - \frac{\sqrt{30}\mathbb{G}_2^{(a)}(A_1'')\mathbb{Q}_{2,2}^{(b)}(E'')}{10}$$

$$\boxed{\text{z73}} \quad \mathbb{Q}_{2,1}^{(c)}(E', a) = -\frac{\sqrt{21}\mathbb{Q}_{3,1}^{(a)}(E')\mathbb{Q}_{1,2}^{(b)}(E')}{42} + \frac{\sqrt{210}\mathbb{Q}_{3,2}^{(a)}(E'')\mathbb{Q}_1^{(b)}(A_2'')}{42} - \frac{\sqrt{21}\mathbb{Q}_{3,2}^{(a)}(E')\mathbb{Q}_{1,1}^{(b)}(E')}{42} + \frac{\sqrt{35}\mathbb{Q}_3^{(a)}(A'_1)\mathbb{Q}_{1,1}^{(b)}(E')}{14} - \frac{\sqrt{35}\mathbb{Q}_3^{(a)}(A'_2)\mathbb{Q}_{1,2}^{(b)}(E')}{14}$$

$$\boxed{\text{z74}} \quad \mathbb{Q}_{2,2}^{(c)}(E', a) = -\frac{\sqrt{210}\mathbb{Q}_{3,1}^{(a)}(E'')\mathbb{Q}_1^{(b)}(A_2'')}{42} - \frac{\sqrt{21}\mathbb{Q}_{3,1}^{(a)}(E')\mathbb{Q}_{1,1}^{(b)}(E')}{42} + \frac{\sqrt{21}\mathbb{Q}_{3,2}^{(a)}(E')\mathbb{Q}_{1,2}^{(b)}(E')}{42} + \frac{\sqrt{35}\mathbb{Q}_3^{(a)}(A'_1)\mathbb{Q}_{1,2}^{(b)}(E')}{14} + \frac{\sqrt{35}\mathbb{Q}_3^{(a)}(A'_2)\mathbb{Q}_{1,1}^{(b)}(E')}{14}$$

$$\boxed{\text{z75}} \quad \mathbb{Q}_{2,1}^{(c)}(E', b) = \frac{\mathbb{Q}_{1,1}^{(a)}(E')\mathbb{Q}_{1,2}^{(b)}(E')}{2} + \frac{\mathbb{Q}_{1,2}^{(a)}(E')\mathbb{Q}_{1,1}^{(b)}(E')}{2}$$

$$\boxed{\text{z76}} \quad \mathbb{Q}_{2,2}^{(c)}(E', b) = \frac{\mathbb{Q}_{1,1}^{(a)}(E')\mathbb{Q}_{1,1}^{(b)}(E')}{2} - \frac{\mathbb{Q}_{1,2}^{(a)}(E')\mathbb{Q}_{1,2}^{(b)}(E')}{2}$$

$$\boxed{\text{z119}} \quad \mathbb{Q}_{2,1}^{(c)}(E', c) = -\frac{\sqrt{3}\mathbb{G}_{2,1}^{(a)}(E')\mathbb{Q}_{1,2}^{(b)}(E')}{6} - \frac{\sqrt{3}\mathbb{G}_{2,2}^{(a)}(E'')\mathbb{Q}_1^{(b)}(A_2'')}{3} - \frac{\sqrt{3}\mathbb{G}_{2,2}^{(a)}(E')\mathbb{Q}_{1,1}^{(b)}(E')}{6}$$

$$\boxed{\text{z120}} \quad \mathbb{Q}_{2,2}^{(c)}(E', c) = \frac{\sqrt{3}\mathbb{G}_{2,1}^{(a)}(E'')\mathbb{Q}_1^{(b)}(A_2'')}{3} - \frac{\sqrt{3}\mathbb{G}_{2,1}^{(a)}(E')\mathbb{Q}_{1,1}^{(b)}(E')}{6} + \frac{\sqrt{3}\mathbb{G}_{2,2}^{(a)}(E')\mathbb{Q}_{1,2}^{(b)}(E')}{6}$$

$$\boxed{\text{z121}} \quad \mathbb{Q}_{3,1}^{(c)}(E', a) = \frac{\sqrt{2}\mathbb{Q}_{3,1}^{(a)}(E')\mathbb{Q}_0^{(b)}(A'_1)}{2}$$

$$\boxed{\text{z122}} \quad \mathbb{Q}_{3,2}^{(c)}(E', a) = \frac{\sqrt{2}\mathbb{Q}_{3,2}^{(a)}(E')\mathbb{Q}_0^{(b)}(A'_1)}{2}$$

$$\boxed{\text{z123}} \quad \mathbb{Q}_{3,1}^{(c)}(E', b) = \frac{\sqrt{39}\mathbb{Q}_{3,1}^{(a)}(E'')\mathbb{Q}_{2,2}^{(b)}(E'')}{26} + \frac{\sqrt{39}\mathbb{Q}_{3,2}^{(a)}(E'')\mathbb{Q}_{2,1}^{(b)}(E'')}{26} - \frac{\sqrt{65}\mathbb{Q}_3^{(a)}(A_2'')\mathbb{Q}_{2,2}^{(b)}(E'')}{13}$$

$$\boxed{\text{z124}} \quad \mathbb{Q}_{3,2}^{(c)}(E', b) = \frac{\sqrt{39}\mathbb{Q}_{3,1}^{(a)}(E'')\mathbb{Q}_{2,1}^{(b)}(E'')}{26} - \frac{\sqrt{39}\mathbb{Q}_{3,2}^{(a)}(E'')\mathbb{Q}_{2,2}^{(b)}(E'')}{26} + \frac{\sqrt{65}\mathbb{Q}_3^{(a)}(A_2'')\mathbb{Q}_{2,1}^{(b)}(E'')}{13}$$

$$\boxed{\text{z125}} \quad \mathbb{Q}_{3,1}^{(c)}(E', c) = \frac{\sqrt{15}\mathbb{G}_{2,1}^{(a)}(E'')\mathbb{Q}_{2,2}^{(b)}(E'')}{10} + \frac{\sqrt{15}\mathbb{G}_{2,2}^{(a)}(E'')\mathbb{Q}_{2,1}^{(b)}(E'')}{10} - \frac{\sqrt{5}\mathbb{G}_2^{(a)}(A_1'')\mathbb{Q}_{2,1}^{(b)}(E'')}{5}$$

$$\boxed{\text{z126}} \quad \mathbb{Q}_{3,2}^{(c)}(E', c) = \frac{\sqrt{15}\mathbb{G}_{2,1}^{(a)}(E'')\mathbb{Q}_{2,1}^{(b)}(E'')}{10} - \frac{\sqrt{15}\mathbb{G}_{2,2}^{(a)}(E'')\mathbb{Q}_{2,2}^{(b)}(E'')}{10} - \frac{\sqrt{5}\mathbb{G}_2^{(a)}(A_1'')\mathbb{Q}_{2,2}^{(b)}(E'')}{5}$$

$$\boxed{\text{z127}} \quad \mathbb{Q}_{4,1}^{(c)}(E', 1) = -\frac{\mathbb{Q}_3^{(a)}(A'_1)\mathbb{Q}_{1,1}^{(b)}(E')}{2} - \frac{\mathbb{Q}_3^{(a)}(A'_2)\mathbb{Q}_{1,2}^{(b)}(E')}{2}$$

$$\boxed{\text{z128}} \quad \mathbb{Q}_{4,2}^{(c)}(E', 1) = -\frac{\mathbb{Q}_3^{(a)}(A'_1)\mathbb{Q}_{1,2}^{(b)}(E')}{2} + \frac{\mathbb{Q}_3^{(a)}(A'_2)\mathbb{Q}_{1,1}^{(b)}(E')}{2}$$

$$\boxed{\text{z129}} \quad \mathbb{Q}_{4,1}^{(c)}(E', 2) = \frac{\sqrt{105}\mathbb{Q}_{3,1}^{(a)}(E')\mathbb{Q}_{1,2}^{(b)}(E')}{28} + \frac{\sqrt{42}\mathbb{Q}_{3,2}^{(a)}(E'')\mathbb{Q}_1^{(b)}(A''_2)}{14} + \frac{\sqrt{105}\mathbb{Q}_{3,2}^{(a)}(E')\mathbb{Q}_{1,1}^{(b)}(E')}{28} - \frac{\sqrt{7}\mathbb{Q}_3^{(a)}(A'_1)\mathbb{Q}_{1,1}^{(b)}(E')}{28} + \frac{\sqrt{7}\mathbb{Q}_3^{(a)}(A'_2)\mathbb{Q}_{1,2}^{(b)}(E')}{28}$$

$$\boxed{\text{z130}} \quad \mathbb{Q}_{4,2}^{(c)}(E', 2) = -\frac{\sqrt{42}\mathbb{Q}_{3,1}^{(a)}(E'')\mathbb{Q}_1^{(b)}(A''_2)}{14} + \frac{\sqrt{105}\mathbb{Q}_{3,1}^{(a)}(E')\mathbb{Q}_{1,1}^{(b)}(E')}{28} - \frac{\sqrt{105}\mathbb{Q}_{3,2}^{(a)}(E')\mathbb{Q}_{1,2}^{(b)}(E')}{28} - \frac{\sqrt{7}\mathbb{Q}_3^{(a)}(A'_1)\mathbb{Q}_{1,2}^{(b)}(E')}{28} - \frac{\sqrt{7}\mathbb{Q}_3^{(a)}(A'_2)\mathbb{Q}_{1,1}^{(b)}(E')}{28}$$

$$\boxed{\text{z131}} \quad \mathbb{Q}_{2,1}^{(c)}(E'', a) = \frac{\sqrt{210}\mathbb{Q}_{3,1}^{(a)}(E'')\mathbb{Q}_{1,2}^{(b)}(E')}{42} + \frac{\sqrt{210}\mathbb{Q}_{3,2}^{(a)}(E'')\mathbb{Q}_{1,1}^{(b)}(E')}{42} + \frac{2\sqrt{21}\mathbb{Q}_{3,2}^{(a)}(E')\mathbb{Q}_1^{(b)}(A''_2)}{21} - \frac{\sqrt{14}\mathbb{Q}_3^{(a)}(A''_2)\mathbb{Q}_{1,2}^{(b)}(E')}{14}$$

$$\boxed{\text{z132}} \quad \mathbb{Q}_{2,2}^{(c)}(E'', a) = \frac{\sqrt{210}\mathbb{Q}_{3,1}^{(a)}(E'')\mathbb{Q}_{1,1}^{(b)}(E')}{42} - \frac{2\sqrt{21}\mathbb{Q}_{3,1}^{(a)}(E')\mathbb{Q}_1^{(b)}(A''_2)}{21} - \frac{\sqrt{210}\mathbb{Q}_{3,2}^{(a)}(E'')\mathbb{Q}_{1,2}^{(b)}(E')}{42} + \frac{\sqrt{14}\mathbb{Q}_3^{(a)}(A''_2)\mathbb{Q}_{1,1}^{(b)}(E')}{14}$$

$$\boxed{\text{z133}} \quad \mathbb{Q}_{2,1}^{(c)}(E'', b) = \frac{\mathbb{Q}_{1,2}^{(a)}(E')\mathbb{Q}_1^{(b)}(A''_2)}{2} + \frac{\mathbb{Q}_1^{(a)}(A''_2)\mathbb{Q}_{1,2}^{(b)}(E')}{2}$$

$$\boxed{\text{z134}} \quad \mathbb{Q}_{2,2}^{(c)}(E'', b) = -\frac{\mathbb{Q}_{1,1}^{(a)}(E')\mathbb{Q}_1^{(b)}(A''_2)}{2} - \frac{\mathbb{Q}_1^{(a)}(A''_2)\mathbb{Q}_{1,1}^{(b)}(E')}{2}$$

$$\boxed{\text{z135}} \quad \mathbb{Q}_{2,1}^{(c)}(E'', c) = \frac{\sqrt{3}\mathbb{G}_{2,1}^{(a)}(E'')\mathbb{Q}_{1,2}^{(b)}(E')}{6} + \frac{\sqrt{3}\mathbb{G}_{2,2}^{(a)}(E'')\mathbb{Q}_{1,1}^{(b)}(E')}{6} + \frac{\sqrt{3}\mathbb{G}_{2,2}^{(a)}(E')\mathbb{Q}_1^{(b)}(A''_2)}{6} + \frac{\mathbb{G}_2^{(a)}(A''_1)\mathbb{Q}_{1,1}^{(b)}(E')}{2}$$

$$\boxed{\text{z136}} \quad \mathbb{Q}_{2,2}^{(c)}(E'', c) = \frac{\sqrt{3}\mathbb{G}_{2,1}^{(a)}(E'')\mathbb{Q}_{1,1}^{(b)}(E')}{6} - \frac{\sqrt{3}\mathbb{G}_{2,1}^{(a)}(E')\mathbb{Q}_1^{(b)}(A''_2)}{6} - \frac{\sqrt{3}\mathbb{G}_{2,2}^{(a)}(E'')\mathbb{Q}_{1,2}^{(b)}(E')}{6} + \frac{\mathbb{G}_2^{(a)}(A''_1)\mathbb{Q}_{1,2}^{(b)}(E')}{2}$$

$$\boxed{\text{z137}} \quad \mathbb{Q}_{3,1}^{(c)}(E'', a) = \frac{\sqrt{2}\mathbb{Q}_{3,1}^{(a)}(E'')\mathbb{Q}_0^{(b)}(A'_1)}{2}$$

$$\boxed{\text{z138}} \quad \mathbb{Q}_{3,2}^{(c)}(E'', a) = \frac{\sqrt{2}\mathbb{Q}_{3,2}^{(a)}(E'')\mathbb{Q}_0^{(b)}(A'_1)}{2}$$

$$\boxed{\text{z139}} \quad \mathbb{Q}_{3,1}^{(c)}(E'', b) = \frac{\sqrt{6}\mathbb{Q}_{3,1}^{(a)}(E')\mathbb{Q}_{2,2}^{(b)}(E'')}{8} + \frac{\sqrt{6}\mathbb{Q}_{3,2}^{(a)}(E')\mathbb{Q}_{2,1}^{(b)}(E'')}{8} - \frac{\sqrt{10}\mathbb{Q}_3^{(a)}(A'_1)\mathbb{Q}_{2,1}^{(b)}(E'')}{8} + \frac{\sqrt{10}\mathbb{Q}_3^{(a)}(A'_2)\mathbb{Q}_{2,2}^{(b)}(E'')}{8}$$

$$\boxed{\text{z140}} \quad \mathbb{Q}_{3,2}^{(c)}(E'', b) = \frac{\sqrt{6}\mathbb{Q}_{3,1}^{(a)}(E')\mathbb{Q}_{2,1}^{(b)}(E'')}{8} - \frac{\sqrt{6}\mathbb{Q}_{3,2}^{(a)}(E')\mathbb{Q}_{2,2}^{(b)}(E'')}{8} - \frac{\sqrt{10}\mathbb{Q}_3^{(a)}(A'_1)\mathbb{Q}_{2,2}^{(b)}(E'')}{8} - \frac{\sqrt{10}\mathbb{Q}_3^{(a)}(A'_2)\mathbb{Q}_{2,1}^{(b)}(E'')}{8}$$

$$\boxed{\text{z141}} \quad \mathbb{Q}_{3,1}^{(c)}(E'', c) = \frac{\mathbb{Q}_{1,1}^{(a)}(E')\mathbb{Q}_{2,2}^{(b)}(E'')}{2} + \frac{\mathbb{Q}_{1,2}^{(a)}(E')\mathbb{Q}_{2,1}^{(b)}(E'')}{2}$$

$$\boxed{\text{z142}} \quad \mathbb{Q}_{3,2}^{(c)}(E'', c) = \frac{\mathbb{Q}_{1,1}^{(a)}(E')\mathbb{Q}_{2,1}^{(b)}(E'')}{2} - \frac{\mathbb{Q}_{1,2}^{(a)}(E')\mathbb{Q}_{2,2}^{(b)}(E'')}{2}$$

$$\boxed{\text{z143}} \quad \mathbb{Q}_{4,1}^{(c)}(E'') = -\frac{\sqrt{21}\mathbb{Q}_{3,1}^{(a)}(E'')\mathbb{Q}_{1,2}^{(b)}(E')}{28} - \frac{\sqrt{21}\mathbb{Q}_{3,2}^{(a)}(E'')\mathbb{Q}_{1,1}^{(b)}(E')}{28} + \frac{\sqrt{210}\mathbb{Q}_{3,2}^{(a)}(E')\mathbb{Q}_1^{(b)}(A_2'')}{28} + \frac{\sqrt{35}\mathbb{Q}_3^{(a)}(A_2'')\mathbb{Q}_{1,2}^{(b)}(E')}{14}$$

$$\boxed{\text{z144}} \quad \mathbb{Q}_{4,2}^{(c)}(E'') = -\frac{\sqrt{21}\mathbb{Q}_{3,1}^{(a)}(E'')\mathbb{Q}_{1,1}^{(b)}(E')}{28} - \frac{\sqrt{210}\mathbb{Q}_{3,1}^{(a)}(E')\mathbb{Q}_1^{(b)}(A_2'')}{28} + \frac{\sqrt{21}\mathbb{Q}_{3,2}^{(a)}(E'')\mathbb{Q}_{1,2}^{(b)}(E')}{28} - \frac{\sqrt{35}\mathbb{Q}_3^{(a)}(A_2'')\mathbb{Q}_{1,1}^{(b)}(E')}{14}$$

$$\boxed{\text{z145}} \quad \mathbb{Q}_{5,1}^{(c)}(E'', 1) = \frac{\mathbb{Q}_3^{(a)}(A'_1)\mathbb{Q}_{2,1}^{(b)}(E'')}{2} + \frac{\mathbb{Q}_3^{(a)}(A'_2)\mathbb{Q}_{2,2}^{(b)}(E'')}$$

$$\boxed{\text{z146}} \quad \mathbb{Q}_{5,2}^{(c)}(E'', 1) = \frac{\mathbb{Q}_3^{(a)}(A'_1)\mathbb{Q}_{2,2}^{(b)}(E'')}{2} - \frac{\mathbb{Q}_3^{(a)}(A'_2)\mathbb{Q}_{2,1}^{(b)}(E'')}$$

$$\boxed{\text{z147}} \quad \mathbb{Q}_{5,1}^{(c)}(E'', 2) = \frac{\sqrt{10}\mathbb{Q}_{3,1}^{(a)}(E')\mathbb{Q}_{2,2}^{(b)}(E'')}{8} + \frac{\sqrt{10}\mathbb{Q}_{3,2}^{(a)}(E')\mathbb{Q}_{2,1}^{(b)}(E'')}{8} + \frac{\sqrt{6}\mathbb{Q}_3^{(a)}(A'_1)\mathbb{Q}_{2,1}^{(b)}(E'')}{8} - \frac{\sqrt{6}\mathbb{Q}_3^{(a)}(A'_2)\mathbb{Q}_{2,2}^{(b)}(E'')}{8}$$

$$\boxed{\text{z148}} \quad \mathbb{Q}_{5,2}^{(c)}(E'', 2) = \frac{\sqrt{10}\mathbb{Q}_{3,1}^{(a)}(E')\mathbb{Q}_{2,1}^{(b)}(E'')}{8} - \frac{\sqrt{10}\mathbb{Q}_{3,2}^{(a)}(E')\mathbb{Q}_{2,2}^{(b)}(E'')}{8} + \frac{\sqrt{6}\mathbb{Q}_3^{(a)}(A'_1)\mathbb{Q}_{2,2}^{(b)}(E'')}{8} + \frac{\sqrt{6}\mathbb{Q}_3^{(a)}(A'_2)\mathbb{Q}_{2,1}^{(b)}(E'')}$$

$$\boxed{\text{z199}} \quad \mathbb{G}_0^{(c)}(A''_1) = \frac{\sqrt{2}\mathbb{G}_{2,1}^{(a)}(E')\mathbb{Q}_{2,1}^{(b)}(E'')}{2} + \frac{\sqrt{2}\mathbb{G}_{2,2}^{(a)}(E')\mathbb{Q}_{2,2}^{(b)}(E'')}$$

$$\boxed{\text{z200}} \quad \mathbb{G}_2^{(c)}(A''_1, a) = \frac{\sqrt{2}\mathbb{Q}_{3,1}^{(a)}(E')\mathbb{Q}_{2,1}^{(b)}(E'')}{2} + \frac{\sqrt{2}\mathbb{Q}_{3,2}^{(a)}(E')\mathbb{Q}_{2,2}^{(b)}(E'')}$$

$$\boxed{\text{z201}} \quad \mathbb{G}_2^{(c)}(A''_1, b) = \frac{\sqrt{2}\mathbb{Q}_{1,1}^{(a)}(E')\mathbb{Q}_{2,1}^{(b)}(E'')}{2} + \frac{\sqrt{2}\mathbb{Q}_{1,2}^{(a)}(E')\mathbb{Q}_{2,2}^{(b)}(E'')}$$

$$\boxed{\text{z202}} \quad \mathbb{G}_2^{(c)}(A''_1, c) = \mathbb{G}_2^{(a)}(A''_1)\mathbb{Q}_0^{(b)}(A'_1)$$

$$\boxed{\text{z203}} \quad \mathbb{G}_3^{(c)}(A''_1, a) = -\frac{\sqrt{2}\mathbb{Q}_{3,1}^{(a)}(E'')\mathbb{Q}_{1,1}^{(b)}(E')}{4} - \frac{\sqrt{2}\mathbb{Q}_{3,2}^{(a)}(E'')\mathbb{Q}_{1,2}^{(b)}(E')}{4} - \frac{\sqrt{3}\mathbb{Q}_3^{(a)}(A'_2)\mathbb{Q}_1^{(b)}(A''_2)}{2}$$

$$\boxed{\text{z204}} \quad \mathbb{G}_3^{(c)}(A''_1, b) = \frac{\sqrt{2}\mathbb{G}_{2,1}^{(a)}(E'')\mathbb{Q}_{1,1}^{(b)}(E')}{2} + \frac{\sqrt{2}\mathbb{G}_{2,2}^{(a)}(E'')\mathbb{Q}_{1,2}^{(b)}(E')}{2}$$

$$\boxed{\text{z205}} \quad \mathbb{G}_1^{(c)}(A'_2, a) = \frac{\sqrt{2}\mathbb{Q}_{1,1}^{(a)}(E')\mathbb{Q}_{1,2}^{(b)}(E')}{2} - \frac{\sqrt{2}\mathbb{Q}_{1,2}^{(a)}(E')\mathbb{Q}_{1,1}^{(b)}(E')}{2}$$

$$\boxed{\text{z206}} \quad \mathbb{G}_1^{(c)}(A'_2, b) = \frac{\sqrt{30}\mathbb{G}_{2,1}^{(a)}(E')\mathbb{Q}_{1,2}^{(b)}(E')}{10} - \frac{\sqrt{30}\mathbb{G}_{2,2}^{(a)}(E')\mathbb{Q}_{1,1}^{(b)}(E')}{10} + \frac{\sqrt{10}\mathbb{G}_2^{(a)}(A''_1)\mathbb{Q}_1^{(b)}(A''_2)}{5}$$

$$\boxed{\text{z207}} \quad \mathbb{G}_3^{(c)}(A'_2, a) = \frac{\sqrt{2}\mathbb{Q}_{3,1}^{(a)}(E')\mathbb{Q}_{1,2}^{(b)}(E')}{2} - \frac{\sqrt{2}\mathbb{Q}_{3,2}^{(a)}(E')\mathbb{Q}_{1,1}^{(b)}(E')}{2}$$

$$\boxed{\text{z208}} \quad \mathbb{G}_3^{(c)}(A'_2, b) = -\frac{\sqrt{5}\mathbb{G}_{2,1}^{(a)}(E')\mathbb{Q}_{1,2}^{(b)}(E')}{5} + \frac{\sqrt{5}\mathbb{G}_{2,2}^{(a)}(E')\mathbb{Q}_{1,1}^{(b)}(E')}{5} + \frac{\sqrt{15}\mathbb{G}_2^{(a)}(A''_1)\mathbb{Q}_1^{(b)}(A''_2)}{5}$$

$$\boxed{\text{z209}} \quad \mathbb{G}_3^{(c)}(A''_2, a) = \frac{\sqrt{2}\mathbb{Q}_{3,1}^{(a)}(E'')\mathbb{Q}_{1,2}^{(b)}(E')}{4} - \frac{\sqrt{2}\mathbb{Q}_{3,2}^{(a)}(E'')\mathbb{Q}_{1,1}^{(b)}(E')}{4} + \frac{\sqrt{3}\mathbb{Q}_3^{(a)}(A'_1)\mathbb{Q}_1^{(b)}(A''_2)}{2}$$

$$\boxed{\text{z210}} \quad \mathbb{G}_3^{(c)}(A''_2, b) = -\frac{\sqrt{2}\mathbb{G}_{2,1}^{(a)}(E'')\mathbb{Q}_{1,2}^{(b)}(E')}{2} + \frac{\sqrt{2}\mathbb{G}_{2,2}^{(a)}(E'')\mathbb{Q}_{1,1}^{(b)}(E')}{2}$$

$$\boxed{\text{z211}} \quad \mathbb{G}_{2,1}^{(c)}(E') = \frac{\sqrt{2}\mathbb{G}_{2,1}^{(a)}(E')\mathbb{Q}_0^{(b)}(A'_1)}{2}$$

$$\boxed{\text{z212}} \quad \mathbb{G}_{2,2}^{(c)}(E') = \frac{\sqrt{2}\mathbb{G}_{2,2}^{(a)}(E')\mathbb{Q}_0^{(b)}(A'_1)}{2}$$

$$\boxed{\text{z213}} \quad \mathbb{G}_{3,1}^{(c)}(E', a) = \frac{\sqrt{15}\mathbb{Q}_{3,1}^{(a)}(E')\mathbb{Q}_{1,2}^{(b)}(E')}{12} - \frac{\sqrt{6}\mathbb{Q}_{3,2}^{(a)}(E'')\mathbb{Q}_1^{(b)}(A''_2)}{6} + \frac{\sqrt{15}\mathbb{Q}_{3,2}^{(a)}(E')\mathbb{Q}_{1,1}^{(b)}(E')}{12} + \frac{\mathbb{Q}_3^{(a)}(A'_1)\mathbb{Q}_{1,1}^{(b)}(E')}{4} - \frac{\mathbb{Q}_3^{(a)}(A'_2)\mathbb{Q}_{1,2}^{(b)}(E')}{4}$$

$$\boxed{\text{z214}} \quad \mathbb{G}_{3,2}^{(c)}(E', a) = \frac{\sqrt{6}\mathbb{Q}_{3,1}^{(a)}(E'')\mathbb{Q}_1^{(b)}(A''_2)}{6} + \frac{\sqrt{15}\mathbb{Q}_{3,1}^{(a)}(E')\mathbb{Q}_{1,1}^{(b)}(E')}{12} - \frac{\sqrt{15}\mathbb{Q}_{3,2}^{(a)}(E')\mathbb{Q}_{1,2}^{(b)}(E')}{12} + \frac{\mathbb{Q}_3^{(a)}(A'_1)\mathbb{Q}_{1,2}^{(b)}(E')}{4} + \frac{\mathbb{Q}_3^{(a)}(A'_2)\mathbb{Q}_{1,1}^{(b)}(E')}{4}$$

$$\boxed{\text{z215}} \quad \mathbb{G}_{3,1}^{(c)}(E', b) = \frac{\sqrt{6}\mathbb{G}_{2,1}^{(a)}(E')\mathbb{Q}_{1,2}^{(b)}(E')}{6} - \frac{\sqrt{6}\mathbb{G}_{2,2}^{(a)}(E'')\mathbb{Q}_1^{(b)}(A''_2)}{6} + \frac{\sqrt{6}\mathbb{G}_{2,2}^{(a)}(E')\mathbb{Q}_{1,1}^{(b)}(E')}{6}$$

$$\boxed{\text{z216}} \quad \mathbb{G}_{3,2}^{(c)}(E', b) = \frac{\sqrt{6}\mathbb{G}_{2,1}^{(a)}(E'')\mathbb{Q}_1^{(b)}(A''_2)}{6} + \frac{\sqrt{6}\mathbb{G}_{2,1}^{(a)}(E')\mathbb{Q}_{1,1}^{(b)}(E')}{6} - \frac{\sqrt{6}\mathbb{G}_{2,2}^{(a)}(E')\mathbb{Q}_{1,2}^{(b)}(E')}{6}$$

$$\boxed{\text{z217}} \quad \mathbb{G}_{1,1}^{(c)}(E'', a) = \frac{\mathbb{Q}_{1,2}^{(a)}(E')\mathbb{Q}_1^{(b)}(A''_2)}{2} - \frac{\mathbb{Q}_1^{(a)}(A''_2)\mathbb{Q}_{1,2}^{(b)}(E')}{2}$$

$$\boxed{\text{z218}} \quad \mathbb{G}_{1,2}^{(c)}(E'', a) = -\frac{\mathbb{Q}_{1,1}^{(a)}(E')\mathbb{Q}_1^{(b)}(A''_2)}{2} + \frac{\mathbb{Q}_1^{(a)}(A''_2)\mathbb{Q}_{1,1}^{(b)}(E')}{2}$$

$$\boxed{\text{z219}} \quad \mathbb{G}_{1,1}^{(c)}(E'', b) = \frac{\sqrt{15}\mathbb{G}_{2,1}^{(a)}(E'')\mathbb{Q}_{1,2}^{(b)}(E')}{10} + \frac{\sqrt{15}\mathbb{G}_{2,2}^{(a)}(E'')\mathbb{Q}_{1,1}^{(b)}(E')}{10} - \frac{\sqrt{15}\mathbb{G}_{2,2}^{(a)}(E')\mathbb{Q}_1^{(b)}(A''_2)}{10} - \frac{\sqrt{5}\mathbb{G}_2^{(a)}(A''_1)\mathbb{Q}_1^{(b)}(E')}{10}$$

$$\boxed{\text{z220}} \quad \mathbb{G}_{1,2}^{(c)}(E'', b) = \frac{\sqrt{15}\mathbb{G}_{2,1}^{(a)}(E'')\mathbb{Q}_{1,1}^{(b)}(E')}{10} + \frac{\sqrt{15}\mathbb{G}_{2,1}^{(a)}(E'')\mathbb{Q}_1^{(b)}(A''_2)}{10} - \frac{\sqrt{15}\mathbb{G}_{2,2}^{(a)}(E'')\mathbb{Q}_{1,2}^{(b)}(E')}{10} - \frac{\sqrt{5}\mathbb{G}_2^{(a)}(A''_1)\mathbb{Q}_{1,2}^{(b)}(E')}{10}$$

$$\boxed{\text{z221}} \quad \mathbb{G}_{2,1}^{(c)}(E'', a) = \frac{\sqrt{2}\mathbb{G}_{2,1}^{(a)}(E'')\mathbb{Q}_0^{(b)}(A'_1)}{2}$$

$$\boxed{\text{z222}} \quad \mathbb{G}_{2,2}^{(c)}(E'', a) = \frac{\sqrt{2}\mathbb{G}_{2,2}^{(a)}(E'')\mathbb{Q}_0^{(b)}(A'_1)}{2}$$

$$\boxed{\text{z223}} \quad \mathbb{G}_{2,1}^{(c)}(E'', b) = -\frac{\mathbb{G}_{2,1}^{(a)}(E')\mathbb{Q}_{2,2}^{(b)}(E'')}{2} - \frac{\mathbb{G}_{2,2}^{(a)}(E')\mathbb{Q}_{2,1}^{(b)}(E'')}{2}$$

$$\boxed{\text{z224}} \quad \mathbb{G}_{2,2}^{(c)}(E'', b) = -\frac{\mathbb{G}_{2,1}^{(a)}(E')\mathbb{Q}_{2,1}^{(b)}(E'')}{2} + \frac{\mathbb{G}_{2,2}^{(a)}(E')\mathbb{Q}_{2,2}^{(b)}(E'')}{2}$$

$$\boxed{\text{z225}} \quad \mathbb{G}_{3,1}^{(c)}(E'', a) = -\frac{\sqrt{15}\mathbb{Q}_{3,1}^{(a)}(E'')\mathbb{Q}_{1,2}^{(b)}(E')}{12} - \frac{\sqrt{15}\mathbb{Q}_{3,2}^{(a)}(E'')\mathbb{Q}_{1,1}^{(b)}(E')}{12} + \frac{\sqrt{6}\mathbb{Q}_{3,2}^{(a)}(E')\mathbb{Q}_1^{(b)}(A''_2)}{12} - \frac{\mathbb{Q}_3^{(a)}(A''_2)\mathbb{Q}_{1,2}^{(b)}(E')}{2}$$

$$\boxed{\text{z226}} \quad \mathbb{G}_{3,2}^{(c)}(E'', a) = -\frac{\sqrt{15}\mathbb{Q}_{3,1}^{(a)}(E'')\mathbb{Q}_{1,1}^{(b)}(E')}{12} - \frac{\sqrt{6}\mathbb{Q}_{3,1}^{(a)}(E')\mathbb{Q}_1^{(b)}(A''_2)}{12} + \frac{\sqrt{15}\mathbb{Q}_{3,2}^{(a)}(E'')\mathbb{Q}_{1,2}^{(b)}(E')}{12} + \frac{\mathbb{Q}_3^{(a)}(A''_2)\mathbb{Q}_{1,1}^{(b)}(E')}{2}$$

$$\boxed{\text{z227}} \quad \mathbb{G}_{3,1}^{(c)}(E'', b) = -\frac{\sqrt{15}\mathbb{G}_{2,1}^{(a)}(E'')\mathbb{Q}_{1,2}^{(b)}(E')}{30} - \frac{\sqrt{15}\mathbb{G}_{2,2}^{(a)}(E'')\mathbb{Q}_{1,1}^{(b)}(E')}{30} - \frac{2\sqrt{15}\mathbb{G}_{2,2}^{(a)}(E')\mathbb{Q}_1^{(b)}(A''_2)}{15} + \frac{\sqrt{5}\mathbb{G}_2^{(a)}(A''_1)\mathbb{Q}_{1,1}^{(b)}(E')}{5}$$

$$\boxed{\text{z228}} \quad \mathbb{G}_{3,2}^{(c)}(E'', b) = -\frac{\sqrt{15}\mathbb{G}_{2,1}^{(a)}(E'')\mathbb{Q}_{1,1}^{(b)}(E')}{30} + \frac{2\sqrt{15}\mathbb{G}_{2,1}^{(a)}(E')\mathbb{Q}_1^{(b)}(A''_2)}{15} + \frac{\sqrt{15}\mathbb{G}_{2,2}^{(a)}(E'')\mathbb{Q}_{1,2}^{(b)}(E')}{30} + \frac{\sqrt{5}\mathbb{G}_2^{(a)}(A''_1)\mathbb{Q}_{1,2}^{(b)}(E')}{5}$$

• 'S'-'S' bond-cluster

\* bra:  $\langle p_x |, \langle p_y |, \langle p_z |$

\* ket:  $|p_x\rangle, |p_y\rangle, |p_z\rangle$

\* wyckoff: **6b6n**

$$\boxed{\text{z23}} \quad \mathbb{Q}_0^{(c)}(A'_1, a) = \mathbb{Q}_0^{(a)}(A'_1)\mathbb{Q}_0^{(b)}(A'_1)$$

$$\boxed{\text{z24}} \quad \mathbb{Q}_0^{(c)}(A'_1, b) = \frac{\sqrt{2}\mathbb{Q}_{2,1}^{(a)}(E'')\mathbb{Q}_{2,1}^{(b)}(E'')}{2} + \frac{\sqrt{2}\mathbb{Q}_{2,2}^{(a)}(E'')\mathbb{Q}_{2,2}^{(b)}(E'')}{2}$$

$$\boxed{\text{z25}} \quad \mathbb{Q}_0^{(c)}(A'_1, c) = \frac{\sqrt{3}\mathbb{M}_{1,1}^{(a)}(E'')\mathbb{M}_{1,1}^{(b)}(E'')}{3} + \frac{\sqrt{3}\mathbb{M}_{1,2}^{(a)}(E'')\mathbb{M}_{1,2}^{(b)}(E'')}{3} + \frac{\sqrt{3}\mathbb{M}_1^{(a)}(A'_2)\mathbb{M}_1^{(b)}(A'_2)}{3}$$

$$\boxed{\text{z26}} \quad \mathbb{Q}_2^{(c)}(A'_1, a) = \mathbb{Q}_2^{(a)}(A'_1)\mathbb{Q}_0^{(b)}(A'_1)$$

$$\boxed{\text{z27}} \quad \mathbb{Q}_2^{(c)}(A'_1, b) = -\frac{\sqrt{6}\mathbb{M}_{1,1}^{(a)}(E'')\mathbb{M}_{1,1}^{(b)}(E'')}{6} - \frac{\sqrt{6}\mathbb{M}_{1,2}^{(a)}(E'')\mathbb{M}_{1,2}^{(b)}(E'')}{6} + \frac{\sqrt{6}\mathbb{M}_1^{(a)}(A'_2)\mathbb{M}_1^{(b)}(A'_2)}{3}$$

$$\boxed{\text{z28}} \quad \mathbb{Q}_3^{(c)}(A'_1) = \frac{\sqrt{2}\mathbb{Q}_{2,1}^{(a)}(E')\mathbb{Q}_{1,1}^{(b)}(E')}{2} + \frac{\sqrt{2}\mathbb{Q}_{2,2}^{(a)}(E')\mathbb{Q}_{1,2}^{(b)}(E')}{2}$$

$$\boxed{\text{z40}} \quad \mathbb{Q}_4^{(c)}(A''_1) = -\frac{\sqrt{2}\mathbb{Q}_{2,1}^{(a)}(E')\mathbb{Q}_{2,1}^{(b)}(E'')}{2} - \frac{\sqrt{2}\mathbb{Q}_{2,2}^{(a)}(E')\mathbb{Q}_{2,2}^{(b)}(E'')}{2}$$

$$\boxed{\text{z41}} \quad \mathbb{Q}_3^{(c)}(A'_2) = -\frac{\sqrt{2}\mathbb{Q}_{2,1}^{(a)}(E')\mathbb{Q}_{1,2}^{(b)}(E')}{2} + \frac{\sqrt{2}\mathbb{Q}_{2,2}^{(a)}(E')\mathbb{Q}_{1,1}^{(b)}(E')}{2}$$

$$\boxed{\text{z42}} \quad \mathbb{Q}_1^{(c)}(A''_2, a) = \mathbb{Q}_0^{(a)}(A'_1)\mathbb{Q}_1^{(b)}(A''_2)$$

$$\boxed{\text{z57}} \quad \mathbb{Q}_1^{(c)}(A''_2, b) = \frac{\sqrt{30}\mathbb{Q}_{2,1}^{(a)}(E'')\mathbb{Q}_{1,2}^{(b)}(E')}{10} - \frac{\sqrt{30}\mathbb{Q}_{2,2}^{(a)}(E'')\mathbb{Q}_{1,1}^{(b)}(E')}{10} + \frac{\sqrt{10}\mathbb{Q}_2^{(a)}(A'_1)\mathbb{Q}_1^{(b)}(A''_2)}{5}$$

$$\boxed{\text{z58}} \quad \mathbb{Q}_1^{(c)}(A''_2, c) = \mathbb{M}_1^{(a)}(A'_2)\mathbb{M}_2^{(b)}(A''_1)$$

$$\boxed{\text{z59}} \quad \mathbb{Q}_1^{(c)}(A''_2, d) = \frac{\sqrt{2}\mathbb{M}_{1,1}^{(a)}(E'')\mathbb{T}_{1,2}^{(b)}(E')}{2} - \frac{\sqrt{2}\mathbb{M}_{1,2}^{(a)}(E'')\mathbb{T}_{1,1}^{(b)}(E')}{2}$$

$$\boxed{\text{z77}} \quad \mathbb{Q}_3^{(c)}(A''_2) = -\frac{\sqrt{5}\mathbb{Q}_{2,1}^{(a)}(E'')\mathbb{Q}_{1,2}^{(b)}(E')}{5} + \frac{\sqrt{5}\mathbb{Q}_{2,2}^{(a)}(E'')\mathbb{Q}_{1,1}^{(b)}(E')}{5} + \frac{\sqrt{15}\mathbb{Q}_2^{(a)}(A'_1)\mathbb{Q}_1^{(b)}(A''_2)}{5}$$

$$\boxed{\text{z78}} \quad \mathbb{Q}_4^{(c)}(A''_2) = -\frac{\sqrt{2}\mathbb{Q}_{2,1}^{(a)}(E')\mathbb{Q}_{2,2}^{(b)}(E'')}{2} + \frac{\sqrt{2}\mathbb{Q}_{2,2}^{(a)}(E')\mathbb{Q}_{2,1}^{(b)}(E'')}{2}$$

$$\boxed{\text{z79}} \quad \mathbb{Q}_{1,1}^{(c)}(E', a) = \frac{\sqrt{2}\mathbb{Q}_0^{(a)}(A'_1)\mathbb{Q}_{1,1}^{(b)}(E')}{2}$$

$$\boxed{\text{z80}} \quad \mathbb{Q}_{1,2}^{(c)}(E', a) = \frac{\sqrt{2}\mathbb{Q}_0^{(a)}(A'_1)\mathbb{Q}_{1,2}^{(b)}(E')}{2}$$

$$\boxed{\text{z81}} \quad \mathbb{Q}_{1,1}^{(c)}(E', b) = \frac{\sqrt{15}\mathbb{Q}_{2,1}^{(a)}(E')\mathbb{Q}_{1,2}^{(b)}(E')}{10} - \frac{\sqrt{15}\mathbb{Q}_{2,2}^{(a)}(E'')\mathbb{Q}_1^{(b)}(A''_2)}{10} + \frac{\sqrt{15}\mathbb{Q}_{2,2}^{(a)}(E')\mathbb{Q}_{1,1}^{(b)}(E')}{10} - \frac{\sqrt{5}\mathbb{Q}_2^{(a)}(A'_1)\mathbb{Q}_{1,1}^{(b)}(E')}{10}$$

$$\boxed{\text{z82}} \quad \mathbb{Q}_{1,2}^{(c)}(E', b) = \frac{\sqrt{15}\mathbb{Q}_{2,1}^{(a)}(E'')\mathbb{Q}_1^{(b)}(A_2'')}{10} + \frac{\sqrt{15}\mathbb{Q}_{2,1}^{(a)}(E')\mathbb{Q}_{1,1}^{(b)}(E')}{10} - \frac{\sqrt{15}\mathbb{Q}_{2,2}^{(a)}(E')\mathbb{Q}_{1,2}^{(b)}(E')}{10} - \frac{\sqrt{5}\mathbb{Q}_2^{(a)}(A'_1)\mathbb{Q}_{1,2}^{(b)}(E')}{10}$$

$$\boxed{\text{z149}} \quad \mathbb{Q}_{1,1}^{(c)}(E', c) = -\frac{\sqrt{2}\mathbb{M}_{1,1}^{(a)}(E'')\mathbb{M}_2^{(b)}(A_1'')}{2}$$

$$\boxed{\text{z150}} \quad \mathbb{Q}_{1,2}^{(c)}(E', c) = -\frac{\sqrt{2}\mathbb{M}_{1,2}^{(a)}(E'')\mathbb{M}_2^{(b)}(A_1'')}{2}$$

$$\boxed{\text{z151}} \quad \mathbb{Q}_{1,1}^{(c)}(E', d) = -\frac{\sqrt{2}\mathbb{M}_1^{(a)}(A_2')\mathbb{T}_{1,2}^{(b)}(E')}{2}$$

$$\boxed{\text{z152}} \quad \mathbb{Q}_{1,2}^{(c)}(E', d) = \frac{\sqrt{2}\mathbb{M}_1^{(a)}(A_2')\mathbb{T}_{1,1}^{(b)}(E')}{2}$$

$$\boxed{\text{z153}} \quad \mathbb{Q}_{2,1}^{(c)}(E', a) = \frac{\sqrt{2}\mathbb{Q}_{2,1}^{(a)}(E')\mathbb{Q}_0^{(b)}(A'_1)}{2}$$

$$\boxed{\text{z154}} \quad \mathbb{Q}_{2,2}^{(c)}(E', a) = \frac{\sqrt{2}\mathbb{Q}_{2,2}^{(a)}(E')\mathbb{Q}_0^{(b)}(A'_1)}{2}$$

$$\boxed{\text{z155}} \quad \mathbb{Q}_{2,1}^{(c)}(E', b) = -\frac{\mathbb{Q}_{2,1}^{(a)}(E'')\mathbb{Q}_{2,2}^{(b)}(E'')}{2} - \frac{\mathbb{Q}_{2,2}^{(a)}(E'')\mathbb{Q}_{2,1}^{(b)}(E'')}{2}$$

$$\boxed{\text{z156}} \quad \mathbb{Q}_{2,2}^{(c)}(E', b) = -\frac{\mathbb{Q}_{2,1}^{(a)}(E'')\mathbb{Q}_{2,1}^{(b)}(E'')}{2} + \frac{\mathbb{Q}_{2,2}^{(a)}(E'')\mathbb{Q}_{2,2}^{(b)}(E'')}{2}$$

$$\boxed{\text{z157}} \quad \mathbb{Q}_{2,1}^{(c)}(E', c) = \frac{\mathbb{M}_{1,1}^{(a)}(E'')\mathbb{M}_{1,2}^{(b)}(E'')}{2} + \frac{\mathbb{M}_{1,2}^{(a)}(E'')\mathbb{M}_{1,1}^{(b)}(E'')}{2}$$

$$\boxed{\text{z158}} \quad \mathbb{Q}_{2,2}^{(c)}(E', c) = \frac{\mathbb{M}_{1,1}^{(a)}(E'')\mathbb{M}_{1,1}^{(b)}(E'')}{2} - \frac{\mathbb{M}_{1,2}^{(a)}(E'')\mathbb{M}_{1,2}^{(b)}(E'')}{2}$$

$$\boxed{\text{z159}} \quad \mathbb{Q}_{3,1}^{(c)}(E') = -\frac{\sqrt{15}\mathbb{Q}_{2,1}^{(a)}(E')\mathbb{Q}_{1,2}^{(b)}(E')}{30} - \frac{2\sqrt{15}\mathbb{Q}_{2,2}^{(a)}(E'')\mathbb{Q}_1^{(b)}(A_2'')}{15} - \frac{\sqrt{15}\mathbb{Q}_{2,2}^{(a)}(E')\mathbb{Q}_{1,1}^{(b)}(E')}{30} + \frac{\sqrt{5}\mathbb{Q}_2^{(a)}(A'_1)\mathbb{Q}_{1,1}^{(b)}(E')}{5}$$

$$\boxed{\text{z160}} \quad \mathbb{Q}_{3,2}^{(c)}(E') = \frac{2\sqrt{15}\mathbb{Q}_{2,1}^{(a)}(E'')\mathbb{Q}_1^{(b)}(A_2'')}{15} - \frac{\sqrt{15}\mathbb{Q}_{2,1}^{(a)}(E')\mathbb{Q}_{1,1}^{(b)}(E')}{30} + \frac{\sqrt{15}\mathbb{Q}_{2,2}^{(a)}(E')\mathbb{Q}_{1,2}^{(b)}(E')}{30} + \frac{\sqrt{5}\mathbb{Q}_2^{(a)}(A'_1)\mathbb{Q}_{1,2}^{(b)}(E')}{5}$$

$$\boxed{\text{z161}} \quad \mathbb{Q}_{2,1}^{(c)}(E'', a) = \frac{\sqrt{2}\mathbb{Q}_0^{(a)}(A'_1)\mathbb{Q}_{2,1}^{(b)}(E'')}{2}$$

$$\boxed{\text{z162}} \quad \mathbb{Q}_{2,2}^{(c)}(E'', a) = \frac{\sqrt{2}\mathbb{Q}_0^{(a)}(A'_1)\mathbb{Q}_{2,2}^{(b)}(E'')}{2}$$

$$\boxed{\text{z163}} \quad \mathbb{Q}_{2,1}^{(c)}(E'', b) = \frac{\sqrt{2}\mathbb{Q}_{2,1}^{(a)}(E'')\mathbb{Q}_0^{(b)}(A'_1)}{2}$$

$$\boxed{\text{z164}} \quad \mathbb{Q}_{2,2}^{(c)}(E'', b) = \frac{\sqrt{2}\mathbb{Q}_{2,2}^{(a)}(E'')\mathbb{Q}_0^{(b)}(A'_1)}{2}$$

$$\boxed{\text{z165}} \quad \mathbb{Q}_{2,1}^{(c)}(E'', c) = -\frac{\sqrt{42}\mathbb{Q}_{2,1}^{(a)}(E')\mathbb{Q}_{2,2}^{(b)}(E'')}{14} - \frac{\sqrt{42}\mathbb{Q}_{2,2}^{(a)}(E')\mathbb{Q}_{2,1}^{(b)}(E'')}{14} + \frac{\sqrt{14}\mathbb{Q}_2^{(a)}(A'_1)\mathbb{Q}_{2,1}^{(b)}(E'')}{14}$$

$$\boxed{\text{z166}} \quad \mathbb{Q}_{2,2}^{(c)}(E'', c) = -\frac{\sqrt{42}\mathbb{Q}_{2,1}^{(a)}(E')\mathbb{Q}_{2,1}^{(b)}(E'')}{14} + \frac{\sqrt{42}\mathbb{Q}_{2,2}^{(a)}(E')\mathbb{Q}_{2,2}^{(b)}(E'')}{14} + \frac{\sqrt{14}\mathbb{Q}_2^{(a)}(A'_1)\mathbb{Q}_{2,2}^{(b)}(E'')}{14}$$

$$\boxed{\text{z229}} \quad \mathbb{Q}_{2,1}^{(c)}(E'', d) = \frac{\mathbb{M}_{1,2}^{(a)}(E'')\mathbb{M}_1^{(b)}(A'_2)}{2} + \frac{\mathbb{M}_1^{(a)}(A'_2)\mathbb{M}_{1,2}^{(b)}(E'')}{2}$$

$$\boxed{\text{z230}} \quad \mathbb{Q}_{2,2}^{(c)}(E'', d) = -\frac{\mathbb{M}_{1,1}^{(a)}(E'')\mathbb{M}_1^{(b)}(A'_2)}{2} - \frac{\mathbb{M}_1^{(a)}(A'_2)\mathbb{M}_{1,1}^{(b)}(E'')}{2}$$

$$\boxed{\text{z231}} \quad \mathbb{Q}_{3,1}^{(c)}(E'') = \frac{\sqrt{6}\mathbb{Q}_{2,1}^{(a)}(E'')\mathbb{Q}_{1,2}^{(b)}(E')}{6} + \frac{\sqrt{6}\mathbb{Q}_{2,2}^{(a)}(E'')\mathbb{Q}_{1,1}^{(b)}(E')}{6} - \frac{\sqrt{6}\mathbb{Q}_{2,2}^{(a)}(E')\mathbb{Q}_1^{(b)}(A''_2)}{6}$$

$$\boxed{\text{z232}} \quad \mathbb{Q}_{3,2}^{(c)}(E'') = \frac{\sqrt{6}\mathbb{Q}_{2,1}^{(a)}(E'')\mathbb{Q}_{1,1}^{(b)}(E')}{6} + \frac{\sqrt{6}\mathbb{Q}_{2,1}^{(a)}(E')\mathbb{Q}_1^{(b)}(A''_2)}{6} - \frac{\sqrt{6}\mathbb{Q}_{2,2}^{(a)}(E')\mathbb{Q}_{1,2}^{(b)}(E')}{6}$$

$$\boxed{\text{z233}} \quad \mathbb{Q}_{4,1}^{(c)}(E'') = \frac{\sqrt{7}\mathbb{Q}_{2,1}^{(a)}(E')\mathbb{Q}_{2,2}^{(b)}(E'')}{14} + \frac{\sqrt{7}\mathbb{Q}_{2,2}^{(a)}(E')\mathbb{Q}_{2,1}^{(b)}(E'')}{14} + \frac{\sqrt{21}\mathbb{Q}_2^{(a)}(A'_1)\mathbb{Q}_{2,1}^{(b)}(E'')}{7}$$

$$\boxed{\text{z234}} \quad \mathbb{Q}_{4,2}^{(c)}(E'') = \frac{\sqrt{7}\mathbb{Q}_{2,1}^{(a)}(E')\mathbb{Q}_{2,1}^{(b)}(E'')}{14} - \frac{\sqrt{7}\mathbb{Q}_{2,2}^{(a)}(E')\mathbb{Q}_{2,2}^{(b)}(E'')}{14} + \frac{\sqrt{21}\mathbb{Q}_2^{(a)}(A'_1)\mathbb{Q}_{2,2}^{(b)}(E'')}{7}$$

$$\boxed{\text{z235}} \quad \mathbb{G}_0^{(c)}(A''_1) = \frac{\sqrt{2}\mathbb{M}_{1,1}^{(a)}(E'')\mathbb{T}_{1,1}^{(b)}(E')}{2} + \frac{\sqrt{2}\mathbb{M}_{1,2}^{(a)}(E'')\mathbb{T}_{1,2}^{(b)}(E')}{2}$$

$$\boxed{\text{z236}} \quad \mathbb{G}_2^{(c)}(A''_1) = -\frac{\sqrt{2}\mathbb{Q}_{2,1}^{(a)}(E'')\mathbb{Q}_{1,1}^{(b)}(E')}{2} - \frac{\sqrt{2}\mathbb{Q}_{2,2}^{(a)}(E'')\mathbb{Q}_{1,2}^{(b)}(E')}{2}$$

$$\boxed{\text{z237}} \quad \mathbb{G}_1^{(c)}(A'_2, a) = \frac{\sqrt{2}\mathbb{Q}_{2,1}^{(a)}(E'')\mathbb{Q}_{2,2}^{(b)}(E'')}{2} - \frac{\sqrt{2}\mathbb{Q}_{2,2}^{(a)}(E'')\mathbb{Q}_{2,1}^{(b)}(E'')}{2}$$

$$\boxed{\text{z238}} \quad \mathbb{G}_1^{(c)}(A'_2, b) = \frac{\sqrt{2}\mathbb{M}_{1,1}^{(a)}(E'')\mathbb{M}_{1,2}^{(b)}(E'')}{2} - \frac{\sqrt{2}\mathbb{M}_{1,2}^{(a)}(E'')\mathbb{M}_{1,1}^{(b)}(E'')}{2}$$

$$\boxed{\text{z239}} \quad \mathbb{G}_{2,1}^{(c)}(E') = \frac{\sqrt{3}\mathbb{Q}_{2,1}^{(a)}(E')\mathbb{Q}_{1,2}^{(b)}(E')}{6} + \frac{\sqrt{3}\mathbb{Q}_{2,2}^{(a)}(E'')\mathbb{Q}_1^{(b)}(A''_2)}{6} + \frac{\sqrt{3}\mathbb{Q}_{2,2}^{(a)}(E')\mathbb{Q}_{1,1}^{(b)}(E')}{6} + \frac{\mathbb{Q}_2^{(a)}(A'_1)\mathbb{Q}_{1,1}^{(b)}(E')}{2}$$

$$\boxed{\text{z240}} \quad \mathbb{G}_{2,2}^{(c)}(E') = -\frac{\sqrt{3}\mathbb{Q}_{2,1}^{(a)}(E'')\mathbb{Q}_1^{(b)}(A''_2)}{6} + \frac{\sqrt{3}\mathbb{Q}_{2,1}^{(a)}(E')\mathbb{Q}_{1,1}^{(b)}(E')}{6} - \frac{\sqrt{3}\mathbb{Q}_{2,2}^{(a)}(E')\mathbb{Q}_{1,2}^{(b)}(E')}{6} + \frac{\mathbb{Q}_2^{(a)}(A'_1)\mathbb{Q}_{1,2}^{(b)}(E')}{2}$$

$$\boxed{\text{z241}} \quad \mathbb{G}_{1,1}^{(c)}(E'') = \frac{\mathbb{M}_{1,2}^{(a)}(E'')\mathbb{M}_1^{(b)}(A'_2)}{2} - \frac{\mathbb{M}_1^{(a)}(A'_2)\mathbb{M}_{1,2}^{(b)}(E'')}{2}$$

$$\boxed{\text{z242}} \quad \mathbb{G}_{1,2}^{(c)}(E'') = -\frac{\mathbb{M}_{1,1}^{(a)}(E'')\mathbb{M}_1^{(b)}(A'_2)}{2} + \frac{\mathbb{M}_1^{(a)}(A'_2)\mathbb{M}_{1,1}^{(b)}(E'')}{2}$$

$$\boxed{\text{z243}} \quad \mathbb{G}_{2,1}^{(c)}(E'', a) = -\frac{\sqrt{3}\mathbb{Q}_{2,1}^{(a)}(E'')\mathbb{Q}_{1,2}^{(b)}(E')}{6} - \frac{\sqrt{3}\mathbb{Q}_{2,2}^{(a)}(E'')\mathbb{Q}_{1,1}^{(b)}(E')}{6} - \frac{\sqrt{3}\mathbb{Q}_{2,2}^{(a)}(E')\mathbb{Q}_1^{(b)}(A''_2)}{3}$$

$$\boxed{\text{z244}} \quad \mathbb{G}_{2,2}^{(c)}(E'', a) = -\frac{\sqrt{3}\mathbb{Q}_{2,1}^{(a)}(E'')\mathbb{Q}_{1,1}^{(b)}(E')}{6} + \frac{\sqrt{3}\mathbb{Q}_{2,1}^{(a)}(E')\mathbb{Q}_1^{(b)}(A''_2)}{3} + \frac{\sqrt{3}\mathbb{Q}_{2,2}^{(a)}(E'')\mathbb{Q}_{1,2}^{(b)}(E')}{6}$$

$$\boxed{\text{z245}} \quad \mathbb{G}_{2,1}^{(c)}(E'', b) = \frac{\mathbb{M}_{1,1}^{(a)}(E'')\mathbb{T}_{1,2}^{(b)}(E')}{2} + \frac{\mathbb{M}_{1,2}^{(a)}(E'')\mathbb{T}_{1,1}^{(b)}(E')}{2}$$

$$\boxed{\text{z246}} \quad \mathbb{G}_{2,2}^{(c)}(E'', b) = \frac{\mathbb{M}_{1,1}^{(a)}(E'')\mathbb{T}_{1,1}^{(b)}(E')}{2} - \frac{\mathbb{M}_{1,2}^{(a)}(E'')\mathbb{T}_{1,2}^{(b)}(E')}{2}$$

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### Atomic SAMB

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- bra:  $\langle d_u |, \langle d_{xz} |, \langle d_{yz} |, \langle d_{xy} |, \langle d_v |$
- ket:  $|d_u\rangle, |d_{xz}\rangle, |d_{yz}\rangle, |d_{xy}\rangle, |d_v\rangle$

$$\boxed{\text{x1}} \quad \mathbb{Q}_0^{(a)}(A'_1) = \begin{bmatrix} \frac{\sqrt{5}}{5} & 0 & 0 & 0 & 0 \\ 0 & \frac{\sqrt{5}}{5} & 0 & 0 & 0 \\ 0 & 0 & \frac{\sqrt{5}}{5} & 0 & 0 \\ 0 & 0 & 0 & \frac{\sqrt{5}}{5} & 0 \\ 0 & 0 & 0 & 0 & \frac{\sqrt{5}}{5} \end{bmatrix}$$

$$\boxed{x2} \quad \mathbb{Q}_2^{(a)}(A'_1) = \begin{bmatrix} \frac{\sqrt{14}}{7} & 0 & 0 & 0 & 0 \\ 0 & -\frac{\sqrt{14}}{7} & 0 & 0 & 0 \\ 0 & 0 & \frac{\sqrt{14}}{14} & 0 & 0 \\ 0 & 0 & 0 & \frac{\sqrt{14}}{14} & 0 \\ 0 & 0 & 0 & 0 & -\frac{\sqrt{14}}{7} \end{bmatrix}$$

$$\boxed{x3} \quad \mathbb{Q}_4^{(a)}(A'_1) = \begin{bmatrix} \frac{3\sqrt{70}}{35} & 0 & 0 & 0 & 0 \\ 0 & \frac{\sqrt{70}}{70} & 0 & 0 & 0 \\ 0 & 0 & -\frac{2\sqrt{70}}{35} & 0 & 0 \\ 0 & 0 & 0 & -\frac{2\sqrt{70}}{35} & 0 \\ 0 & 0 & 0 & 0 & \frac{\sqrt{70}}{70} \end{bmatrix}$$

$$\boxed{x4} \quad \mathbb{Q}_4^{(a)}(A''_1) = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & \frac{1}{2} & 0 \\ 0 & 0 & 0 & 0 & -\frac{1}{2} \\ 0 & \frac{1}{2} & 0 & 0 & 0 \\ 0 & 0 & -\frac{1}{2} & 0 & 0 \end{bmatrix}$$

$$\boxed{x5} \quad \mathbb{Q}_4^{(a)}(A''_2) = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & \frac{1}{2} & 0 & 0 \\ 0 & \frac{1}{2} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & \frac{1}{2} \\ 0 & 0 & 0 & \frac{1}{2} & 0 \end{bmatrix}$$

$$\boxed{x6} \quad \mathbb{Q}_{2,1}^{(a)}(E') = \begin{bmatrix} 0 & 0 & 0 & 0 & -\frac{\sqrt{14}}{7} \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & \frac{\sqrt{42}}{14} & 0 \\ 0 & 0 & \frac{\sqrt{42}}{14} & 0 & 0 \\ -\frac{\sqrt{14}}{7} & 0 & 0 & 0 & 0 \end{bmatrix}$$

$$\boxed{x7} \quad \mathbb{Q}_{2,2}^{(a)}(E') = \begin{bmatrix} 0 & -\frac{\sqrt{14}}{7} & 0 & 0 & 0 \\ -\frac{\sqrt{14}}{7} & 0 & 0 & 0 & 0 \\ 0 & 0 & -\frac{\sqrt{42}}{14} & 0 & 0 \\ 0 & 0 & 0 & \frac{\sqrt{42}}{14} & 0 \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

$$\boxed{x8} \quad \mathbb{Q}_{4,1}^{(a)}(E', 1) = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & -\frac{\sqrt{2}}{2} \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & -\frac{\sqrt{2}}{2} & 0 & 0 & 0 \end{bmatrix}$$

$$\boxed{x9} \quad \mathbb{Q}_{4,2}^{(a)}(E', 1) = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & \frac{\sqrt{2}}{2} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & -\frac{\sqrt{2}}{2} \end{bmatrix}$$

$$\boxed{x10} \quad \mathbb{Q}_{4,1}^{(a)}(E', 2) = \begin{bmatrix} 0 & 0 & 0 & 0 & \frac{\sqrt{42}}{14} \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & \frac{\sqrt{14}}{7} & 0 \\ 0 & 0 & \frac{\sqrt{14}}{7} & 0 & 0 \\ \frac{\sqrt{42}}{14} & 0 & 0 & 0 & 0 \end{bmatrix}$$

$$\boxed{x11} \quad \mathbb{Q}_{4,2}^{(a)}(E', 2) = \begin{bmatrix} 0 & \frac{\sqrt{42}}{14} & 0 & 0 & 0 \\ \frac{\sqrt{42}}{14} & 0 & 0 & 0 & 0 \\ 0 & 0 & -\frac{\sqrt{14}}{7} & 0 & 0 \\ 0 & 0 & 0 & \frac{\sqrt{14}}{7} & 0 \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

$$\boxed{x12} \quad \mathbb{Q}_{2,1}^{(a)}(E'') = \begin{bmatrix} 0 & 0 & \frac{\sqrt{14}}{14} & 0 & 0 \\ 0 & 0 & -\frac{\sqrt{42}}{14} & 0 & 0 \\ \frac{\sqrt{14}}{14} & -\frac{\sqrt{42}}{14} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & \frac{\sqrt{42}}{14} \\ 0 & 0 & 0 & \frac{\sqrt{42}}{14} & 0 \end{bmatrix}$$

$$\boxed{x13} \quad \mathbb{Q}_{2,2}^{(a)}(E'') = \begin{bmatrix} 0 & 0 & 0 & -\frac{\sqrt{14}}{14} & 0 \\ 0 & 0 & 0 & -\frac{\sqrt{42}}{14} & 0 \\ 0 & 0 & 0 & 0 & -\frac{\sqrt{42}}{14} \\ -\frac{\sqrt{14}}{14} & -\frac{\sqrt{42}}{14} & 0 & 0 & 0 \\ 0 & 0 & -\frac{\sqrt{42}}{14} & 0 & 0 \end{bmatrix}$$

$$\boxed{x14} \quad \mathbb{Q}_{4,1}^{(a)}(E'') = \begin{bmatrix} 0 & 0 & \frac{\sqrt{21}}{7} & 0 & 0 \\ 0 & 0 & \frac{\sqrt{7}}{14} & 0 & 0 \\ \frac{\sqrt{21}}{7} & \frac{\sqrt{7}}{14} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & -\frac{\sqrt{7}}{14} \\ 0 & 0 & 0 & -\frac{\sqrt{7}}{14} & 0 \end{bmatrix}$$

$$\boxed{x15} \quad \mathbb{Q}_{4,2}^{(a)}(E'') = \begin{bmatrix} 0 & 0 & 0 & -\frac{\sqrt{21}}{7} & 0 \\ 0 & 0 & 0 & \frac{\sqrt{7}}{14} & 0 \\ 0 & 0 & 0 & 0 & \frac{\sqrt{7}}{14} \\ -\frac{\sqrt{21}}{7} & \frac{\sqrt{7}}{14} & 0 & 0 & 0 \\ 0 & 0 & \frac{\sqrt{7}}{14} & 0 & 0 \end{bmatrix}$$

$$\boxed{x16} \quad \mathbb{M}_3^{(a)}(A''_1) = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & \frac{i}{2} & 0 \\ 0 & 0 & 0 & 0 & \frac{i}{2} \\ 0 & -\frac{i}{2} & 0 & 0 & 0 \\ 0 & 0 & -\frac{i}{2} & 0 & 0 \end{bmatrix}$$

$$\boxed{x17} \quad \mathbb{M}_1^{(a)}(A'_2) = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & -\frac{\sqrt{10}i}{5} \\ 0 & 0 & 0 & \frac{\sqrt{10}i}{10} & 0 \\ 0 & 0 & -\frac{\sqrt{10}i}{10} & 0 & 0 \\ 0 & \frac{\sqrt{10}i}{5} & 0 & 0 & 0 \end{bmatrix}$$

$$\boxed{x18} \quad \mathbb{M}_3^{(a)}(A'_2) = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & \frac{\sqrt{10}i}{10} \\ 0 & 0 & 0 & \frac{\sqrt{10}i}{5} & 0 \\ 0 & 0 & -\frac{\sqrt{10}i}{5} & 0 & 0 \\ 0 & -\frac{\sqrt{10}i}{10} & 0 & 0 & 0 \end{bmatrix}$$

$$\boxed{x19} \quad \mathbb{M}_3^{(a)}(A''_2) = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & -\frac{i}{2} & 0 & 0 \\ 0 & \frac{i}{2} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & \frac{i}{2} \\ 0 & 0 & 0 & -\frac{i}{2} & 0 \end{bmatrix}$$

$$\boxed{x20} \quad \mathbb{M}_{3,1}^{(a)}(E') = \begin{bmatrix} 0 & 0 & 0 & 0 & -\frac{\sqrt{2}i}{2} \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ \frac{\sqrt{2}i}{2} & 0 & 0 & 0 & 0 \end{bmatrix}$$

$$\boxed{x21} \quad \mathbb{M}_{3,2}^{(a)}(E') = \begin{bmatrix} 0 & -\frac{\sqrt{2}i}{2} & 0 & 0 & 0 \\ \frac{\sqrt{2}i}{2} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

$$\boxed{\text{x22}} \quad \mathbb{M}_{1,1}^{(a)}(E'') = \begin{bmatrix} 0 & 0 & \frac{\sqrt{30}i}{10} & 0 & 0 \\ 0 & 0 & \frac{\sqrt{10}i}{10} & 0 & 0 \\ -\frac{\sqrt{30}i}{10} & -\frac{\sqrt{10}i}{10} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & \frac{\sqrt{10}i}{10} \\ 0 & 0 & 0 & -\frac{\sqrt{10}i}{10} & 0 \end{bmatrix}$$

$$\boxed{\text{x23}} \quad \mathbb{M}_{1,2}^{(a)}(E'') = \begin{bmatrix} 0 & 0 & 0 & -\frac{\sqrt{30}i}{10} & 0 \\ 0 & 0 & 0 & \frac{\sqrt{10}i}{10} & 0 \\ 0 & 0 & 0 & 0 & -\frac{\sqrt{10}i}{10} \\ \frac{\sqrt{30}i}{10} & -\frac{\sqrt{10}i}{10} & 0 & 0 & 0 \\ 0 & 0 & \frac{\sqrt{10}i}{10} & 0 & 0 \end{bmatrix}$$

$$\boxed{\text{x24}} \quad \mathbb{M}_{3,1}^{(a)}(E'') = \begin{bmatrix} 0 & 0 & \frac{\sqrt{5}i}{5} & 0 & 0 \\ 0 & 0 & -\frac{\sqrt{15}i}{10} & 0 & 0 \\ -\frac{\sqrt{5}i}{5} & \frac{\sqrt{15}i}{10} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & -\frac{\sqrt{15}i}{10} \\ 0 & 0 & 0 & \frac{\sqrt{15}i}{10} & 0 \end{bmatrix}$$

$$\boxed{\text{x25}} \quad \mathbb{M}_{3,2}^{(a)}(E'') = \begin{bmatrix} 0 & 0 & 0 & -\frac{\sqrt{5}i}{5} & 0 \\ 0 & 0 & 0 & -\frac{\sqrt{15}i}{10} & 0 \\ 0 & 0 & 0 & 0 & \frac{\sqrt{15}i}{10} \\ \frac{\sqrt{5}i}{5} & \frac{\sqrt{15}i}{10} & 0 & 0 & 0 \\ 0 & 0 & -\frac{\sqrt{15}i}{10} & 0 & 0 \end{bmatrix}$$

- bra:  $\langle p_x |, \langle p_y |, \langle p_z |$
- ket:  $|p_x\rangle, |p_y\rangle, |p_z\rangle$

$$\boxed{\text{x26}} \quad \mathbb{Q}_0^{(a)}(A'_1) = \begin{bmatrix} \frac{\sqrt{3}}{3} & 0 & 0 \\ 0 & \frac{\sqrt{3}}{3} & 0 \\ 0 & 0 & \frac{\sqrt{3}}{3} \end{bmatrix}$$

$$\boxed{\text{x27}} \quad \mathbb{Q}_2^{(a)}(A'_1) = \begin{bmatrix} -\frac{\sqrt{6}}{6} & 0 & 0 \\ 0 & -\frac{\sqrt{6}}{6} & 0 \\ 0 & 0 & \frac{\sqrt{6}}{3} \end{bmatrix}$$

$$\boxed{\text{x28}} \quad \mathbb{Q}_{2,1}^{(a)}(E') = \begin{bmatrix} 0 & \frac{\sqrt{2}}{2} & 0 \\ \frac{\sqrt{2}}{2} & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

$$\boxed{\text{x29}} \quad \mathbb{Q}_{2,2}^{(a)}(E') = \begin{bmatrix} \frac{\sqrt{2}}{2} & 0 & 0 \\ 0 & -\frac{\sqrt{2}}{2} & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

$$\boxed{\text{x30}} \quad \mathbb{Q}_{2,1}^{(a)}(E'') = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & \frac{\sqrt{2}}{2} \\ 0 & \frac{\sqrt{2}}{2} & 0 \end{bmatrix}$$

$$\boxed{\text{x31}} \quad \mathbb{Q}_{2,2}^{(a)}(E'') = \begin{bmatrix} 0 & 0 & -\frac{\sqrt{2}}{2} \\ 0 & 0 & 0 \\ -\frac{\sqrt{2}}{2} & 0 & 0 \end{bmatrix}$$

$$\boxed{\text{x32}} \quad \mathbb{M}_1^{(a)}(A'_2) = \begin{bmatrix} 0 & -\frac{\sqrt{2}i}{2} & 0 \\ \frac{\sqrt{2}i}{2} & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

$$\boxed{\text{x33}} \quad \mathbb{M}_{1,1}^{(a)}(E'') = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & -\frac{\sqrt{2}i}{2} \\ 0 & \frac{\sqrt{2}i}{2} & 0 \end{bmatrix}$$

$$\boxed{\text{x34}} \quad \mathbb{M}_{1,2}^{(a)}(E'') = \begin{bmatrix} 0 & 0 & \frac{\sqrt{2}i}{2} \\ 0 & 0 & 0 \\ -\frac{\sqrt{2}i}{2} & 0 & 0 \end{bmatrix}$$

- bra:  $\langle d_u |, \langle d_{xz} |, \langle d_{yz} |, \langle d_{xy} |, \langle d_v |$
- ket:  $|p_x\rangle, |p_y\rangle, |p_z\rangle$

$$\boxed{\text{x35}} \quad \mathbb{Q}_3^{(a)}(A'_1) = \begin{bmatrix} 0 & 0 & 0 \\ 0 & \frac{1}{2} & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \\ \frac{1}{2} & 0 & 0 \end{bmatrix}$$

$$\boxed{\text{x36}} \quad \mathbb{Q}_3^{(a)}(A'_2) = \begin{bmatrix} 0 & 0 & 0 \\ \frac{1}{2} & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & -\frac{1}{2} & 0 \end{bmatrix}$$

$$\boxed{x37} \quad \mathbb{Q}_1^{(a)}(A''_2) = \begin{bmatrix} 0 & 0 & \frac{\sqrt{5}}{5} \\ 0 & 0 & 0 \\ 0 & \frac{\sqrt{15}}{10} & 0 \\ \frac{\sqrt{15}}{10} & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

$$\boxed{x38} \quad \mathbb{Q}_3^{(a)}(A''_2) = \begin{bmatrix} 0 & 0 & \frac{\sqrt{30}}{10} \\ 0 & 0 & 0 \\ 0 & -\frac{\sqrt{10}}{10} & 0 \\ -\frac{\sqrt{10}}{10} & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

$$\boxed{x39} \quad \mathbb{Q}_{1,1}^{(a)}(E') = \begin{bmatrix} -\frac{\sqrt{5}}{10} & 0 & 0 \\ \frac{\sqrt{15}}{10} & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & \frac{\sqrt{15}}{10} \\ 0 & \frac{\sqrt{15}}{10} & 0 \end{bmatrix}$$

$$\boxed{x40} \quad \mathbb{Q}_{1,2}^{(a)}(E') = \begin{bmatrix} 0 & -\frac{\sqrt{5}}{10} & 0 \\ 0 & -\frac{\sqrt{15}}{10} & 0 \\ 0 & 0 & \frac{\sqrt{15}}{10} \\ 0 & 0 & 0 \\ \frac{\sqrt{15}}{10} & 0 & 0 \end{bmatrix}$$

$$\boxed{x41} \quad \mathbb{Q}_{3,1}^{(a)}(E') = \begin{bmatrix} \frac{\sqrt{5}}{5} & 0 & 0 \\ -\frac{\sqrt{15}}{30} & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & \frac{2\sqrt{15}}{15} \\ 0 & -\frac{\sqrt{15}}{30} & 0 \end{bmatrix}$$

$$\boxed{x42} \quad \mathbb{Q}_{3,2}^{(a)}(E') = \begin{bmatrix} 0 & \frac{\sqrt{5}}{5} & 0 \\ 0 & \frac{\sqrt{15}}{30} & 0 \\ 0 & 0 & \frac{2\sqrt{15}}{15} \\ 0 & 0 & 0 \\ -\frac{\sqrt{15}}{30} & 0 & 0 \end{bmatrix}$$

$$\boxed{x43} \quad \mathbb{Q}_{3,1}^{(a)}(E'') = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & -\frac{\sqrt{6}}{6} \\ 0 & \frac{\sqrt{6}}{6} & 0 \\ -\frac{\sqrt{6}}{6} & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

$$\boxed{\text{x44}} \quad \mathbb{Q}_{3,2}^{(a)}(E'') = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ \frac{\sqrt{6}}{6} & 0 & 0 \\ 0 & \frac{\sqrt{6}}{6} & 0 \\ 0 & 0 & \frac{\sqrt{6}}{6} \end{bmatrix}$$

$$\boxed{\text{x45}} \quad \mathbb{G}_2^{(a)}(A''_1) = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ \frac{1}{2} & 0 & 0 \\ 0 & -\frac{1}{2} & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

$$\boxed{\text{x46}} \quad \mathbb{G}_{2,1}^{(a)}(E') = \begin{bmatrix} -\frac{1}{2} & 0 & 0 \\ -\frac{\sqrt{3}}{6} & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & \frac{\sqrt{3}}{6} \\ 0 & -\frac{\sqrt{3}}{6} & 0 \end{bmatrix}$$

$$\boxed{\text{x47}} \quad \mathbb{G}_{2,2}^{(a)}(E') = \begin{bmatrix} 0 & -\frac{1}{2} & 0 \\ 0 & \frac{\sqrt{3}}{6} & 0 \\ 0 & 0 & \frac{\sqrt{3}}{6} \\ 0 & 0 & 0 \\ -\frac{\sqrt{3}}{6} & 0 & 0 \end{bmatrix}$$

$$\boxed{\text{x48}} \quad \mathbb{G}_{2,1}^{(a)}(E'') = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & \frac{\sqrt{3}}{3} \\ 0 & \frac{\sqrt{3}}{6} & 0 \\ -\frac{\sqrt{3}}{6} & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

$$\boxed{\text{x49}} \quad \mathbb{G}_{2,2}^{(a)}(E'') = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ \frac{\sqrt{3}}{6} & 0 & 0 \\ 0 & \frac{\sqrt{3}}{6} & 0 \\ 0 & 0 & -\frac{\sqrt{3}}{3} \end{bmatrix}$$

$$\boxed{\text{x50}} \quad \mathbb{M}_2^{(a)}(A''_1) = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ \frac{i}{2} & 0 & 0 \\ 0 & -\frac{i}{2} & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

$$\boxed{x51} \quad \mathbb{M}_{2,1}^{(a)}(E') = \begin{bmatrix} -\frac{i}{2} & 0 & 0 \\ -\frac{\sqrt{3}i}{6} & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & \frac{\sqrt{3}i}{6} \\ 0 & -\frac{\sqrt{3}i}{6} & 0 \end{bmatrix}$$

$$\boxed{x52} \quad \mathbb{M}_{2,2}^{(a)}(E') = \begin{bmatrix} 0 & -\frac{i}{2} & 0 \\ 0 & \frac{\sqrt{3}i}{6} & 0 \\ 0 & 0 & \frac{\sqrt{3}i}{6} \\ 0 & 0 & 0 \\ -\frac{\sqrt{3}i}{6} & 0 & 0 \end{bmatrix}$$

$$\boxed{x53} \quad \mathbb{M}_{2,1}^{(a)}(E'') = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & \frac{\sqrt{3}i}{3} \\ 0 & \frac{\sqrt{3}i}{6} & 0 \\ -\frac{\sqrt{3}i}{6} & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

$$\boxed{x54} \quad \mathbb{M}_{2,2}^{(a)}(E'') = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ \frac{\sqrt{3}i}{6} & 0 & 0 \\ 0 & \frac{\sqrt{3}i}{6} & 0 \\ 0 & 0 & -\frac{\sqrt{3}i}{3} \end{bmatrix}$$

$$\boxed{x55} \quad \mathbb{T}_3^{(a)}(A'_1) = \begin{bmatrix} 0 & 0 & 0 \\ 0 & -\frac{i}{2} & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \\ -\frac{i}{2} & 0 & 0 \end{bmatrix}$$

$$\boxed{x56} \quad \mathbb{T}_3^{(a)}(A'_2) = \begin{bmatrix} 0 & 0 & 0 \\ -\frac{i}{2} & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & \frac{i}{2} & 0 \end{bmatrix}$$

$$\boxed{x57} \quad \mathbb{T}_1^{(a)}(A''_2) = \begin{bmatrix} 0 & 0 & -\frac{\sqrt{5}i}{5} \\ 0 & 0 & 0 \\ 0 & -\frac{\sqrt{15}i}{10} & 0 \\ -\frac{\sqrt{15}i}{10} & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

$$\boxed{x58} \quad \mathbb{T}_3^{(a)}(A_2'') = \begin{bmatrix} 0 & 0 & -\frac{\sqrt{30}i}{10} \\ 0 & 0 & 0 \\ 0 & \frac{\sqrt{10}i}{10} & 0 \\ \frac{\sqrt{10}i}{10} & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

$$\boxed{x59} \quad \mathbb{T}_{1,1}^{(a)}(E') = \begin{bmatrix} \frac{\sqrt{5}i}{10} & 0 & 0 \\ -\frac{\sqrt{15}i}{10} & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & -\frac{\sqrt{15}i}{10} \\ 0 & -\frac{\sqrt{15}i}{10} & 0 \end{bmatrix}$$

$$\boxed{x60} \quad \mathbb{T}_{1,2}^{(a)}(E') = \begin{bmatrix} 0 & \frac{\sqrt{5}i}{10} & 0 \\ 0 & \frac{\sqrt{15}i}{10} & 0 \\ 0 & 0 & -\frac{\sqrt{15}i}{10} \\ 0 & 0 & 0 \\ -\frac{\sqrt{15}i}{10} & 0 & 0 \end{bmatrix}$$

$$\boxed{x61} \quad \mathbb{T}_{3,1}^{(a)}(E') = \begin{bmatrix} -\frac{\sqrt{5}i}{5} & 0 & 0 \\ \frac{\sqrt{15}i}{30} & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & -\frac{2\sqrt{15}i}{15} \\ 0 & \frac{\sqrt{15}i}{30} & 0 \end{bmatrix}$$

$$\boxed{x62} \quad \mathbb{T}_{3,2}^{(a)}(E') = \begin{bmatrix} 0 & -\frac{\sqrt{5}i}{5} & 0 \\ 0 & -\frac{\sqrt{15}i}{30} & 0 \\ 0 & 0 & -\frac{2\sqrt{15}i}{15} \\ 0 & 0 & 0 \\ \frac{\sqrt{15}i}{30} & 0 & 0 \end{bmatrix}$$

$$\boxed{x63} \quad \mathbb{T}_{3,1}^{(a)}(E'') = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & \frac{\sqrt{6}i}{6} \\ 0 & -\frac{\sqrt{6}i}{6} & 0 \\ \frac{\sqrt{6}i}{6} & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

$$\boxed{x64} \quad \mathbb{T}_{3,2}^{(a)}(E'') = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ -\frac{\sqrt{6}i}{6} & 0 & 0 \\ 0 & -\frac{\sqrt{6}i}{6} & 0 \\ 0 & 0 & -\frac{\sqrt{6}i}{6} \end{bmatrix}$$

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**Cluster SAMB**


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- Site cluster

\*\* Wyckoff: 1a

$$\boxed{y1} \quad \mathbb{Q}_0^{(s)}(A'_1) = [1]$$

\*\* Wyckoff: 2i

$$\boxed{y2} \quad \mathbb{Q}_0^{(s)}(A'_1) = \left[ \frac{\sqrt{2}}{2}, \frac{\sqrt{2}}{2} \right]$$

$$\boxed{y3} \quad \mathbb{Q}_1^{(s)}(A''_2) = \left[ \frac{\sqrt{2}}{2}, -\frac{\sqrt{2}}{2} \right]$$

- Bond cluster

\*\* Wyckoff: 3b@3j

$$\boxed{y4} \quad \mathbb{Q}_0^{(s)}(A'_1) = \left[ \frac{\sqrt{3}}{3}, \frac{\sqrt{3}}{3}, \frac{\sqrt{3}}{3} \right]$$

$$\boxed{y5} \quad \mathbb{M}_1^{(s)}(A'_2) = \left[ \frac{\sqrt{3}i}{3}, \frac{\sqrt{3}i}{3}, \frac{\sqrt{3}i}{3} \right]$$

$$\boxed{y6} \quad \mathbb{Q}_{1,1}^{(s)}(E') = \left[ \frac{\sqrt{2}}{2}, 0, -\frac{\sqrt{2}}{2} \right]$$

$$\boxed{y7} \quad \mathbb{Q}_{1,2}^{(s)}(E') = \left[ -\frac{\sqrt{6}}{6}, \frac{\sqrt{6}}{3}, -\frac{\sqrt{6}}{6} \right]$$

$$\boxed{y8} \quad \mathbb{T}_{1,1}^{(s)}(E') = \left[ \frac{\sqrt{6}i}{6}, -\frac{\sqrt{6}i}{3}, \frac{\sqrt{6}i}{6} \right]$$

$$\boxed{y9} \quad \mathbb{T}_{1,2}^{(s)}(E') = \left[ \frac{\sqrt{2}i}{2}, 0, -\frac{\sqrt{2}i}{2} \right]$$

\*\* Wyckoff: 6b@6n

$$\boxed{y10} \quad \mathbb{Q}_0^{(s)}(A'_1) = \left[ \frac{\sqrt{6}}{6}, \frac{\sqrt{6}}{6}, \frac{\sqrt{6}}{6}, \frac{\sqrt{6}}{6}, \frac{\sqrt{6}}{6}, \frac{\sqrt{6}}{6} \right]$$

$$\boxed{y11} \quad \mathbb{M}_2^{(s)}(A''_1) = \left[ \frac{\sqrt{6}i}{6}, \frac{\sqrt{6}i}{6}, \frac{\sqrt{6}i}{6}, -\frac{\sqrt{6}i}{6}, -\frac{\sqrt{6}i}{6}, -\frac{\sqrt{6}i}{6} \right]$$

$$\boxed{y12} \quad \mathbb{M}_1^{(s)}(A'_2) = \left[ \frac{\sqrt{6}i}{6}, \frac{\sqrt{6}i}{6}, \frac{\sqrt{6}i}{6}, \frac{\sqrt{6}i}{6}, \frac{\sqrt{6}i}{6}, \frac{\sqrt{6}i}{6} \right]$$

$$\boxed{y13} \quad \mathbb{Q}_1^{(s)}(A''_2) = \left[ \frac{\sqrt{6}}{6}, \frac{\sqrt{6}}{6}, \frac{\sqrt{6}}{6}, -\frac{\sqrt{6}}{6}, -\frac{\sqrt{6}}{6}, -\frac{\sqrt{6}}{6} \right]$$

$$\boxed{y14} \quad \mathbb{Q}_{1,1}^{(s)}(E') = \left[ \frac{1}{2}, 0, -\frac{1}{2}, \frac{1}{2}, 0, -\frac{1}{2} \right]$$

$$\boxed{y15} \quad \mathbb{Q}_{1,2}^{(s)}(E') = \left[ -\frac{\sqrt{3}}{6}, \frac{\sqrt{3}}{3}, -\frac{\sqrt{3}}{6}, -\frac{\sqrt{3}}{6}, \frac{\sqrt{3}}{3}, -\frac{\sqrt{3}}{6} \right]$$

$$\boxed{y16} \quad \mathbb{T}_{1,1}^{(s)}(E') = \left[ \frac{\sqrt{3}i}{6}, -\frac{\sqrt{3}i}{3}, \frac{\sqrt{3}i}{6}, \frac{\sqrt{3}i}{6}, -\frac{\sqrt{3}i}{3}, \frac{\sqrt{3}i}{6} \right]$$

$$\boxed{y17} \quad \mathbb{T}_{1,2}^{(s)}(E') = \left[ \frac{i}{2}, 0, -\frac{i}{2}, \frac{i}{2}, 0, -\frac{i}{2} \right]$$

$$\boxed{y18} \quad \mathbb{M}_{1,1}^{(s)}(E'') = \left[ \frac{i}{2}, 0, -\frac{i}{2}, -\frac{i}{2}, 0, \frac{i}{2} \right]$$

$$\boxed{y19} \quad \mathbb{M}_{1,2}^{(s)}(E'') = \left[ -\frac{\sqrt{3}i}{6}, \frac{\sqrt{3}i}{3}, -\frac{\sqrt{3}i}{6}, \frac{\sqrt{3}i}{6}, -\frac{\sqrt{3}i}{3}, \frac{\sqrt{3}i}{6} \right]$$

$$\boxed{y20} \quad \mathbb{Q}_{2,1}^{(s)}(E'') = \left[ -\frac{\sqrt{3}}{6}, \frac{\sqrt{3}}{3}, -\frac{\sqrt{3}}{6}, \frac{\sqrt{3}}{6}, -\frac{\sqrt{3}}{3}, \frac{\sqrt{3}}{6} \right]$$

$$\boxed{y21} \quad \mathbb{Q}_{2,2}^{(s)}(E'') = \left[ -\frac{1}{2}, 0, \frac{1}{2}, \frac{1}{2}, 0, -\frac{1}{2} \right]$$

\*\* Wyckoff: 6a@6n

$$\boxed{\text{y22}} \quad \mathbb{Q}_0^{(s)}(A'_1) = \left[ \frac{\sqrt{6}}{6}, \frac{\sqrt{6}}{6}, \frac{\sqrt{6}}{6}, \frac{\sqrt{6}}{6}, \frac{\sqrt{6}}{6}, \frac{\sqrt{6}}{6} \right]$$

$$\boxed{\text{y23}} \quad \mathbb{T}_0^{(s)}(A'_1) = \left[ \frac{\sqrt{6}i}{6}, \frac{\sqrt{6}i}{6}, \frac{\sqrt{6}i}{6}, \frac{\sqrt{6}i}{6}, \frac{\sqrt{6}i}{6}, \frac{\sqrt{6}i}{6} \right]$$

$$\boxed{\text{y24}} \quad \mathbb{Q}_1^{(s)}(A''_2) = \left[ \frac{\sqrt{6}}{6}, \frac{\sqrt{6}}{6}, \frac{\sqrt{6}}{6}, -\frac{\sqrt{6}}{6}, -\frac{\sqrt{6}}{6}, -\frac{\sqrt{6}}{6} \right]$$

$$\boxed{\text{y25}} \quad \mathbb{T}_1^{(s)}(A''_2) = \left[ \frac{\sqrt{6}i}{6}, \frac{\sqrt{6}i}{6}, \frac{\sqrt{6}i}{6}, -\frac{\sqrt{6}i}{6}, -\frac{\sqrt{6}i}{6}, -\frac{\sqrt{6}i}{6} \right]$$

$$\boxed{\text{y26}} \quad \mathbb{Q}_{1,1}^{(s)}(E') = \left[ \frac{1}{2}, 0, -\frac{1}{2}, \frac{1}{2}, 0, -\frac{1}{2} \right]$$

$$\boxed{\text{y27}} \quad \mathbb{Q}_{1,2}^{(s)}(E') = \left[ -\frac{\sqrt{3}}{6}, \frac{\sqrt{3}}{3}, -\frac{\sqrt{3}}{6}, -\frac{\sqrt{3}}{6}, \frac{\sqrt{3}}{3}, -\frac{\sqrt{3}}{6} \right]$$

$$\boxed{\text{y28}} \quad \mathbb{T}_{1,1}^{(s)}(E') = \left[ \frac{i}{2}, 0, -\frac{i}{2}, \frac{i}{2}, 0, -\frac{i}{2} \right]$$

$$\boxed{\text{y29}} \quad \mathbb{T}_{1,2}^{(s)}(E') = \left[ -\frac{\sqrt{3}i}{6}, \frac{\sqrt{3}i}{3}, -\frac{\sqrt{3}i}{6}, -\frac{\sqrt{3}i}{6}, \frac{\sqrt{3}i}{3}, -\frac{\sqrt{3}i}{6} \right]$$

$$\boxed{\text{y30}} \quad \mathbb{M}_{1,1}^{(s)}(E'') = \left[ -\frac{\sqrt{3}i}{6}, \frac{\sqrt{3}i}{3}, -\frac{\sqrt{3}i}{6}, \frac{\sqrt{3}i}{6}, -\frac{\sqrt{3}i}{3}, \frac{\sqrt{3}i}{6} \right]$$

$$\boxed{\text{y31}} \quad \mathbb{M}_{1,2}^{(s)}(E'') = \left[ -\frac{i}{2}, 0, \frac{i}{2}, \frac{i}{2}, 0, -\frac{i}{2} \right]$$

$$\boxed{\text{y32}} \quad \mathbb{Q}_{2,1}^{(s)}(E'') = \left[ -\frac{\sqrt{3}}{6}, \frac{\sqrt{3}}{3}, -\frac{\sqrt{3}}{6}, \frac{\sqrt{3}}{6}, -\frac{\sqrt{3}}{3}, \frac{\sqrt{3}}{6} \right]$$

$$\boxed{\text{y33}} \quad \mathbb{Q}_{2,2}^{(s)}(E'') = \left[ -\frac{1}{2}, 0, \frac{1}{2}, \frac{1}{2}, 0, -\frac{1}{2} \right]$$

Table 5: Orbital of each site

#	site	orbital
1	Mo	$ d_u\rangle,  d_{xz}\rangle,  d_{yz}\rangle,  d_{xy}\rangle,  d_v\rangle$
2	S	$ p_x\rangle,  p_y\rangle,  p_z\rangle$

Table 6: Neighbor and bra-ket of each bond

#	head	tail	neighbor	head (bra)	tail (ket)
1	Mo	Mo	[1]	[d]	[d]
2	Mo	S	[1]	[d]	[p]
3	S	S	[1]	[p]	[p]

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— Site in Unit Cell —

Sites in (conventional) cell (no plus set), SL = sublattice

Table 7: 'Mo' (#1) site cluster (1a), -6m2

SL	position ( $s$ )	mapping
1	[ 0.00000, 0.00000, 0.00000]	[1,2,3,4,5,6,7,8,9,10,11,12]

Table 8: 'S' (#2) site cluster (2i), 3m.

SL	position ( $s$ )	mapping
1	[ 0.66667, 0.33333, 0.12425]	[1,2,3,7,8,9]
2	[ 0.66667, 0.33333, 0.87575]	[4,5,6,10,11,12]

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### Bond in Unit Cell

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Bonds in (conventional) cell (no plus set): tail, head = (SL, plus set), (N)D = (non)directional (listed up to 5th neighbor at most)

Table 9: 1-th 'Mo'-'Mo' [1] (#1) bond cluster (3b@3j), ND,  $|\mathbf{v}|=3.1661$  (cartesian)

SL	vector ( $\mathbf{v}$ )	center ( $c$ )	mapping	head	tail	$R$ (primitive)
1	[-1.00000, -1.00000, 0.00000]	[ 0.50000, 0.50000, 0.00000]	[1,4,-7,-10]	(1,1)	(1,1)	[1,1,0]

*continued ...*

Table 9

SL	vector ( $\mathbf{v}$ )	center ( $\mathbf{c}$ )	mapping	head	tail	$\mathbf{R}$ (primitive)
2	[ 1.00000, 0.00000, 0.00000]	[ 0.50000, 0.00000, 0.00000]	[2,5,-9,-12]	(1,1)	(1,1)	[-1,0,0]
3	[ 0.00000, 1.00000, 0.00000]	[ 0.00000, 0.50000, 0.00000]	[3,6,-8,-11]	(1,1)	(1,1)	[0,-1,0]

Table 10: 1-th 'Mo'-'S' [1] (#2) bond cluster (6a@6n), D,  $|\mathbf{v}|=3.0849$  (cartesian)

SL	vector ( $\mathbf{v}$ )	center ( $\mathbf{c}$ )	mapping	head	tail	$\mathbf{R}$ (primitive)
1	[ 0.33333, -0.33333, -0.12425]	[ 0.83333, 0.16667, 0.06212]	[1,7]	(1,1)	(1,1)	[-1,0,0]
2	[ 0.33333, 0.66667, -0.12425]	[ 0.83333, 0.66667, 0.06212]	[2,9]	(1,1)	(1,1)	[-1,-1,0]
3	[-0.66667, -0.33333, -0.12425]	[ 0.33333, 0.16667, 0.06212]	[3,8]	(1,1)	(1,1)	[0,0,0]
4	[ 0.33333, -0.33333, 0.12425]	[ 0.83333, 0.16667, 0.93788]	[4,10]	(1,1)	(2,1)	[-1,0,-1]
5	[ 0.33333, 0.66667, 0.12425]	[ 0.83333, 0.66667, 0.93788]	[5,12]	(1,1)	(2,1)	[-1,-1,-1]
6	[-0.66667, -0.33333, 0.12425]	[ 0.33333, 0.16667, 0.93788]	[6,11]	(1,1)	(2,1)	[0,0,-1]

Table 11: 1-th 'S'-'S' [1] (#3) bond cluster (**6b@6n**), ND,  $|\mathbf{v}| = 3.1661$  (cartesian)

SL	vector ( $\mathbf{v}$ )	center ( $\mathbf{c}$ )	mapping	head	tail	$\mathbf{R}$ (primitive)
1	[ -1.00000, -1.00000, 0.00000 ]	[ 0.166667, 0.833333, 0.12425 ]	[1,-7]	(1,1)	(1,1)	[1,1,0]
2	[ 1.00000, 0.00000, 0.00000 ]	[ 0.166667, 0.333333, 0.12425 ]	[2,-9]	(1,1)	(1,1)	[-1,0,0]
3	[ 0.00000, 1.00000, 0.00000 ]	[ 0.666667, 0.833333, 0.12425 ]	[3,-8]	(1,1)	(1,1)	[0,-1,0]
4	[ -1.00000, -1.00000, 0.00000 ]	[ 0.166667, 0.833333, 0.87575 ]	[4,-10]	(2,1)	(2,1)	[1,1,0]
5	[ 1.00000, 0.00000, 0.00000 ]	[ 0.166667, 0.333333, 0.87575 ]	[5,-12]	(2,1)	(2,1)	[-1,0,0]
6	[ 0.00000, 1.00000, 0.00000 ]	[ 0.666667, 0.833333, 0.87575 ]	[6,-11]	(2,1)	(2,1)	[0,-1,0]