

PG No. 27 D_{6h} 6/mmm [hexagonal] (polar, internal axial quadrupole)

* Harmonics for rank 0

* Harmonics for rank 1

$$\vec{\mathbb{Q}}_1^{(2,1)}[g](A_{2u})$$

** symmetry

z

** expression

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

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

** symmetry

x

y

** expression

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

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

* Harmonics for rank 2

$$\vec{\mathbb{Q}}_2^{(2,-1)}[g](A_{1g})$$

** symmetry

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

** expression

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

$$\vec{\mathbb{Q}}_2^{(2,1)}[g](A_{1g})$$

** symmetry

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

** expression

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

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

** symmetry

$\sqrt{3}yz$

$-\sqrt{3}xz$

** expression

$$\frac{\sqrt{2}G_ux}{2} + \frac{\sqrt{6}G_vx}{6} + \frac{\sqrt{6}G_{xy}y}{6} - \frac{\sqrt{6}G_{xz}z}{6}$$

$$\frac{\sqrt{2}G_uy}{2} - \frac{\sqrt{6}G_vy}{6} + \frac{\sqrt{6}G_{xy}x}{6} - \frac{\sqrt{6}G_{yz}z}{6}$$

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

** symmetry

$\sqrt{3}yz$

$-\sqrt{3}xz$

** expression

$$-\frac{\sqrt{42}G_ux(x^2+y^2-4z^2)}{28} - \frac{\sqrt{14}G_vx(x^2-9y^2+6z^2)}{28} - \frac{\sqrt{14}G_{xy}y(3x^2-2y^2+3z^2)}{14} + \frac{\sqrt{14}G_{xz}z(3x^2+3y^2-2z^2)}{14}$$

$$-\frac{\sqrt{42}G_{uy}\left(x^2+y^2-4z^2\right)}{28}-\frac{\sqrt{14}G_{vy}\left(9x^2-y^2-6z^2\right)}{28}+\frac{\sqrt{14}G_{xy}x\left(2x^2-3y^2-3z^2\right)}{14}+\frac{\sqrt{14}G_{yz}z\left(3x^2+3y^2-2z^2\right)}{14}$$

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

** symmetry

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

$$-\sqrt{3}xy$$

** expression

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

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

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

** symmetry

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

$$-\sqrt{3}xy$$

** expression

$$-\frac{5\sqrt{42}G_uxyz}{14}+\frac{\sqrt{14}G_{xy}z\left(3x^2+3y^2-2z^2\right)}{28}-\frac{\sqrt{14}G_{xz}y\left(9x^2-y^2-6z^2\right)}{28}+\frac{\sqrt{14}G_{yz}x\left(x^2-9y^2+6z^2\right)}{28}$$

$$-\frac{5\sqrt{42}G_uz(x-y)(x+y)}{28}+\frac{\sqrt{14}G_vz\left(3x^2+3y^2-2z^2\right)}{28}-\frac{\sqrt{14}G_{xz}x\left(2x^2-3y^2-3z^2\right)}{14}-\frac{\sqrt{14}G_{yz}y\left(3x^2-2y^2+3z^2\right)}{14}$$

* Harmonics for rank 3

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

** symmetry

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

** expression

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

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

** symmetry

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

** expression

$$-\frac{\sqrt{15}G_vxy\left(x^2+y^2-6z^2\right)}{6}+\frac{\sqrt{15}G_{xy}(x-y)(x+y)\left(x^2+y^2-6z^2\right)}{12}-\frac{\sqrt{15}G_{xz}yz\left(3x^2+3y^2-4z^2\right)}{12}+\frac{\sqrt{15}G_{yz}xz\left(3x^2+3y^2-4z^2\right)}{12}$$

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

** symmetry

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

** expression

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

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

** symmetry

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

** expression

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

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

** symmetry

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

** expression

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

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

** symmetry

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

** expression

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

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

** symmetry

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

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

** expression

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

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

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

** symmetry

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

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

** expression

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

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

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

** symmetry

$$\sqrt{15}xyz$$

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

** expression

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

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

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

** symmetry

$$\sqrt{15}xyz$$

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

** expression

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

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

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

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

* Harmonics for rank 4

$$\vec{\mathbb{Q}}_4^{(2,-1)}[g](A_{1g})$$

** symmetry

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

** expression

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

$$\vec{\mathbb{Q}}_4^{(2,1)}[g](A_{1g})$$

** symmetry

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

** expression

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

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

$$\vec{\mathbb{Q}}_4^{(2,-1)}[g](B_{1g})$$

** symmetry

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

** expression

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

$$\vec{\mathbb{Q}}_4^{(2,1)}[g](B_{1g})$$

** symmetry

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

** expression

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

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

$$\vec{\mathbb{Q}}_4^{(2,-1)}[g](B_{2g})$$

** symmetry

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

** expression

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

$\vec{\mathbb{Q}}_4^{(2,1)}[g](B_{2g})$
** symmetry

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

** expression

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

$\vec{\mathbb{Q}}_{4,1}^{(2,-1)}[g](E_{1g}), \vec{\mathbb{Q}}_{4,2}^{(2,-1)}[g](E_{1g})$
** symmetry

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

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

** expression

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

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

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

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

** expression

$$3\sqrt{11}G_{ux}(x^4 + 2x^2y^2 - 12x^2z^2 + y^4 - 12y^2z^2 + 8z^4) + \frac{\sqrt{33}G_vx(x^4 - 12x^2y^2 + 2x^2z^2 - 13y^4 + 114y^2z^2 - 20z^4)}{88} \\ + \frac{\sqrt{33}G_{xy}y(4x^4 + x^2y^2 - 27x^2z^2 - 3y^4 + 29y^2z^2 - 10z^4)}{44} \\ - \frac{\sqrt{33}G_{xz}z(4x^4 + 15x^2y^2 - 13x^2z^2 + 11y^4 - 27y^2z^2 + 4z^4)}{44} + \frac{7\sqrt{33}G_{yz}xyz(x^2 + y^2 - 2z^2)}{44}$$

$$3\sqrt{11}G_{uy}(x^4 + 2x^2y^2 - 12x^2z^2 + y^4 - 12y^2z^2 + 8z^4) + \frac{\sqrt{33}G_vy(13x^4 + 12x^2y^2 - 114x^2z^2 - y^4 - 2y^2z^2 + 20z^4)}{88} \\ - \frac{\sqrt{33}G_{xy}x(3x^4 - x^2y^2 - 29x^2z^2 - 4y^4 + 27y^2z^2 + 10z^4)}{44} + \frac{7\sqrt{33}G_{xz}xyz(x^2 + y^2 - 2z^2)}{44} \\ - \frac{\sqrt{33}G_{yz}z(11x^4 + 15x^2y^2 - 27x^2z^2 + 4y^4 - 13y^2z^2 + 4z^4)}{44}$$

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

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

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

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

** 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

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

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

** 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

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

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

** 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

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