

| Massive particle | |
|------------------|------------------------|
| Pole residue: | $-\frac{1}{r_2} > 0$ |
| Polarisations: | 1 |
| Square mass: | $-\frac{t_2}{r_2} > 0$ |
| Spin: | 0 |
| Parity: | Odd |

(No massless particles)

Lagrangian density

$$\begin{aligned}
&\frac{2}{3}t_2\omega_{\kappa\lambda}^{\kappa\lambda}\omega_{\kappa\lambda}^{\prime\prime}+\frac{1}{3}t_2\omega_{\kappa\lambda}^{\prime}\omega_{\kappa\lambda}^{\kappa\lambda\prime}+2r_1\partial_{\lambda}\omega_{\kappa}^{\kappa\lambda}\partial^{\prime}\omega_{\lambda}^{\alpha\alpha\prime}- \\
&\frac{2}{3}r_1\partial^{\beta}\omega_{\kappa}^{\theta\alpha}\partial_{\theta}\omega_{\alpha\beta}^{\kappa}+\frac{2}{3}r_2\partial^{\beta}\omega_{\kappa}^{\theta\alpha}\partial_{\theta}\omega_{\alpha\beta}^{\kappa-\frac{2}{3}}r_1\partial_{\theta}\omega_{\alpha\beta}^{\kappa}\partial_{\kappa}\omega^{\alpha\beta\theta}- \\
&\frac{1}{3}r_2\partial_{\theta}\omega_{\alpha\beta}^{\kappa}\partial_{\kappa}\omega^{\alpha\beta\theta}+\frac{2}{3}r_1\partial_{\theta}\omega_{\alpha\beta}^{\kappa}\partial_{\kappa}\omega^{\theta\alpha\beta}-\frac{2}{3}r_2\partial_{\theta}\omega_{\alpha\beta}^{\kappa}\partial_{\kappa}\omega^{\theta\alpha\beta}+ \\
&2r_1\partial_{\alpha}\omega_{\lambda}^{\alpha}\partial_{\theta}\omega_{\lambda}^{\theta\kappa\lambda}-2r_1\partial_{\theta}\omega_{\lambda}^{\alpha}\partial_{\kappa}\omega^{\theta\kappa\lambda}+2r_1\partial_{\alpha}\omega_{\lambda}^{\alpha}\partial_{\theta}\omega^{\kappa\lambda\theta}- \\
&4r_1\partial_{\theta}\omega_{\lambda}^{\alpha}\partial_{\kappa}\omega^{\kappa\lambda\theta}+\frac{1}{6}t_2\partial^{\alpha}f_{\theta\kappa}\partial^{\kappa}f_{\alpha}^{\theta}-\frac{1}{6}t_2\partial^{\alpha}f_{\kappa\theta}\partial^{\kappa}f_{\alpha}^{\theta}+ \\
&\frac{1}{6}t_2\partial^{\alpha}f_{\kappa}^{\lambda}\partial^{\kappa}f_{\alpha\lambda}^{\lambda}+\frac{1}{3}t_2\omega_{\iota\theta\kappa}\partial^{\kappa}f^{\iota\theta}-\frac{2}{3}t_2\omega_{\iota\kappa\theta}\partial^{\kappa}f^{\iota\theta}- \\
&\frac{1}{3}t_2\omega_{\theta\iota\kappa}\partial^{\kappa}f^{\iota\theta}+\frac{2}{3}t_2\omega_{\theta\kappa\iota}\partial^{\kappa}f^{\iota\theta}-\frac{1}{6}t_2\partial^{\alpha}f_{\kappa}^{\lambda}\partial^{\kappa}f_{\lambda\alpha}^{\lambda}- \\
&\frac{1}{6}t_2\partial_{\kappa}f_{\theta}^{\lambda}\partial^{\kappa}f_{\lambda}^{\theta}+\frac{1}{6}t_2\partial_{\kappa}f_{\theta}^{\lambda}\partial^{\kappa}f_{\lambda}^{\theta}+\frac{2}{3}r_1\partial_{\kappa}\omega^{\alpha\beta\theta}\partial^{\kappa}\omega_{\alpha\beta\theta}+ \\
&\frac{1}{3}r_2\partial_{\kappa}\omega^{\alpha\beta\theta}\partial^{\kappa}\omega_{\alpha\beta\theta}-\frac{2}{3}r_1\partial_{\kappa}\omega^{\theta\alpha\beta}\partial^{\kappa}\omega_{\alpha\beta\theta}+\frac{2}{3}r_2\partial_{\kappa}\omega^{\theta\alpha\beta}\partial^{\kappa}\omega_{\alpha\beta\theta}+ \\
&\frac{2}{3}r_1\partial^{\beta}\omega_{\iota}^{\alpha\lambda}\partial_{\lambda}\omega_{\alpha\beta}^{\iota}-\frac{2}{3}r_2\partial^{\beta}\omega_{\iota}^{\alpha\lambda}\partial_{\lambda}\omega_{\alpha\beta}^{\iota}-\frac{8}{3}r_1\partial^{\beta}\omega_{\iota}^{\lambda\alpha}\partial_{\lambda}\omega_{\alpha\beta}^{\iota}+ \\
&\frac{2}{3}r_2\partial^{\beta}\omega_{\iota}^{\lambda\alpha}\partial_{\lambda}\omega_{\alpha\beta}^{\iota}-2r_1\partial_{\alpha}\omega_{\lambda}^{\alpha}\partial^{\lambda}\omega_{\theta}^{\theta\kappa}+\frac{2}{3}\partial^{\lambda}\omega_{\lambda}^{\alpha}\partial^{\alpha}\omega_{\alpha}^{\lambda}\partial^{\lambda}\omega_{\kappa}^{\theta\kappa}
\end{aligned}$$

Added source term:

$f^{\alpha\beta}\tau_{\alpha\beta}+\omega^{\alpha\beta\chi}\sigma_{\alpha\beta\chi}$

| | $\omega_{1+}^{\#1} \dagger^{\alpha\beta}$ | $\omega_{1+}^{\#2} \dagger^{\alpha\beta}$ | $f_{1+}^{\#1} \dagger^{\alpha\beta}$ | $\omega_{1-}^{\#1} \dagger^{\alpha}$ | $\omega_{1-}^{\#2} \dagger^{\alpha}$ | $f_{1-}^{\#1} \dagger^{\alpha}$ | $f_{1-}^{\#2} \dagger^{\alpha}$ |
|---|---|---|--------------------------------------|--------------------------------------|--------------------------------------|---------------------------------|---------------------------------|
| $\omega_{1+}^{\#1} \dagger^{\alpha\beta}$ | $\frac{2t_2}{3}$ | $\frac{\sqrt{2}t_2}{3}$ | $\frac{1}{3}i\sqrt{2}kt_2$ | 0 | 0 | 0 | 0 |
| $\omega_{1+}^{\#2} \dagger^{\alpha\beta}$ | $\frac{\sqrt{2}t_2}{3}$ | $\frac{t_2}{3}$ | $\frac{ikt_2}{3}$ | 0 | 0 | 0 | 0 |
| $f_{1+}^{\#1} \dagger^{\alpha\beta}$ | $-\frac{1}{3}i\sqrt{2}kt_2$ | $-\frac{1}{3}ikt_2$ | $\frac{k^2t_2}{3}$ | 0 | 0 | 0 | 0 |
| $\omega_{1-}^{\#1} \dagger^{\alpha}$ | 0 | 0 | 0 | $-k^2r_1$ | 0 | 0 | 0 |
| $\omega_{1-}^{\#2} \dagger^{\alpha}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $f_{1-}^{\#1} \dagger^{\alpha}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $f_{1-}^{\#2} \dagger^{\alpha}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | $\sigma_{1+}^{\#1} \dagger^{\alpha\beta}$ | $\sigma_{1+}^{\#2} \dagger^{\alpha\beta}$ | $\tau_{1+}^{\#1} \dagger^{\alpha\beta}$ | $\sigma_{1-}^{\#1} \dagger^{\alpha}$ | $\sigma_{1-}^{\#2} \dagger^{\alpha}$ | $\tau_{1-}^{\#1} \dagger^{\alpha}$ | $\tau_{1-}^{\#2} \dagger^{\alpha}$ |
|---|---|---|---|--------------------------------------|--------------------------------------|------------------------------------|------------------------------------|
| $\sigma_{1+}^{\#1} \dagger^{\alpha\beta}$ | $\frac{6}{(3+k^2)^2t_2}$ | $\frac{3\sqrt{2}}{(3+k^2)^2t_2}$ | $\frac{3i\sqrt{2}k}{(3+k^2)^2t_2}$ | 0 | 0 | 0 | 0 |
| $\sigma_{1+}^{\#2} \dagger^{\alpha\beta}$ | $\frac{3\sqrt{2}}{(3+k^2)^2t_2}$ | $\frac{3}{(3+k^2)^2t_2}$ | $\frac{3ik}{(3+k^2)^2t_2}$ | 0 | 0 | 0 | 0 |
| $\tau_{1+}^{\#1} \dagger^{\alpha\beta}$ | $-\frac{3i\sqrt{2}k}{(3+k^2)^2t_2}$ | $-\frac{3ik}{(3+k^2)^2t_2}$ | $\frac{3k^2}{(3+k^2)^2t_2}$ | 0 | 0 | 0 | 0 |
| $\sigma_{1-}^{\#1} \dagger^{\alpha}$ | 0 | 0 | 0 | $-\frac{1}{k^2r_1}$ | 0 | 0 | 0 |
| $\sigma_{1-}^{\#2} \dagger^{\alpha}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $\tau_{1-}^{\#1} \dagger^{\alpha}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $\tau_{1-}^{\#2} \dagger^{\alpha}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Source constraints

| SO(3) irreps | # |
|--|----|
| $\tau_{0+}^{\#2} == 0$ | 1 |
| $\tau_{0+}^{\#1} == 0$ | 1 |
| $\sigma_{0+}^{\#1} == 0$ | 1 |
| $\tau_{1-}^{\#2\alpha} == 0$ | 3 |
| $\tau_{1-}^{\#1\alpha} == 0$ | 3 |
| $\sigma_{1-}^{\#2\alpha} == 0$ | 3 |
| $\tau_{1+}^{\#1\alpha\beta} + ik\sigma_{1+}^{\#1\alpha\beta} == 0$ | 3 |
| $\sigma_{1+}^{\#1\alpha\beta} == \sigma_{1+}^{\#2\alpha\beta}$ | 3 |
| $\tau_{2+}^{\#1\alpha\beta} == 0$ | 5 |
| $\sigma_{2+}^{\#1\alpha\beta} == 0$ | 5 |
| Total #: | 28 |

$\omega_{2+}^{\#1} \dagger^{\alpha\beta}$
 $f_{2+}^{\#1} \dagger^{\alpha\beta}$
 $\omega_{2-}^{\#1} \dagger^{\alpha\beta\chi}$

| | | |
|---|---|----------|
| 0 | 0 | 0 |
| 0 | 0 | k^2r_1 |
| 0 | 0 | 0 |

$\sigma_{2+}^{\#1} \dagger^{\alpha\beta}$
 $\tau_{2+}^{\#1} \dagger^{\alpha\beta}$
 $\sigma_{2-}^{\#1} \dagger^{\alpha\beta\chi}$

| | | |
|---|---|--------------------|
| 0 | 0 | 0 |
| 0 | 0 | 0 |
| 0 | 0 | $\frac{1}{k^2r_1}$ |

$\omega_{0+}^{\#1} \dagger$
 $f_{0+}^{\#1} \dagger$
 $f_{0+}^{\#2} \dagger$
 $\omega_{0-}^{\#1} \dagger$

| | | | |
|---|---|---|--------------|
| 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | $k^2r_2+t_2$ |

$\sigma_{0+}^{\#1} \dagger$
 $\tau_{0+}^{\#1} \dagger$
 $\tau_{0+}^{\#2} \dagger$
 $\sigma_{0-}^{\#1} \dagger$

| | | | |
|---|---|---|------------------------|
| 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | $\frac{1}{k^2r_2+t_2}$ |

Unitarity conditions

$$r_2 < 0 \ \&\& \ t_2 > 0$$