# PSALTer results panel

$$\mathcal{S} == \iiiint \left( \frac{1}{6} \left( 2 \left( t_1 - 2 t_3 \right) \mathcal{A}^{\alpha\prime}{}_{\alpha} \mathcal{A}_{\prime}{}^{\theta}{}_{\theta} + 6 \mathcal{A}^{\alpha\beta\chi} \sigma_{\alpha\beta\chi} + 6 f^{\alpha\beta} \tau (\Delta+\mathcal{K})_{\alpha\beta} - 4 t_1 \mathcal{A}_{\alpha}{}^{\theta}{}_{\theta} \partial_\prime f^{\alpha\prime} + 8 t_3 \mathcal{A}_{\alpha}{}^{\theta}{}_{\theta} \partial_\prime f^{\alpha\prime} + 4 t_1 \mathcal{A}_{\prime}{}^{\theta}{}_{\theta} \partial^\prime f^{\alpha}{}_{\alpha} - 8 t_3 \mathcal{A}_{\prime}{}^{\theta}{}_{\theta} \partial^\prime f^{\alpha}{}_{\alpha} - 2 t_1 \partial_\prime f^{\theta}{}_{\theta} \partial^\prime f^{\alpha}{}_{\alpha} + 4 t_3 \partial_\prime f^{\theta}{}_{\theta} \partial^\prime f^{\alpha}{}_{\alpha} - 2 t_1 \partial_\prime f^{\alpha\prime} \partial_\theta f_{\alpha}{}^{\theta} + 4 t_3 \partial_\prime f^{\alpha\prime} \partial_\theta f_{\alpha}{}^{\theta} + 4 t_1 \partial^\prime f^{\alpha}{}_{\alpha} \partial_\theta f_{\prime}{}^{\theta} - 8 t_3 \partial^\prime f^{\alpha}{}_{\alpha} \partial_\theta f_{\prime}{}^{\theta} + 8 r_2 \partial_\beta \mathcal{A}_{\alpha\prime\theta} \partial^\theta \mathcal{A}^{\alpha\beta\prime} - 4 r_2 \partial_\beta \mathcal{A}_{\alpha\theta\prime} \partial^\theta \mathcal{A}^{\alpha\beta\prime} + 4 r_2 \partial_\beta \mathcal{A}_{\prime\theta\alpha} \partial^\theta \mathcal{A}^{\alpha\beta\prime} - 2 r_2 \partial_\prime \mathcal{A}_{\alpha\beta\theta} \partial^\theta \mathcal{A}^{\alpha\beta\prime} + 2 r_2 \partial_\theta \mathcal{A}_{\alpha\beta\prime} \partial^\theta \mathcal{A}^{\alpha\beta\prime} - 4 r_2 \partial_\theta \mathcal{A}_{\alpha\prime\beta} \partial^\theta \mathcal{A}^{\alpha\beta\prime} + 6 r_5 \partial_\prime \mathcal{A}_{\theta}{}^{\kappa}{}_{\kappa} \partial^\theta \mathcal{A}^{\alpha\prime}{}_{\alpha} - 6 r_5 \partial_\theta \mathcal{A}_{\prime}{}^{\kappa}{}_{\kappa} \partial^\theta \mathcal{A}^{\alpha\prime}{}_{\alpha} - 6 t_1 \partial_\alpha f_{\prime\theta} \partial^\theta f^{\alpha\prime} - 3 t_1 \partial_\alpha f_{\theta\prime} \partial^\theta f^{\alpha\prime} + 3 t_1 \partial_\prime f_{\alpha\theta} \partial^\theta f^{\alpha\prime} + 3 t_1 \partial_\theta f_{\alpha\prime} \partial^\theta f^{\alpha\prime} + 3 t_1 \partial_\theta f_{\prime\alpha} \partial^\theta f^{\alpha\prime} + 6 t_1 \mathcal{A}_{\alpha\theta\prime} \left( \mathcal{A}^{\alpha\prime\theta} + 2 \partial^\theta f^{\alpha\prime} \right) - 6 r_5 \partial_\alpha \mathcal{A}^{\alpha\prime\theta} \partial_\kappa \mathcal{A}_{\prime}{}^{\kappa}{}_{\theta} + 12 r_5 \partial^\theta \mathcal{A}^{\alpha\prime}{}_{\alpha} \partial_\kappa \mathcal{A}_{\prime}{}^{\kappa}{}_{\theta} + 6 r_5 \partial_\alpha \mathcal{A}^{\alpha\prime\theta} \partial_\kappa \mathcal{A}_{\theta}{}^{\kappa}{}_{\prime} - 12 r_5 \partial^\theta \mathcal{A}^{\alpha\prime}{}_{\alpha} \partial_\kappa \mathcal{A}_{\theta}{}^{\kappa}{}_{\prime} \right) \right) [t, x, y, z] \, dz \, dy \, dx \, dt$$

# Wave operator

| | $\overset{0^+}{\cdot}\mathcal{A}^{\parallel}$ | $\overset{0^+}{\cdot}f^{\parallel}$ | $\overset{0^+}{\cdot}f^{\perp}$ | $\overset{0^-}{\cdot}\mathcal{A}^{\parallel}$ |
|---|---|---|---|---|
| $\overset{0^+}{\cdot}\mathcal{A}^{\parallel}\dagger$ | $t_3$ | $-i\sqrt{2}\,k\,t_3$ | $0$ | $0$ |
| $\overset{0^+}{\cdot}f^{\parallel}\dagger$ | $i\sqrt{2}\,k\,t_3$ | $2k^2 t_3$ | $0$ | $0$ |
| $\overset{0^+}{\cdot}f^{\perp}\dagger$ | $0$ | $0$ | $0$ | $0$ |
| $\overset{0^-}{\cdot}\mathcal{A}^{\parallel}\dagger$ | $0$ | $0$ | $0$ | $k^2 r_2 - t_1$ |

| | $\overset{1^+}{\cdot}\mathcal{A}^{\parallel}{}_{\alpha\beta}$ | $\overset{1^+}{\cdot}\mathcal{A}^{\perp}{}_{\alpha\beta}$ | $\overset{1^+}{\cdot}f^{\parallel}{}_{\alpha\beta}$ | $\overset{1^-}{\cdot}\mathcal{A}^{\parallel}{}_{\alpha}$ | $\overset{1^-}{\cdot}\mathcal{A}^{\perp}{}_{\alpha}$ | $\overset{1^-}{\cdot}f^{\parallel}{}_{\alpha}$ | $\overset{1^-}{\cdot}f^{\perp}{}_{\alpha}$ |
|---|---|---|---|---|---|---|---|
| $\overset{1^+}{\cdot}\mathcal{A}^{\parallel}\dagger^{\alpha\beta}$ | $k^2 r_5 - \frac{t_1}{2}$ | $-\frac{t_1}{\sqrt{2}}$ | $-\frac{ikt_1}{\sqrt{2}}$ | $0$ | $0$ | $0$ | $0$ |
| $\overset{1^+}{\cdot}\mathcal{A}^{\perp}\dagger^{\alpha\beta}$ | $-\frac{t_1}{\sqrt{2}}$ | $0$ | $0$ | $0$ | $0$ | $0$ | $0$ |
| $\overset{1^+}{\cdot}f^{\parallel}\dagger^{\alpha\beta}$ | $\frac{ikt_1}{\sqrt{2}}$ | $0$ | $0$ | $0$ | $0$ | $0$ | $0$ |
| $\overset{1^-}{\cdot}\mathcal{A}^{\parallel}\dagger^{\alpha}$ | $0$ | $0$ | $0$ | $\frac{1}{6}\left(6k^2 r_5 + t_1 + 4t_3\right)$ | $\frac{t_1 - 2t_3}{3\sqrt{2}}$ | $0$ | $\frac{1}{3}ik\left(t_1 - 2t_3\right)$ |
| $\overset{1^-}{\cdot}\mathcal{A}^{\perp}\dagger^{\alpha}$ | $0$ | $0$ | $0$ | $\frac{t_1 - 2t_3}{3\sqrt{2}}$ | $\frac{t_1 + t_3}{3}$ | $0$ | $\frac{1}{3}i\sqrt{2}\,k\left(t_1 + t_3\right)$ |
| $\overset{1^-}{\cdot}f^{\parallel}\dagger^{\alpha}$ | $0$ | $0$ | $0$ | $0$ | $0$ | $0$ | $0$ |
| $\overset{1^-}{\cdot}f^{\perp}\dagger^{\alpha}$ | $0$ | $0$ | $0$ | $-\frac{1}{3}ik\left(t_1 - 2t_3\right)$ | $-\frac{1}{3}i\sqrt{2}\,k\left(t_1 + t_3\right)$ | $0$ | $\frac{2}{3}k^2\left(t_1 + t_3\right)$ |

| | $\overset{2^+}{\cdot}\mathcal{A}^{\parallel}{}_{\alpha\beta}$ | $\overset{2^+}{\cdot}f^{\parallel}{}_{\alpha\beta}$ | $\overset{2^-}{\cdot}\mathcal{A}^{\parallel}{}_{\alpha\beta\chi}$ |
|---|---|---|---|
| $\overset{2^+}{\cdot}\mathcal{A}^{\parallel}\dagger^{\alpha\beta}$ | $\frac{t_1}{2}$ | $-\frac{ikt_1}{\sqrt{2}}$ | $0$ |
| $\overset{2^+}{\cdot}f^{\parallel}\dagger^{\alpha\beta}$ | $\frac{ikt_1}{\sqrt{2}}$ | $k^2 t_1$ | $0$ |
| $\overset{2^-}{\cdot}\mathcal{A}^{\parallel}\dagger^{\alpha\beta\chi}$ | $0$ | $0$ | $\frac{t_1}{2}$ |

# Saturated propagator

| | $\overset{0^+}{\cdot}\sigma^{\parallel}$ | $\overset{0^+}{\cdot}\tau^{\parallel}$ | $\overset{0^+}{\cdot}\tau^{\perp}$ | $\overset{0^-}{\cdot}\sigma^{\parallel}$ |
|---|---|---|---|---|
| $\overset{0^+}{\cdot}\sigma^{\parallel}\dagger$ | $\frac{1}{\left(1+2k^2\right)^2 t_3}$ | $-\frac{i\sqrt{2}\,k}{\left(1+2k^2\right)^2 t_3}$ | $0$ | $0$ |
| $\overset{0^+}{\cdot}\tau^{\parallel}\dagger$ | $\frac{i\sqrt{2}\,k}{\left(1+2k^2\right)^2 t_3}$ | $\frac{2k^2}{\left(1+2k^2\right)^2 t_3}$ | $0$ | $0$ |
| $\overset{0^+}{\cdot}\tau^{\perp}\dagger$ | $0$ | $0$ | $0$ | $0$ |
| $\overset{0^-}{\cdot}\sigma^{\parallel}\dagger$ | $0$ | $0$ | $0$ | $\frac{1}{k^2 r_2 - t_1}$ |

| | $\overset{1^+}{\cdot}\sigma^{\parallel}{}_{\alpha\beta}$ | $\overset{1^+}{\cdot}\sigma^{\perp}{}_{\alpha\beta}$ | $\overset{1^+}{\cdot}\tau^{\parallel}{}_{\alpha\beta}$ | $\overset{1^-}{\cdot}\sigma^{\parallel}{}_{\alpha}$ | $\overset{1^-}{\cdot}\sigma^{\perp}{}_{\alpha}$ | $\overset{1^-}{\cdot}\tau^{\parallel}{}_{\alpha}$ | $\overset{1^-}{\cdot}\tau^{\perp}{}_{\alpha}$ |
|---|---|---|---|---|---|---|---|
| $\overset{1^+}{\cdot}\sigma^{\parallel}\dagger^{\alpha\beta}$ | $0$ | $-\frac{\sqrt{2}}{t_1 + k^2 t_1}$ | $-\frac{i\sqrt{2}\,k}{t_1 + k^2 t_1}$ | $0$ | $0$ | $0$ | $0$ |
| $\overset{1^+}{\cdot}\sigma^{\perp}\dagger^{\alpha\beta}$ | $-\frac{\sqrt{2}}{t_1 + k^2 t_1}$ | $\frac{-2k^2 r_5 + t_1}{\left(1+k^2\right)^2 t_1^2}$ | $-\frac{i\left(2k^3 r_5 - k t_1\right)}{\left(1+k^2\right)^2 t_1^2}$ | $0$ | $0$ | $0$ | $0$ |
| $\overset{1^+}{\cdot}\tau^{\parallel}\dagger^{\alpha\beta}$ | $\frac{i\sqrt{2}\,k}{t_1 + k^2 t_1}$ | $\frac{i\left(2k^3 r_5 - k t_1\right)}{\left(1+k^2\right)^2 t_1^2}$ | $\frac{-2k^4 r_5 + k^2 t_1}{\left(1+k^2\right)^2 t_1^2}$ | $0$ | $0$ | $0$ | $0$ |
| $\overset{1^-}{\cdot}\sigma^{\parallel}\dagger^{\alpha}$ | $0$ | $0$ | $0$ | $\frac{2\left(t_1 + t_3\right)}{3t_1 t_3 + 2k^2 r_5\left(t_1 + t_3\right)}$ | $-\frac{\sqrt{2}\left(t_1 - 2t_3\right)}{\left(1+2k^2\right)\left(3t_1 t_3 + 2k^2 r_5\left(t_1 + t_3\right)\right)}$ | $0$ | $-\frac{2ik\left(t_1 - 2t_3\right)}{\left(1+2k^2\right)\left(3t_1 t_3 + 2k^2 r_5\left(t_1 + t_3\right)\right)}$ |
| $\overset{1^-}{\cdot}\sigma^{\perp}\dagger^{\alpha}$ | $0$ | $0$ | $0$ | $-\frac{\sqrt{2}\left(t_1 - 2t_3\right)}{\left(1+2k^2\right)\left(3t_1 t_3 + 2k^2 r_5\left(t_1 + t_3\right)\right)}$ | $\frac{6k^2 r_5 + t_1 + 4t_3}{\left(1+2k^2\right)^2\left(3t_1 t_3 + 2k^2 r_5\left(t_1 + t_3\right)\right)}$ | $0$ | $\frac{i\sqrt{2}\,k\left(6k^2 r_5 + t_1 + 4t_3\right)}{\left(1+2k^2\right)^2\left(3t_1 t_3 + 2k^2 r_5\left(t_1 + t_3\right)\right)}$ |
| $\overset{1^-}{\cdot}\tau^{\parallel}\dagger^{\alpha}$ | $0$ | $0$ | $0$ | $0$ | $0$ | $0$ | $0$ |
| $\overset{1^-}{\cdot}\tau^{\perp}\dagger^{\alpha}$ | $0$ | $0$ | $0$ | $\frac{2ik\left(t_1 - 2t_3\right)}{\left(1+2k^2\right)\left(3t_1 t_3 + 2k^2 r_5\left(t_1 + t_3\right)\right)}$ | $-\frac{i\sqrt{2}\,k\left(6k^2 r_5 + t_1 + 4t_3\right)}{\left(1+2k^2\right)^2\left(3t_1 t_3 + 2k^2 r_5\left(t_1 + t_3\right)\right)}$ | $0$ | $\frac{2k^2\left(6k^2 r_5 + t_1 + 4t_3\right)}{\left(1+2k^2\right)^2\left(3t_1 t_3 + 2k^2 r_5\left(t_1 + t_3\right)\right)}$ |

| | $\overset{2^+}{\cdot}\sigma^{\parallel}{}_{\alpha\beta}$ | $\overset{2^+}{\cdot}\tau^{\parallel}{}_{\alpha\beta}$ | $\overset{2^-}{\cdot}\sigma^{\parallel}{}_{\alpha\beta\chi}$ |
|---|---|---|---|
| $\overset{2^+}{\cdot}\sigma^{\parallel}\dagger^{\alpha\beta}$ | $\frac{2}{\left(1+2k^2\right)^2 t_1}$ | $-\frac{2i\sqrt{2}\,k}{\left(1+2k^2\right)^2 t_1}$ | $0$ |
| $\overset{2^+}{\cdot}\tau^{\parallel}\dagger^{\alpha\beta}$ | $\frac{2i\sqrt{2}\,k}{\left(1+2k^2\right)^2 t_1}$ | $\frac{4k^2}{\left(1+2k^2\right)^2 t_1}$ | $0$ |
| $\overset{2^-}{\cdot}\sigma^{\parallel}\dagger^{\alpha\beta\chi}$ | $0$ | $0$ | $\frac{2}{t_1}$ |

# Source constraints

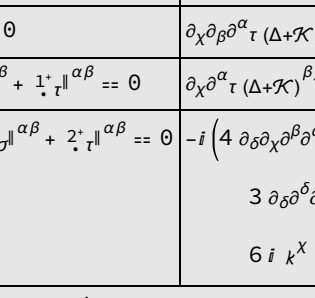
| Spin-parity form | Covariant form | Multiplicities |
|---|---|---|
| $\overset{0^+}{\cdot}\tau^{\perp} == 0$ | $\partial_\beta \partial_\alpha \tau (\Delta+\mathcal{K})^{\alpha\beta} == 0$ | 1 |
| $-2ik\,\overset{0^+}{\cdot}\sigma^{\parallel} + \overset{0^+}{\cdot}\tau^{\parallel} == 0$ | $\partial_\beta \partial_\alpha \tau (\Delta+\mathcal{K})^{\alpha\beta} == \partial_\beta \partial^\beta \tau (\Delta+\mathcal{K})^{\alpha}{}_{\alpha} + 2 \partial_\chi \partial^\chi \partial_\beta \sigma^{\alpha}{}_{\alpha}{}^{\beta}$ | 1 |
| $2ik\,\overset{1^-}{\cdot}\sigma^{\perp}{}^{\alpha} + \overset{1^-}{\cdot}\tau^{\perp}{}^{\alpha} == 0$ | $\partial_\chi \partial_\beta \partial^\alpha \tau (\Delta+\mathcal{K})^{\beta\chi} == \partial_\chi \partial^\chi \partial_\beta \tau (\Delta+\mathcal{K})^{\alpha\beta} + 2 \partial_\delta \partial^\delta \partial_\chi \partial_\beta \sigma^{\beta\alpha\chi}$ | 3 |
| $\overset{1^-}{\cdot}\tau^{\parallel}{}^{\alpha} == 0$ | $\partial_\chi \partial_\beta \partial^\alpha \tau (\Delta+\mathcal{K})^{\beta\chi} == \partial_\chi \partial^\chi \partial_\beta \tau (\Delta+\mathcal{K})^{\beta\alpha}$ | 3 |
| $ik\,\overset{1^+}{\cdot}\sigma^{\perp}{}^{\alpha\beta} + \overset{1^+}{\cdot}\tau^{\parallel}{}^{\alpha\beta} == 0$ | $\partial_\chi \partial^\alpha \tau (\Delta+\mathcal{K})^{\beta\chi} + \partial_\chi \partial^\beta \tau (\Delta+\mathcal{K})^{\chi\alpha} + \partial_\chi \partial^\chi \tau (\Delta+\mathcal{K})^{\alpha\beta} + 2 \partial_\delta \partial_\chi \partial^\alpha \sigma^{\chi\beta\delta} + 2 \partial_\delta \partial^\delta \partial_\chi \sigma^{\chi\alpha\beta} == \partial_\chi \partial^\alpha \tau (\Delta+\mathcal{K})^{\chi\beta} + \partial_\chi \partial^\beta \tau (\Delta+\mathcal{K})^{\alpha\chi} + \partial_\chi \partial^\chi \tau (\Delta+\mathcal{K})^{\beta\alpha} + 2 \partial_\delta \partial_\chi \partial^\beta \sigma^{\chi\alpha\delta}$ | 3 |
| $-2ik\,\overset{2^+}{\cdot}\sigma^{\parallel}{}^{\alpha\beta} + \overset{2^+}{\cdot}\tau^{\parallel}{}^{\alpha\beta} == 0$ | $-i\Big(4 \partial_\delta \partial_\chi \partial^\beta \partial^\alpha \tau (\Delta+\mathcal{K})^{\chi\delta} + 2 \partial_\delta \partial^\delta \partial^\beta \partial^\alpha \tau (\Delta+\mathcal{K})^{\chi}{}_{\chi} - 3 \partial_\delta \partial^\delta \partial_\chi \partial^\alpha \tau (\Delta+\mathcal{K})^{\beta\chi} - 3 \partial_\delta \partial^\delta \partial_\chi \partial^\beta \tau (\Delta+\mathcal{K})^{\alpha\chi} - 3 \partial_\delta \partial^\delta \partial_\chi \partial^\beta \tau (\Delta+\mathcal{K})^{\chi\alpha} + 3 \partial_\delta \partial^\delta \partial_\chi \partial^\chi \tau (\Delta+\mathcal{K})^{\alpha\beta} + 3 \partial_\delta \partial^\delta \partial_\chi \partial^\chi \tau (\Delta+\mathcal{K})^{\beta\alpha} + 4i\,k^\chi\,\partial_\epsilon \partial_\chi \partial^\beta \partial^\alpha \sigma^{\delta}{}_{\delta}{}^{\epsilon} - 6i\,k^\chi\,\partial_\epsilon \partial_\delta \partial_\chi \partial^\alpha \sigma^{\delta\beta\epsilon} - 6i\,k^\chi\,\partial_\epsilon \partial_\delta \partial_\chi \partial^\beta \sigma^{\delta\alpha\epsilon} + 6i\,k^\chi\,\partial_\epsilon \partial^\epsilon \partial_\delta \partial_\chi \sigma^{\alpha\beta\delta} + 6i\,k^\chi\,\partial_\epsilon \partial^\epsilon \partial_\delta \partial_\chi \sigma^{\beta\alpha\delta} + 2\,\eta^{\alpha\beta}\,\partial_\epsilon \partial^\epsilon \partial_\delta \partial^\delta \tau (\Delta+\mathcal{K})^{\chi}{}_{\chi} - 2\,\eta^{\alpha\beta}\,\partial_\epsilon \partial^\epsilon \partial_\delta \partial^\delta \tau (\Delta+\mathcal{K})^{\chi\delta} - 4i\,\eta^{\alpha\beta}\,k^\chi\,\partial_\phi \partial^\phi \partial_\epsilon \partial_\chi \sigma^{\delta}{}_{\delta}{}^{\epsilon}\Big) == 0$ | 5 |
| Total expected gauge generators: | | 16 |

# Massive spectrum




Massive particle

| | |
|---|---|
| Pole residue: | $-\frac{1}{r_2} > 0$ |
| Square mass: | $\frac{t_1}{r_2} > 0$ |
| Spin: | 0 |
| Parity: | Odd |




Massive particle

| | |
|---|---|
| Pole residue: | $\frac{6t_1 t_3 (t_1 + t_3) - 3r_5 (t_1^2 + 2t_3^2)}{2r_5 (t_1 + t_3)(-3t_1 t_3 + r_5 (t_1 + t_3))} > 0$ |
| Square mass: | $-\frac{3t_1 t_3}{2r_5 t_1 + 2r_5 t_3} > 0$ |
| Spin: | 1 |
| Parity: | Odd |

# Massless spectrum

(There are no massless particles)

# Gauge symmetries

(Not yet implemented in PSALTer)

# Unitarity conditions

$t_3 > 0 \;\&\&\; t_1 < -t_3 \;\&\&\; r_5 < 0 \;\&\&\; r_2 < 0$

# Validity assumptions

(Not yet implemented in PSALTer)