

PG No. 35  $C_{3v}(1)$   $3m$  (31m setting) [ trigonal ] (polar, internal axial quadrupole)

\* Harmonics for rank 0

\* Harmonics for rank 1

$$\bar{Q}_1^{(2,1)}[g](A_1)$$

\*\* symmetry

$$z$$

\*\* expression

$$\frac{\sqrt{30}G_vxy}{5} - \frac{\sqrt{30}G_{xy}(x-y)(x+y)}{10} + \frac{\sqrt{30}G_{xzyz}}{10} - \frac{\sqrt{30}G_{yzxz}}{10}$$

$$\bar{Q}_{1,1}^{(2,1)}[g](E), \bar{Q}_{1,2}^{(2,1)}[g](E)$$

\*\* symmetry

$$x$$

$$y$$

\*\* expression

$$-\frac{3\sqrt{10}G_uyz}{10} - \frac{\sqrt{30}G_vyz}{10} + \frac{\sqrt{30}G_{xyxz}}{10} - \frac{\sqrt{30}G_{xzyz}}{10} - \frac{\sqrt{30}G_{yz}(y-z)(y+z)}{10}$$

$$\frac{3\sqrt{10}G_uxz}{10} - \frac{\sqrt{30}G_vxz}{10} - \frac{\sqrt{30}G_{xyyz}}{10} + \frac{\sqrt{30}G_{xz}(x-z)(x+z)}{10} + \frac{\sqrt{30}G_{yzxy}}{10}$$

\* Harmonics for rank 2

$$\bar{Q}_2^{(2,-1)}[g](A_1)$$

\*\* symmetry

$$-\frac{x^2}{2} - \frac{y^2}{2} + z^2$$

\*\* expression

$$\frac{\sqrt{2}G_{xzy}}{2} - \frac{\sqrt{2}G_{yzx}}{2}$$

$$\bar{Q}_2^{(2,1)}[g](A_1)$$

\*\* symmetry

$$-\frac{x^2}{2} - \frac{y^2}{2} + z^2$$

\*\* expression

$$\frac{5\sqrt{42}G_vxyz}{14} - \frac{5\sqrt{42}G_{xy}z(x-y)(x+y)}{28} - \frac{\sqrt{42}G_{xzy}(x^2+y^2-4z^2)}{28} + \frac{\sqrt{42}G_{yzx}(x^2+y^2-4z^2)}{28}$$

$$\bar{Q}_{2,1}^{(2,-1)}[g](E, 1), \bar{Q}_{2,2}^{(2,-1)}[g](E, 1)$$

\*\* symmetry

$$\sqrt{3}xz$$

$$\sqrt{3}yz$$

\*\* expression

$$-\frac{\sqrt{2}G_u y}{2} + \frac{\sqrt{6}G_v y}{6} - \frac{\sqrt{6}G_{xy}x}{6} + \frac{\sqrt{6}G_{yz}z}{6}$$

$$\frac{\sqrt{2}G_u x}{2} + \frac{\sqrt{6}G_v x}{6} + \frac{\sqrt{6}G_{xy}y}{6} - \frac{\sqrt{6}G_{xz}z}{6}$$

$$\bar{Q}_{2,1}^{(2,-1)}[g](E, 2), \bar{Q}_{2,2}^{(2,-1)}[g](E, 2)$$

\*\* symmetry

$$\frac{\sqrt{3}(x-y)(x+y)}{2}$$

$$-\sqrt{3}xy$$

\*\* expression

$$\frac{\sqrt{6}G_{xy}z}{3} - \frac{\sqrt{6}G_{xzy}}{6} - \frac{\sqrt{6}G_{yzx}}{6}$$

$$\frac{\sqrt{6}G_v z}{3} - \frac{\sqrt{6}G_{xz}x}{6} + \frac{\sqrt{6}G_{yz}y}{6}$$

$$\bar{\mathbb{Q}}_{2,1}^{(2,1)}[g](E, 1), \bar{\mathbb{Q}}_{2,2}^{(2,1)}[g](E, 1)$$

\*\* symmetry

$$\sqrt{3}xz$$

$$\sqrt{3}yz$$

\*\* expression

$$\begin{aligned} & \frac{\sqrt{42}G_{ux}(x^2 + y^2 - 4z^2)}{28} + \frac{\sqrt{14}G_{vy}(9x^2 - y^2 - 6z^2)}{28} - \frac{\sqrt{14}G_{xyx}(2x^2 - 3y^2 - 3z^2)}{14} - \frac{\sqrt{14}G_{yzz}(3x^2 + 3y^2 - 2z^2)}{14} \\ & - \frac{\sqrt{42}G_{ux}(x^2 + y^2 - 4z^2)}{28} - \frac{\sqrt{14}G_{vx}(x^2 - 9y^2 + 6z^2)}{28} - \frac{\sqrt{14}G_{xyy}(3x^2 - 2y^2 + 3z^2)}{14} + \frac{\sqrt{14}G_{xzz}(3x^2 + 3y^2 - 2z^2)}{14} \end{aligned}$$

$$\bar{\mathbb{Q}}_{2,1}^{(2,1)}[g](E, 2), \bar{\mathbb{Q}}_{2,2}^{(2,1)}[g](E, 2)$$

\*\* symmetry

$$\frac{\sqrt{3}(x-y)(x+y)}{2}$$

$$-\sqrt{3}xy$$

\*\* expression

$$\begin{aligned} & -\frac{5\sqrt{42}G_{uxyz}}{14} + \frac{\sqrt{14}G_{xyx}(3x^2 + 3y^2 - 2z^2)}{28} - \frac{\sqrt{14}G_{xzy}(9x^2 - y^2 - 6z^2)}{28} + \frac{\sqrt{14}G_{yzz}(x^2 - 9y^2 + 6z^2)}{28} \\ & - \frac{5\sqrt{42}G_{uz}(x-y)(x+y)}{28} + \frac{\sqrt{14}G_{vz}(3x^2 + 3y^2 - 2z^2)}{28} - \frac{\sqrt{14}G_{xzx}(2x^2 - 3y^2 - 3z^2)}{14} - \frac{\sqrt{14}G_{yzy}(3x^2 - 2y^2 + 3z^2)}{14} \end{aligned}$$

\* Harmonics for rank 3

$$\bar{\mathbb{Q}}_3^{(2,-1)}[g](A_1, 1)$$

\*\* symmetry

$$-\frac{z(3x^2 + 3y^2 - 2z^2)}{2}$$

\*\* expression

$$-\frac{\sqrt{30}G_vxy}{10} + \frac{\sqrt{30}G_{xy}(x-y)(x+y)}{20} + \frac{\sqrt{30}G_{xzyz}}{5} - \frac{\sqrt{30}G_{yzzx}}{5}$$

$$\bar{\mathbb{Q}}_3^{(2,-1)}[g](A_1, 2)$$

\*\* symmetry

$$\frac{\sqrt{10}x(x^2 - 3y^2)}{4}$$

\*\* expression

$$\frac{\sqrt{3}G_vyz}{2} + \frac{\sqrt{3}G_{xyxz}}{2} - \frac{\sqrt{3}G_{xzyx}}{2} - \frac{\sqrt{3}G_{yzz}(x-y)(x+y)}{4}$$

$$\bar{\mathbb{Q}}_3^{(2,1)}[g](A_1, 1)$$

\*\* symmetry

$$-\frac{z(3x^2 + 3y^2 - 2z^2)}{2}$$

\*\* expression

$$-\frac{\sqrt{15}G_vxy(x^2 + y^2 - 6z^2)}{6} + \frac{\sqrt{15}G_{xy}(x-y)(x+y)(x^2 + y^2 - 6z^2)}{12} - \frac{\sqrt{15}G_{xzyz}(3x^2 + 3y^2 - 4z^2)}{12} + \frac{\sqrt{15}G_{yzzx}(3x^2 + 3y^2 - 4z^2)}{12}$$

$$\bar{\mathbb{Q}}_3^{(2,1)}[g](A_1, 2)$$

\*\* symmetry

$$\frac{\sqrt{10}x(x^2 - 3y^2)}{4}$$

\*\* expression

$$\begin{aligned} & -\frac{7\sqrt{2}G_{uxyz}(3x^2 - y^2)}{8} + \frac{\sqrt{6}G_vyz(3x^2 + 3y^2 - 4z^2)}{24} + \frac{\sqrt{6}G_{xyxz}(3x^2 + 3y^2 - 4z^2)}{24} \\ & - \frac{\sqrt{6}G_{xzyx}(17x^2 - 11y^2 - 18z^2)}{24} + \frac{\sqrt{6}G_{yzz}(2x^4 - 21x^2y^2 + 9x^2z^2 + 5y^4 - 9y^2z^2)}{24} \end{aligned}$$

$$\vec{Q}_3^{(2,-1)}[g](A_2)$$

\*\* symmetry

$$\frac{\sqrt{10}y(3x^2 - y^2)}{4}$$

\*\* expression

$$-\frac{\sqrt{3}G_vxz}{2} + \frac{\sqrt{3}G_{xy}yz}{2} + \frac{\sqrt{3}G_{xz}(x-y)(x+y)}{4} - \frac{\sqrt{3}G_{yz}xy}{2}$$

$$\vec{Q}_3^{(2,1)}[g](A_2)$$

\*\* symmetry

$$\frac{\sqrt{10}y(3x^2 - y^2)}{4}$$

\*\* expression

$$\frac{7\sqrt{2}G_uxz(x^2 - 3y^2)}{8} - \frac{\sqrt{6}G_vxz(3x^2 + 3y^2 - 4z^2)}{24} + \frac{\sqrt{6}G_{xy}yz(3x^2 + 3y^2 - 4z^2)}{24} + \frac{\sqrt{6}G_{xz}(5x^4 - 21x^2y^2 - 9x^2z^2 + 2y^4 + 9y^2z^2)}{24} + \frac{\sqrt{6}G_{yz}xy(11x^2 - 17y^2 + 18z^2)}{24}$$

$$\vec{Q}_{3,1}^{(2,-1)}[g](E, 1), \vec{Q}_{3,2}^{(2,-1)}[g](E, 1)$$

\*\* symmetry

$$-\frac{\sqrt{6}x(x^2 + y^2 - 4z^2)}{4}$$

$$-\frac{\sqrt{6}y(x^2 + y^2 - 4z^2)}{4}$$

\*\* expression

$$-\frac{\sqrt{15}G_uyz}{5} + \frac{3\sqrt{5}G_vyz}{10} - \frac{3\sqrt{5}G_{xy}xz}{10} + \frac{3\sqrt{5}G_{xz}xy}{10} - \frac{\sqrt{5}G_{yz}(5x^2 - y^2 - 4z^2)}{20}$$

$$\frac{\sqrt{15}G_uxz}{5} + \frac{3\sqrt{5}G_vxz}{10} + \frac{3\sqrt{5}G_{xy}yz}{10} - \frac{\sqrt{5}G_{xz}(x^2 - 5y^2 + 4z^2)}{20} - \frac{3\sqrt{5}G_{yz}xy}{10}$$

$$\vec{Q}_{3,1}^{(2,-1)}[g](E, 2), \vec{Q}_{3,2}^{(2,-1)}[g](E, 2)$$

\*\* symmetry

$$-\frac{\sqrt{15}z(x-y)(x+y)}{2}$$

$$\sqrt{15}xyz$$

\*\* expression

$$\frac{\sqrt{6}G_uxy}{2} + \frac{\sqrt{2}G_{xy}(x^2 + y^2 - 2z^2)}{4}$$

$$\frac{\sqrt{6}G_u(x-y)(x+y)}{4} + \frac{\sqrt{2}G_v(x^2 + y^2 - 2z^2)}{4}$$

$$\vec{Q}_{3,1}^{(2,1)}[g](E, 1), \vec{Q}_{3,2}^{(2,1)}[g](E, 1)$$

\*\* symmetry

$$-\frac{\sqrt{6}x(x^2 + y^2 - 4z^2)}{4}$$

$$-\frac{\sqrt{6}y(x^2 + y^2 - 4z^2)}{4}$$

\*\* expression

$$\frac{\sqrt{30}G_uyz(3x^2 + 3y^2 - 4z^2)}{24} + \frac{\sqrt{10}G_vyz(27x^2 - y^2 - 8z^2)}{24} - \frac{\sqrt{10}G_{xy}xz(13x^2 - 15y^2 - 8z^2)}{24} - \frac{\sqrt{10}G_{xz}xy(x^2 + y^2 - 6z^2)}{24} + \frac{\sqrt{10}G_{yz}(2x^4 + 3x^2y^2 - 15x^2z^2 + y^4 - 9y^2z^2 + 4z^4)}{24}$$

$$-\frac{\sqrt{30}G_uxz(3x^2 + 3y^2 - 4z^2)}{24} - \frac{\sqrt{10}G_vxz(x^2 - 27y^2 + 8z^2)}{24} - \frac{\sqrt{10}G_{xy}yz(15x^2 - 13y^2 + 8z^2)}{24} - \frac{\sqrt{10}G_{xz}(x^4 + 3x^2y^2 - 9x^2z^2 + 2y^4 - 15y^2z^2 + 4z^4)}{24} + \frac{\sqrt{10}G_{yz}xy(x^2 + y^2 - 6z^2)}{24}$$

$$\bar{Q}_{3,1}^{(2,1)}[g](E, 2), \bar{Q}_{3,2}^{(2,1)}[g](E, 2)$$

\*\* symmetry

$$-\frac{\sqrt{15}z(x-y)(x+y)}{2}$$

$$\sqrt{15}xyz$$

\*\* expression

$$-\frac{\sqrt{3}G_u xy(x^2+y^2-6z^2)}{3} - \frac{7G_v xy(x-y)(x+y)}{6} + \frac{G_{xy}(5x^4-18x^2y^2-12x^2z^2+5y^4-12y^2z^2+4z^4)}{12}$$

$$+ \frac{7G_{xz}yz(3x^2+y^2-2z^2)}{12} + \frac{7G_{yz}xz(x^2+3y^2-2z^2)}{12}$$

$$-\frac{\sqrt{3}G_u(x-y)(x+y)(x^2+y^2-6z^2)}{6} - \frac{G_v(x^4-12x^2y^2+6x^2z^2+y^4+6y^2z^2-2z^4)}{6}$$

$$-\frac{7G_{xy}xy(x-y)(x+y)}{6} + \frac{7G_{xz}xz(x-z)(x+z)}{6} - \frac{7G_{yz}yz(y-z)(y+z)}{6}$$

\* Harmonics for rank 4

$$\bar{Q}_4^{(2,-1)}[g](A_1, 1)$$

\*\* symmetry

$$\frac{3x^4}{8} + \frac{3x^2y^2}{4} - 3x^2z^2 + \frac{3y^4}{8} - 3y^2z^2 + z^4$$

\*\* expression

$$-\frac{\sqrt{105}G_vxyz}{7} + \frac{\sqrt{105}G_{xy}z(x-y)(x+y)}{14} - \frac{\sqrt{105}G_{xz}y(x^2+y^2-4z^2)}{28} + \frac{\sqrt{105}G_{yz}x(x^2+y^2-4z^2)}{28}$$

$$\bar{Q}_4^{(2,-1)}[g](A_1, 2)$$

\*\* symmetry

$$\frac{\sqrt{70}xz(x^2-3y^2)}{4}$$

\*\* expression

$$-\frac{3\sqrt{2}G_u y(3x^2-y^2)}{8} - \frac{\sqrt{6}G_v y(x^2+y^2-4z^2)}{8} - \frac{\sqrt{6}G_{xy}x(x^2+y^2-4z^2)}{8} - \frac{\sqrt{6}G_{xz}xyz}{4} - \frac{\sqrt{6}G_{yz}z(x-y)(x+y)}{8}$$

$$\bar{Q}_4^{(2,1)}[g](A_1, 1)$$

\*\* symmetry

$$\frac{3x^4}{8} + \frac{3x^2y^2}{4} - 3x^2z^2 + \frac{3y^4}{8} - 3y^2z^2 + z^4$$

\*\* expression

$$-\frac{7\sqrt{330}G_vxyz(x^2+y^2-2z^2)}{44} + \frac{7\sqrt{330}G_{xy}z(x-y)(x+y)(x^2+y^2-2z^2)}{88}$$

$$+ \frac{\sqrt{330}G_{xz}y(x^4+2x^2y^2-12x^2z^2+y^4-12y^2z^2+8z^4)}{88} - \frac{\sqrt{330}G_{yz}x(x^4+2x^2y^2-12x^2z^2+y^4-12y^2z^2+8z^4)}{88}$$

$$\bar{Q}_4^{(2,1)}[g](A_1, 2)$$

\*\* symmetry

$$\frac{\sqrt{70}xz(x^2-3y^2)}{4}$$

\*\* expression

$$\frac{3\sqrt{77}G_u y(3x^2-y^2)(x^2+y^2-8z^2)}{88} + \frac{\sqrt{231}G_v y(7x^4-16x^2y^2+6x^2z^2+y^4+6y^2z^2-4z^4)}{88}$$

$$-\frac{\sqrt{231}G_{xy}x(x^4-7x^2y^2-3x^2z^2+4y^4-3y^2z^2+2z^4)}{44} - \frac{\sqrt{231}G_{xz}xyz(11x^2-y^2-10z^2)}{44} - \frac{\sqrt{231}G_{yz}z(x^4+9x^2y^2-5x^2z^2-4y^4+5y^2z^2)}{44}$$

$$\bar{Q}_4^{(2,-1)}[g](A_2)$$

\*\* symmetry

$$\frac{\sqrt{70}yz(3x^2-y^2)}{4}$$

\*\* expression

$$\frac{3\sqrt{2}G_u x(x^2-3y^2)}{8} + \frac{\sqrt{6}G_v x(x^2+y^2-4z^2)}{8} - \frac{\sqrt{6}G_{xy}y(x^2+y^2-4z^2)}{8} + \frac{\sqrt{6}G_{xz}z(x-y)(x+y)}{8} - \frac{\sqrt{6}G_{yz}xyz}{4}$$

$$\bar{Q}_4^{(2,1)}[g](A_2)$$

\*\* symmetry

$$\frac{\sqrt{70}yz(3x^2 - y^2)}{4}$$

\*\* expression

$$\begin{aligned} & -\frac{3\sqrt{77}G_{ux}(x^2 - 3y^2)(x^2 + y^2 - 8z^2)}{88} - \frac{\sqrt{231}G_vx(x^4 - 16x^2y^2 + 6x^2z^2 + 7y^4 + 6y^2z^2 - 4z^4)}{88} \\ & - \frac{\sqrt{231}G_{xy}y(4x^4 - 7x^2y^2 - 3x^2z^2 + y^4 - 3y^2z^2 + 2z^4)}{44} + \frac{\sqrt{231}G_{xz}z(4x^4 - 9x^2y^2 - 5x^2z^2 - y^4 + 5y^2z^2)}{44} + \frac{\sqrt{231}G_{yz}xyz(x^2 - 11y^2 + 10z^2)}{44} \end{aligned}$$

$$\bar{Q}_{4,1}^{(2,-1)}[g](E, 1), \bar{Q}_{4,2}^{(2,-1)}[g](E, 1)$$

\*\* symmetry

$$-\frac{\sqrt{10}xz(3x^2 + 3y^2 - 4z^2)}{4}$$

$$-\frac{\sqrt{10}yz(3x^2 + 3y^2 - 4z^2)}{4}$$

\*\* expression

$$\begin{aligned} & \frac{3\sqrt{14}G_{uy}(x^2 + y^2 - 4z^2)}{56} - \frac{\sqrt{42}G_vy(5x^2 + y^2 - 8z^2)}{56} + \frac{\sqrt{42}G_{xy}x(3x^2 - y^2 - 8z^2)}{56} + \frac{\sqrt{42}G_{xz}xyz}{4} - \frac{\sqrt{42}G_{yz}z(13x^2 - y^2 - 4z^2)}{56} \\ & - \frac{3\sqrt{14}G_{ux}(x^2 + y^2 - 4z^2)}{56} - \frac{\sqrt{42}G_vx(x^2 + 5y^2 - 8z^2)}{56} + \frac{\sqrt{42}G_{xy}y(x^2 - 3y^2 + 8z^2)}{56} - \frac{\sqrt{42}G_{xz}z(x^2 - 13y^2 + 4z^2)}{56} - \frac{\sqrt{42}G_{yz}xyz}{4} \end{aligned}$$

$$\bar{Q}_{4,1}^{(2,-1)}[g](E, 2), \bar{Q}_{4,2}^{(2,-1)}[g](E, 2)$$

\*\* symmetry

$$\frac{\sqrt{35}(x^2 - 2xy - y^2)(x^2 + 2xy - y^2)}{8}$$

$$\frac{\sqrt{35}xy(x - y)(x + y)}{2}$$

\*\* expression

$$\begin{aligned} & \sqrt{3}G_vxyz + \frac{\sqrt{3}G_{xyz}(x - y)(x + y)}{2} - \frac{\sqrt{3}G_{xzy}(3x^2 - y^2)}{4} - \frac{\sqrt{3}G_{yz}x(x^2 - 3y^2)}{4} \\ & - \frac{\sqrt{3}G_vz(x - y)(x + y)}{2} + \sqrt{3}G_{xy}xyz + \frac{\sqrt{3}G_{xz}x(x^2 - 3y^2)}{4} - \frac{\sqrt{3}G_{yz}y(3x^2 - y^2)}{4} \end{aligned}$$

$$\bar{Q}_{4,1}^{(2,-1)}[g](E, 3), \bar{Q}_{4,2}^{(2,-1)}[g](E, 3)$$

\*\* symmetry

$$-\frac{\sqrt{5}(x - y)(x + y)(x^2 + y^2 - 6z^2)}{4}$$

$$\frac{\sqrt{5}xy(x^2 + y^2 - 6z^2)}{2}$$

\*\* expression

$$\begin{aligned} & -\frac{6\sqrt{7}G_{ux}yz}{7} - \frac{\sqrt{21}G_{xy}z(3x^2 + 3y^2 - 2z^2)}{14} + \frac{\sqrt{21}G_{xz}y(2x^2 - y^2 + z^2)}{14} - \frac{\sqrt{21}G_{yz}x(x^2 - 2y^2 - z^2)}{14} \\ & - \frac{3\sqrt{7}G_{uz}(x - y)(x + y)}{7} - \frac{\sqrt{21}G_vz(3x^2 + 3y^2 - 2z^2)}{14} + \frac{\sqrt{21}G_{xz}x(x^2 - 5y^2 + 2z^2)}{28} + \frac{\sqrt{21}G_{yz}y(5x^2 - y^2 - 2z^2)}{28} \end{aligned}$$

$$\bar{Q}_{4,1}^{(2,1)}[g](E, 1), \bar{Q}_{4,2}^{(2,1)}[g](E, 1)$$

\*\* symmetry

$$-\frac{\sqrt{10}xz(3x^2 + 3y^2 - 4z^2)}{4}$$

$$-\frac{\sqrt{10}yz(3x^2 + 3y^2 - 4z^2)}{4}$$

\*\* expression

$$\begin{aligned}
& - \frac{3\sqrt{11}G_{uy}(x^4 + 2x^2y^2 - 12x^2z^2 + y^4 - 12y^2z^2 + 8z^4)}{88} - \frac{\sqrt{33}G_{vy}(13x^4 + 12x^2y^2 - 114x^2z^2 - y^4 - 2y^2z^2 + 20z^4)}{88} \\
& + \frac{\sqrt{33}G_{xyx}(3x^4 - x^2y^2 - 29x^2z^2 - 4y^4 + 27y^2z^2 + 10z^4)}{44} - \frac{7\sqrt{33}G_{xzyz}(x^2 + y^2 - 2z^2)}{44} \\
& + \frac{\sqrt{33}G_{yzz}(11x^4 + 15x^2y^2 - 27x^2z^2 + 4y^4 - 13y^2z^2 + 4z^4)}{44} \\
& \frac{3\sqrt{11}G_{ux}(x^4 + 2x^2y^2 - 12x^2z^2 + y^4 - 12y^2z^2 + 8z^4)}{88} + \frac{\sqrt{33}G_{vx}(x^4 - 12x^2y^2 + 2x^2z^2 - 13y^4 + 114y^2z^2 - 20z^4)}{88} \\
& + \frac{\sqrt{33}G_{xyy}(4x^4 + x^2y^2 - 27x^2z^2 - 3y^4 + 29y^2z^2 - 10z^4)}{44} \\
& - \frac{\sqrt{33}G_{xzz}(4x^4 + 15x^2y^2 - 13x^2z^2 + 11y^4 - 27y^2z^2 + 4z^4)}{44} + \frac{7\sqrt{33}G_{yzyz}(x^2 + y^2 - 2z^2)}{44}
\end{aligned}$$

$$\vec{\mathbb{Q}}_{4,1}^{(2,1)}[g](E, 2), \vec{\mathbb{Q}}_{4,2}^{(2,1)}[g](E, 2)$$

\*\* symmetry

$$\frac{\sqrt{35}(x^2 - 2xy - y^2)(x^2 + 2xy - y^2)}{8}$$

$$\frac{\sqrt{35}xy(x-y)(x+y)}{2}$$

\*\* expression

$$\begin{aligned}
& - \frac{9\sqrt{154}G_{uxyz}(x-y)(x+y)}{22} + \frac{\sqrt{462}G_{vxyz}(x^2 + y^2 - 2z^2)}{44} + \frac{\sqrt{462}G_{xyyz}(x-y)(x+y)(x^2 + y^2 - 2z^2)}{88} \\
& - \frac{\sqrt{462}G_{xzyz}(9x^4 - 14x^2y^2 - 12x^2z^2 + y^4 + 4y^2z^2)}{88} + \frac{\sqrt{462}G_{yzyz}(x^4 - 14x^2y^2 + 4x^2z^2 + 9y^4 - 12y^2z^2)}{88} \\
& \frac{9\sqrt{154}G_{uz}(x^2 - 2xy - y^2)(x^2 + 2xy - y^2)}{88} - \frac{\sqrt{462}G_{vz}(x-y)(x+y)(x^2 + y^2 - 2z^2)}{88} + \frac{\sqrt{462}G_{xyxyz}(x^2 + y^2 - 2z^2)}{44} \\
& + \frac{\sqrt{462}G_{xzx}(x^4 - 8x^2y^2 - 2x^2z^2 + 3y^4 + 6y^2z^2)}{44} + \frac{\sqrt{462}G_{yzyz}(3x^4 - 8x^2y^2 + 6x^2z^2 + y^4 - 2y^2z^2)}{44}
\end{aligned}$$

$$\vec{\mathbb{Q}}_{4,1}^{(2,1)}[g](E, 3), \vec{\mathbb{Q}}_{4,2}^{(2,1)}[g](E, 3)$$

\*\* symmetry

$$- \frac{\sqrt{5}(x-y)(x+y)(x^2 + y^2 - 6z^2)}{4}$$

$$\frac{\sqrt{5}xy(x^2 + y^2 - 6z^2)}{2}$$

\*\* expression

$$\begin{aligned}
& \frac{21\sqrt{22}G_{uxyz}(x^2 + y^2 - 2z^2)}{44} + \frac{21\sqrt{66}G_{vxyz}(x-y)(x+y)}{44} - \frac{\sqrt{66}G_{xyyz}(9x^4 - 24x^2y^2 - 10x^2z^2 + 9y^4 - 10y^2z^2 + 2z^4)}{44} \\
& + \frac{\sqrt{66}G_{xzyz}(x^4 + 2x^2y^2 - 12x^2z^2 + y^4 - 12y^2z^2 + 8z^4)}{44} + \frac{\sqrt{66}G_{yzyz}(x^4 + 2x^2y^2 - 12x^2z^2 + y^4 - 12y^2z^2 + 8z^4)}{44} \\
& \frac{21\sqrt{22}G_{uz}(x-y)(x+y)(x^2 + y^2 - 2z^2)}{88} + \frac{\sqrt{66}G_{vz}(3x^4 - 78x^2y^2 + 20x^2z^2 + 3y^4 + 20y^2z^2 - 4z^4)}{88} + \frac{21\sqrt{66}G_{xyxyz}(x-y)(x+y)}{44} \\
& + \frac{\sqrt{66}G_{xzx}(x^4 + 2x^2y^2 - 12x^2z^2 + y^4 - 12y^2z^2 + 8z^4)}{44} - \frac{\sqrt{66}G_{yzyz}(x^4 + 2x^2y^2 - 12x^2z^2 + y^4 - 12y^2z^2 + 8z^4)}{44}
\end{aligned}$$