

PG No. 16 $C_3 \quad 3 \quad [\text{trigonal}]$ (axial, internal polar quadrupole)

* Harmonics for rank 0

* Harmonics for rank 1

$$\vec{G}_1^{(2,1)}[q](A)$$

** symmetry

$$z$$

** expression

$$\frac{\sqrt{30}Q_vxy}{5} - \frac{\sqrt{30}Q_{xy}(x-y)(x+y)}{10} + \frac{\sqrt{30}Q_{xz}yz}{10} - \frac{\sqrt{30}Q_{yz}xz}{10}$$

$$\vec{G}_{1,1}^{(2,1)}[q](E), \vec{G}_{1,2}^{(2,1)}[q](E)$$

** symmetry

$$x$$

$$y$$

** expression

$$-\frac{3\sqrt{10}Q_uyz}{10} - \frac{\sqrt{30}Q_vyz}{10} + \frac{\sqrt{30}Q_{xy}xz}{10} - \frac{\sqrt{30}Q_{xz}xy}{10} - \frac{\sqrt{30}Q_{yz}(y-z)(y+z)}{10}$$

$$\frac{3\sqrt{10}Q_uxz}{10} - \frac{\sqrt{30}Q_vxz}{10} - \frac{\sqrt{30}Q_{xy}yz}{10} + \frac{\sqrt{30}Q_{xz}(x-z)(x+z)}{10} + \frac{\sqrt{30}Q_{yz}xy}{10}$$

* Harmonics for rank 2

$$\vec{G}_2^{(2,-1)}[q](A)$$

** symmetry

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

** expression

$$\frac{\sqrt{2}Q_{xz}y}{2} - \frac{\sqrt{2}Q_{yz}x}{2}$$

$$\vec{G}_2^{(2,1)}[q](A)$$

** symmetry

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

** expression

$$\frac{5\sqrt{42}Q_vxyz}{14} - \frac{5\sqrt{42}Q_{xy}z(x-y)(x+y)}{28} - \frac{\sqrt{42}Q_{xz}y(x^2+y^2-4z^2)}{28} + \frac{\sqrt{42}Q_{yz}x(x^2+y^2-4z^2)}{28}$$

$$\vec{G}_{2,1}^{(2,-1)}[q](E,1), \vec{G}_{2,2}^{(2,-1)}[q](E,1)$$

** symmetry

$$\sqrt{3}yz$$

$$-\sqrt{3}xz$$

** expression

$$\frac{\sqrt{2}Q_u x}{2} + \frac{\sqrt{6}Q_v x}{6} + \frac{\sqrt{6}Q_{xy}y}{6} - \frac{\sqrt{6}Q_{xz}z}{6}$$

$$\frac{\sqrt{2}Q_u y}{2} - \frac{\sqrt{6}Q_v y}{6} + \frac{\sqrt{6}Q_{xy}x}{6} - \frac{\sqrt{6}Q_{yz}z}{6}$$

$$\vec{G}_{2,1}^{(2,-1)}[q](E,2), \vec{G}_{2,2}^{(2,-1)}[q](E,2)$$

** symmetry

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

$$-\sqrt{3}xy$$

** expression

$$\frac{\sqrt{6}Q_{xy}z}{3} - \frac{\sqrt{6}Q_{xz}y}{6} - \frac{\sqrt{6}Q_{yz}x}{6}$$

$$\frac{\sqrt{6}Q_v z}{3} - \frac{\sqrt{6}Q_{xz} x}{6} + \frac{\sqrt{6}Q_{yz} y}{6}$$

$$\vec{\mathbb{G}}_{2,1}^{(2,1)}[q](E, 1), \vec{\mathbb{G}}_{2,2}^{(2,1)}[q](E, 1)$$

** symmetry

$$\sqrt{3}yz$$

$$-\sqrt{3}xz$$

** expression

$$\begin{aligned} & -\frac{\sqrt{42}Q_u x (x^2 + y^2 - 4z^2)}{28} - \frac{\sqrt{14}Q_v x (x^2 - 9y^2 + 6z^2)}{28} - \frac{\sqrt{14}Q_{xy} y (3x^2 - 2y^2 + 3z^2)}{14} + \frac{\sqrt{14}Q_{xz} z (3x^2 + 3y^2 - 2z^2)}{14} \\ & -\frac{\sqrt{42}Q_u y (x^2 + y^2 - 4z^2)}{28} - \frac{\sqrt{14}Q_v y (9x^2 - y^2 - 6z^2)}{28} + \frac{\sqrt{14}Q_{xy} x (2x^2 - 3y^2 - 3z^2)}{14} + \frac{\sqrt{14}Q_{yz} z (3x^2 + 3y^2 - 2z^2)}{14} \end{aligned}$$

$$\vec{\mathbb{G}}_{2,1}^{(2,1)}[q](E, 2), \vec{\mathbb{G}}_{2,2}^{(2,1)}[q](E, 2)$$

** symmetry

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

$$-\sqrt{3}xy$$

** expression

$$\begin{aligned} & -\frac{5\sqrt{42}Q_u xyz}{14} + \frac{\sqrt{14}Q_{xy} z (3x^2 + 3y^2 - 2z^2)}{28} - \frac{\sqrt{14}Q_{xz} y (9x^2 - y^2 - 6z^2)}{28} + \frac{\sqrt{14}Q_{yz} x (x^2 - 9y^2 + 6z^2)}{28} \\ & -\frac{5\sqrt{42}Q_u z (x-y)(x+y)}{28} + \frac{\sqrt{14}Q_v z (3x^2 + 3y^2 - 2z^2)}{28} - \frac{\sqrt{14}Q_{xz} x (2x^2 - 3y^2 - 3z^2)}{14} - \frac{\sqrt{14}Q_{yz} y (3x^2 - 2y^2 + 3z^2)}{14} \end{aligned}$$

* Harmonics for rank 3

$$\vec{\mathbb{G}}_3^{(2,-1)}[q](A, 1)$$

** symmetry

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

** expression

$$-\frac{\sqrt{30}Q_v xy}{10} + \frac{\sqrt{30}Q_{xy} (x-y)(x+y)}{20} + \frac{\sqrt{30}Q_{xz} yz}{5} - \frac{\sqrt{30}Q_{yz} xz}{5}$$

$$\vec{\mathbb{G}}_3^{(2,-1)}[q](A, 2)$$

** symmetry

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

** expression

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

$$\vec{\mathbb{G}}_3^{(2,-1)}[q](A, 3)$$

** symmetry

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

** expression

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

$$\vec{\mathbb{G}}_3^{(2,1)}[q](A, 1)$$

** symmetry

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

** expression

$$-\frac{\sqrt{15}Q_v xy (x^2 + y^2 - 6z^2)}{6} + \frac{\sqrt{15}Q_{xy} (x-y)(x+y)(x^2 + y^2 - 6z^2)}{12} - \frac{\sqrt{15}Q_{xz} yz (3x^2 + 3y^2 - 4z^2)}{12} + \frac{\sqrt{15}Q_{yz} xz (3x^2 + 3y^2 - 4z^2)}{12}$$

$$\vec{\mathbb{G}}_3^{(2,1)}[q](A, 2)$$

** symmetry

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

** expression

$$\begin{aligned} & \frac{7\sqrt{2}Q_u xz(x^2 - 3y^2)}{8} - \frac{\sqrt{6}Q_v xz(3x^2 + 3y^2 - 4z^2)}{24} + \frac{\sqrt{6}Q_{xy}yz(3x^2 + 3y^2 - 4z^2)}{24} \\ & + \frac{\sqrt{6}Q_{xz}(5x^4 - 21x^2y^2 - 9x^2z^2 + 2y^4 + 9y^2z^2)}{24} + \frac{\sqrt{6}Q_{yz}xy(11x^2 - 17y^2 + 18z^2)}{24} \end{aligned}$$

$$\vec{\mathbb{G}}_3^{(2,1)}[q](A, 3)$$

** symmetry

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

** expression

$$\begin{aligned} & -\frac{7\sqrt{2}Q_u yz(3x^2 - y^2)}{8} + \frac{\sqrt{6}Q_v yz(3x^2 + 3y^2 - 4z^2)}{24} + \frac{\sqrt{6}Q_{xy}xz(3x^2 + 3y^2 - 4z^2)}{24} \\ & - \frac{\sqrt{6}Q_{xz}xy(17x^2 - 11y^2 - 18z^2)}{24} + \frac{\sqrt{6}Q_{yz}(2x^4 - 21x^2y^2 + 9x^2z^2 + 5y^4 - 9y^2z^2)}{24} \end{aligned}$$

$$\vec{\mathbb{G}}_{3,1}^{(2,-1)}[q](E, 1), \vec{\mathbb{G}}_{3,2}^{(2,-1)}[q](E, 1)$$

** symmetry

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

** expression

$$\begin{aligned} & -\frac{\sqrt{15}Q_u yz}{5} + \frac{3\sqrt{5}Q_v yz}{10} - \frac{3\sqrt{5}Q_{xy}xz}{10} + \frac{3\sqrt{5}Q_{xz}xy}{10} - \frac{\sqrt{5}Q_{yz}(5x^2 - y^2 - 4z^2)}{20} \\ & \frac{\sqrt{15}Q_u xz}{5} + \frac{3\sqrt{5}Q_v xz}{10} + \frac{3\sqrt{5}Q_{xy}yz}{10} - \frac{\sqrt{5}Q_{xz}(x^2 - 5y^2 + 4z^2)}{20} - \frac{3\sqrt{5}Q_{yz}xy}{10} \end{aligned}$$

$$\vec{\mathbb{G}}_{3,1}^{(2,-1)}[q](E, 2), \vec{\mathbb{G}}_{3,2}^{(2,-1)}[q](E, 2)$$

** symmetry

$$\begin{aligned} & \sqrt{15}xyz \\ & \frac{\sqrt{15}z(x-y)(x+y)}{2} \end{aligned}$$

** expression

$$\begin{aligned} & \frac{\sqrt{6}Q_u(x-y)(x+y)}{4} + \frac{\sqrt{2}Q_v(x^2 + y^2 - 2z^2)}{4} \\ & -\frac{\sqrt{6}Q_u xy}{2} - \frac{\sqrt{2}Q_{xy}(x^2 + y^2 - 2z^2)}{4} \end{aligned}$$

$$\vec{\mathbb{G}}_{3,1}^{(2,1)}[q](E, 1), \vec{\mathbb{G}}_{3,2}^{(2,1)}[q](E, 1)$$

** symmetry

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

** expression

$$\begin{aligned} & \frac{\sqrt{30}Q_u yz(3x^2 + 3y^2 - 4z^2)}{24} + \frac{\sqrt{10}Q_v yz(27x^2 - y^2 - 8z^2)}{24} - \frac{\sqrt{10}Q_{xy}xz(13x^2 - 15y^2 - 8z^2)}{24} \\ & - \frac{\sqrt{10}Q_{xz}xy(x^2 + y^2 - 6z^2)}{24} + \frac{\sqrt{10}Q_{yz}(2x^4 + 3x^2y^2 - 15x^2z^2 + y^4 - 9y^2z^2 + 4z^4)}{24} \end{aligned}$$

$$-\frac{\sqrt{30}Q_u xz(3x^2+3y^2-4z^2)}{24}-\frac{\sqrt{10}Q_v xz(x^2-27y^2+8z^2)}{24}-\frac{\sqrt{10}Q_{xy}yz(15x^2-13y^2+8z^2)}{24}$$

$$-\frac{\sqrt{10}Q_{xz}(x^4+3x^2y^2-9x^2z^2+2y^4-15y^2z^2+4z^4)}{24}+\frac{\sqrt{10}Q_{yz}xy(x^2+y^2-6z^2)}{24}$$

$$\vec{\mathbb{G}}_{3,1}^{(2,1)}[q](E,2), \vec{\mathbb{G}}_{3,2}^{(2,1)}[q](E,2)$$

** symmetry

$$\sqrt{15}xyz$$

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

** expression

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

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

$$\frac{\sqrt{3}Q_{uxy}(x^2+y^2-6z^2)}{3}+\frac{7Q_vxy(x-y)(x+y)}{6}-\frac{Q_{xy}(5x^4-18x^2y^2-12x^2z^2+5y^4-12y^2z^2+4z^4)}{12}$$

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

* Harmonics for rank 4

$$\vec{\mathbb{G}}_4^{(2,-1)}[q](A,1)$$

** symmetry

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

** expression

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

$$\vec{\mathbb{G}}_4^{(2,-1)}[q](A,2)$$

** symmetry

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

** expression

$$-\frac{3\sqrt{2}Q_u y(3x^2-y^2)}{8}-\frac{\sqrt{6}Q_v y(x^2+y^2-4z^2)}{8}-\frac{\sqrt{6}Q_{xy}y(x^2+y^2-4z^2)}{8}-\frac{\sqrt{6}Q_{xz}xyz}{4}-\frac{\sqrt{6}Q_{yz}z(x-y)(x+y)}{8}$$

$$\vec{\mathbb{G}}_4^{(2,-1)}[q](A,3)$$

** symmetry

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

** expression

$$\frac{3\sqrt{2}Q_u x(x^2-3y^2)}{8}+\frac{\sqrt{6}Q_v x(x^2+y^2-4z^2)}{8}-\frac{\sqrt{6}Q_{xy}y(x^2+y^2-4z^2)}{8}+\frac{\sqrt{6}Q_{xz}z(x-y)(x+y)}{8}-\frac{\sqrt{6}Q_{yz}xyz}{4}$$

$$\vec{\mathbb{G}}_4^{(2,1)}[q](A,1)$$

** symmetry

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

** expression

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

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

$$\vec{\mathbb{G}}_4^{(2,1)}[q](A,2)$$

** symmetry

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

** expression

$$\frac{3\sqrt{77}Q_{uy}(3x^2 - y^2)(x^2 + y^2 - 8z^2)}{88} + \frac{\sqrt{231}Q_{vy}(7x^4 - 16x^2y^2 + 6x^2z^2 + y^4 + 6y^2z^2 - 4z^4)}{88} \\ - \frac{\sqrt{231}Q_{xy}(x^4 - 7x^2y^2 - 3x^2z^2 + 4y^4 - 3y^2z^2 + 2z^4)}{44} - \frac{\sqrt{231}Q_{xz}xyz(11x^2 - y^2 - 10z^2)}{44} - \frac{\sqrt{231}Q_{yz}z(x^4 + 9x^2y^2 - 5x^2z^2 - 4y^4 + 5y^2z^2)}{44}$$

$\vec{\mathbb{G}}_4^{(2,1)}[q](A, 3)$

** symmetry

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

** expression

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

$\vec{\mathbb{G}}_{4,1}^{(2,-1)}[q](E, 1), \vec{\mathbb{G}}_{4,2}^{(2,-1)}[q](E, 1)$

** symmetry

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

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

** expression

$$-\frac{3\sqrt{14}Q_{ux}(x^2 + y^2 - 4z^2)}{56} - \frac{\sqrt{42}Q_{vx}(x^2 + 5y^2 - 8z^2)}{56} + \frac{\sqrt{42}Q_{xy}y(x^2 - 3y^2 + 8z^2)}{56} - \frac{\sqrt{42}Q_{xz}z(x^2 - 13y^2 + 4z^2)}{56} - \frac{\sqrt{42}Q_{yz}xyz}{4} \\ - \frac{3\sqrt{14}Q_{uy}(x^2 + y^2 - 4z^2)}{56} + \frac{\sqrt{42}Q_{vy}(5x^2 + y^2 - 8z^2)}{56} - \frac{\sqrt{42}Q_{xy}x(3x^2 - y^2 - 8z^2)}{56} - \frac{\sqrt{42}Q_{xz}xyz}{4} + \frac{\sqrt{42}Q_{yz}z(13x^2 - y^2 - 4z^2)}{56}$$

$\vec{\mathbb{G}}_{4,1}^{(2,-1)}[q](E, 2), \vec{\mathbb{G}}_{4,2}^{(2,-1)}[q](E, 2)$

** 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

$$\sqrt{3}Q_{vxyz} + \frac{\sqrt{3}Q_{xy}z(x - y)(x + y)}{2} - \frac{\sqrt{3}Q_{xz}y(3x^2 - y^2)}{4} - \frac{\sqrt{3}Q_{yz}x(x^2 - 3y^2)}{4} \\ - \frac{\sqrt{3}Q_vz(x - y)(x + y)}{2} + \sqrt{3}Q_{xy}xyz + \frac{\sqrt{3}Q_{xz}x(x^2 - 3y^2)}{4} - \frac{\sqrt{3}Q_{yz}y(3x^2 - y^2)}{4}$$

$\vec{\mathbb{G}}_{4,1}^{(2,-1)}[q](E, 3), \vec{\mathbb{G}}_{4,2}^{(2,-1)}[q](E, 3)$

** 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

$$-\frac{6\sqrt{7}Q_{uxyz}}{7} - \frac{\sqrt{21}Q_{xy}z(3x^2 + 3y^2 - 2z^2)}{14} + \frac{\sqrt{21}Q_{xz}y(2x^2 - y^2 + z^2)}{14} - \frac{\sqrt{21}Q_{yz}x(x^2 - 2y^2 - z^2)}{14} \\ - \frac{3\sqrt{7}Q_{uz}z(x - y)(x + y)}{7} - \frac{\sqrt{21}Q_vz(3x^2 + 3y^2 - 2z^2)}{14} + \frac{\sqrt{21}Q_{xz}x(x^2 - 5y^2 + 2z^2)}{28} + \frac{\sqrt{21}Q_{yz}y(5x^2 - y^2 - 2z^2)}{28}$$

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

** symmetry

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

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

** expression

$$\begin{aligned} & \frac{3\sqrt{11}Q_u x(x^4+2x^2y^2-12x^2z^2+y^4-12y^2z^2+8z^4)}{88} + \frac{\sqrt{33}Q_v x(x^4-12x^2y^2+2x^2z^2-13y^4+114y^2z^2-20z^4)}{88} \\ & + \frac{\sqrt{33}Q_{xy}y(4x^4+x^2y^2-27x^2z^2-3y^4+29y^2z^2-10z^4)}{44} \\ & - \frac{\sqrt{33}Q_{xz}z(4x^4+15x^2y^2-13x^2z^2+11y^4-27y^2z^2+4z^4)}{44} + \frac{7\sqrt{33}Q_{yz}xyz(x^2+y^2-2z^2)}{44} \\ & \frac{3\sqrt{11}Q_u y(x^4+2x^2y^2-12x^2z^2+y^4-12y^2z^2+8z^4)}{88} + \frac{\sqrt{33}Q_v y(13x^4+12x^2y^2-114x^2z^2-y^4-2y^2z^2+20z^4)}{88} \\ & - \frac{\sqrt{33}Q_{xy}x(3x^4-x^2y^2-29x^2z^2-4y^4+27y^2z^2+10z^4)}{44} + \frac{7\sqrt{33}Q_{xz}xyz(x^2+y^2-2z^2)}{44} \\ & - \frac{\sqrt{33}Q_{yz}z(11x^4+15x^2y^2-27x^2z^2+4y^4-13y^2z^2+4z^4)}{44} \end{aligned}$$

$$\tilde{\mathbb{G}}_{4,1}^{(2,1)}[q](E,2), \tilde{\mathbb{G}}_{4,2}^{(2,1)}[q](E,2)$$

** 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

$$\begin{aligned} & -\frac{9\sqrt{154}Q_u xyz(x-y)(x+y)}{22} + \frac{\sqrt{462}Q_v xyz(x^2+y^2-2z^2)}{44} + \frac{\sqrt{462}Q_{xy}z(x-y)(x+y)(x^2+y^2-2z^2)}{88} \\ & - \frac{\sqrt{462}Q_{xz}y(9x^4-14x^2y^2-12x^2z^2+y^4+4y^2z^2)}{88} + \frac{\sqrt{462}Q_{yz}x(x^4-14x^2y^2+4x^2z^2+9y^4-12y^2z^2)}{88} \\ & \frac{9\sqrt{154}Q_u z(x^2-2xy-y^2)(x^2+2xy-y^2)}{88} - \frac{\sqrt{462}Q_v z(x-y)(x+y)(x^2+y^2-2z^2)}{88} + \frac{\sqrt{462}Q_{xy}xyz(x^2+y^2-2z^2)}{44} \\ & + \frac{\sqrt{462}Q_{xz}x(x^4-8x^2y^2-2x^2z^2+3y^4+6y^2z^2)}{44} + \frac{\sqrt{462}Q_{yz}y(3x^4-8x^2y^2+6x^2z^2+y^4-2y^2z^2)}{44} \end{aligned}$$

$$\tilde{\mathbb{G}}_{4,1}^{(2,1)}[q](E,3), \tilde{\mathbb{G}}_{4,2}^{(2,1)}[q](E,3)$$

** 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

$$\begin{aligned} & \frac{21\sqrt{22}Q_u xyz(x^2+y^2-2z^2)}{44} + \frac{21\sqrt{66}Q_v xyz(x-y)(x+y)}{44} - \frac{\sqrt{66}Q_{xy}z(9x^4-24x^2y^2-10x^2z^2+9y^4-10y^2z^2+2z^4)}{44} \\ & + \frac{\sqrt{66}Q_{xz}y(x^4+2x^2y^2-12x^2z^2+y^4-12y^2z^2+8z^4)}{44} + \frac{\sqrt{66}Q_{yz}x(x^4+2x^2y^2-12x^2z^2+y^4-12y^2z^2+8z^4)}{44} \\ & \frac{21\sqrt{22}Q_u z(x-y)(x+y)(x^2+y^2-2z^2)}{88} + \frac{\sqrt{66}Q_v z(3x^4-78x^2y^2+20x^2z^2+3y^4+20y^2z^2-4z^4)}{88} + \frac{21\sqrt{66}Q_{xy}xyz(x-y)(x+y)}{44} \\ & + \frac{\sqrt{66}Q_{xz}x(x^4+2x^2y^2-12x^2z^2+y^4-12y^2z^2+8z^4)}{44} - \frac{\sqrt{66}Q_{yz}y(x^4+2x^2y^2-12x^2z^2+y^4-12y^2z^2+8z^4)}{44} \end{aligned}$$