| | $\omega_{0^+}^{\#1}$ | $f_{0^+}^{\#1}$ | $f_{0^+}^{\#2}$ | $\omega_{0^-}^{\#1}$ |
|---|---|---|---|---|
| $\omega_{0^+}^{\#1}$ | 0 | 0 | 0 | 0 |
| $f_{0^+}^{\#1}$ | 0 | 0 | 0 | 0 |
| $f_{0^+}^{\#2}$ | 0 | 0 | 0 | 0 |
| $\omega_{0^-}^{\#1}$ | 0 | 0 | 0 | $k^2 r_2 + t_2$ |

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

| | $\sigma_{1^+\,\alpha\beta}^{\#1}$ | $\sigma_{1^+\,\alpha\beta}^{\#2}$ | $\tau_{1^+\,\alpha\beta}^{\#1}$ | $\sigma_{1^-\,\alpha}^{\#1}$ | $\sigma_{1^-\,\alpha}^{\#2}$ | $\tau_{1^-\,\alpha}^{\#1}$ | $\tau_{1^-\,\alpha}^{\#2}$ |
|---|---|---|---|---|---|---|---|
| $\sigma_{1^+}^{\#1\,\alpha\beta}$ | $\frac{1}{k^2 (2 r_3 + r_5)}$ | $-\frac{\sqrt{2}}{k^2 (1+k^2) (2 r_3 + r_5)}$ | $-\frac{i \sqrt{2}}{k (1+k^2) (2 r_3 + r_5)}$ | 0 | 0 | 0 | 0 |
| $\sigma_{1^+}^{\#2\,\alpha\beta}$ | $-\frac{\sqrt{2}}{k^2 (1+k^2) (2 r_3 + r_5)}$ | $\frac{3 k^2 (2 r_3 + r_5) + 2 t_2}{(k+k^3)^2 (2 r_3 + r_5) t_2}$ | $\frac{i (3 k^2 (2 r_3 + r_5) + 2 t_2)}{k (1+k^2)^2 (2 r_3 + r_5) t_2}$ | 0 | 0 | 0 | 0 |
| $\tau_{1^+}^{\#1\,\alpha\beta}$ | $\frac{i \sqrt{2}}{k (1+k^2) (2 r_3 + r_5)}$ | $-\frac{i (3 k^2 (2 r_3 + r_5) + 2 t_2)}{k (1+k^2)^2 (2 r_3 + r_5) t_2}$ | $\frac{3 k^2 (2 r_3 + r_5) + 2 t_2}{(1+k^2)^2 (2 r_3 + r_5) t_2}$ | 0 | 0 | 0 | 0 |
| $\sigma_{1^-}^{\#1\,\alpha}$ | 0 | 0 | 0 | $\frac{2}{k^2 (r_3 + 2 r_5)}$ | 0 | 0 | 0 |
| $\sigma_{1^-}^{\#2\,\alpha}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $\tau_{1^-}^{\#1\,\alpha}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $\tau_{1^-}^{\#2\,\alpha}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | $\omega_{1^+\,\alpha\beta}^{\#1}$ | $\omega_{1^+\,\alpha\beta}^{\#2}$ | $f_{1^+\,\alpha\beta}^{\#1}$ | $\omega_{1^-\,\alpha}^{\#1}$ | $\omega_{1^-\,\alpha}^{\#2}$ | $f_{1^-\,\alpha}^{\#1}$ | $f_{1^-\,\alpha}^{\#2}$ |
|---|---|---|---|---|---|---|---|
| $\omega_{1^+}^{\#1\,\alpha\beta}$ | $k^2 (2 r_3 + r_5) + \frac{2 t_2}{3}$ | $\frac{\sqrt{2}\, t_2}{3}$ | $\frac{1}{3} i \sqrt{2}\, k t_2$ | 0 | 0 | 0 | 0 |
| $\omega_{1^+}^{\#2\,\alpha\beta}$ | $\frac{\sqrt{2}\, t_2}{3}$ | $\frac{t_2}{3}$ | $\frac{i k t_2}{3}$ | 0 | 0 | 0 | 0 |
| $f_{1^+}^{\#1\,\alpha\beta}$ | $-\frac{1}{3} i \sqrt{2}\, k t_2$ | $-\frac{1}{3} i k t_2$ | $\frac{k^2 t_2}{3}$ | 0 | 0 | 0 | 0 |
| $\omega_{1^-}^{\#1\,\alpha}$ | 0 | 0 | 0 | $\frac{1}{2} k^2 (r_3 + 2 r_5)$ | 0 | 0 | 0 |
| $\omega_{1^-}^{\#2\,\alpha}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $f_{1^-}^{\#1\,\alpha}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| $f_{1^-}^{\#2\,\alpha}$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | $\sigma_{2^+\,\alpha\beta\chi}^{\#1}$ | $\tau_{2^+\,\alpha\beta}^{\#1}$ | $\sigma_{2^-\,\alpha\beta\chi}^{\#1}$ |
|---|---|---|---|
| $\sigma_{2^+}^{\#1\,\alpha\beta\chi}$ | 0 | 0 | 0 |
| $\tau_{2^+}^{\#1\,\alpha\beta}$ | 0 | 0 | $-\frac{2}{3 k^2 r_3}$ |
| $\sigma_{2^-}^{\#1\,\alpha\beta\chi}$ | 0 | $-\frac{2}{3 k^2 r_3}$ | 0 |

| | $\omega_{2^+\,\alpha\beta}^{\#1}$ | $f_{2^+\,\alpha\beta}^{\#1}$ | $\omega_{2^-\,\alpha\beta\chi}^{\#1}$ |
|---|---|---|---|
| $\omega_{2^+}^{\#1\,\alpha\beta}$ | $-\frac{3 k^2 r_3}{2}$ | 0 | 0 |
| $f_{2^+}^{\#1\,\alpha\beta}$ | 0 | 0 | 0 |
| $\omega_{2^-}^{\#1\,\alpha\beta\chi}$ | 0 | 0 | 0 |

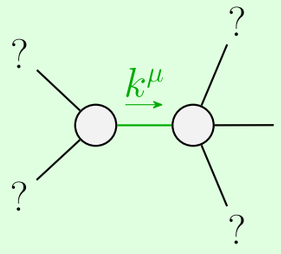
Lagrangian density

$$
\begin{aligned}
&\tfrac{2}{3} t_2\, \omega_{I}^{\kappa\lambda}\, \omega_{\kappa\lambda}' + \tfrac{1}{3} t_2\, \omega_{\kappa\lambda}'\, \omega_{I}^{\kappa\lambda} - \tfrac{1}{2} r_3\, \partial_I \omega^{\kappa\lambda}{}_{\kappa}\, \partial' \omega_{\lambda}{}^{\alpha} - \\
&r_5\, \partial_I \omega^{\kappa\lambda}{}_{\kappa}\, \partial' \omega_{\lambda}{}^{\alpha} + \tfrac{2}{3} r_2\, \partial^{\beta} \omega^{\theta\alpha}{}_{\kappa}\, \partial_{\theta} \omega_{\alpha\beta}{}^{\kappa} - \tfrac{1}{3} r_2\, \partial_{\theta} \omega_{\alpha\beta}{}^{\kappa}\, \partial_{\kappa} \omega^{\alpha\beta\theta} - \\
&\tfrac{2}{3} r_2\, \partial_{\theta} \omega_{\alpha\beta}{}^{\kappa}\, \partial_{\kappa} \omega^{\theta\alpha\beta} + \tfrac{1}{2} r_3\, \partial_{\alpha} \omega_{\lambda}{}^{\alpha}{}_{\theta}\, \partial_{\kappa} \omega^{\theta\kappa\lambda} - r_5\, \partial_{\alpha} \omega_{\lambda}{}^{\alpha}{}_{\theta}\, \partial_{\kappa} \omega^{\theta\kappa\lambda} - \\
&\tfrac{1}{2} r_3\, \partial_{\theta} \omega_{\lambda}{}^{\alpha}{}_{\alpha}\, \partial_{\kappa} \omega^{\theta\kappa\lambda} + r_5\, \partial_{\theta} \omega_{\lambda}{}^{\alpha}{}_{\alpha}\, \partial_{\kappa} \omega^{\theta\kappa\lambda} - \tfrac{1}{2} r_3\, \partial_{\alpha} \omega_{\lambda}{}^{\alpha}{}_{\theta}\, \partial_{\kappa} \omega^{\kappa\lambda\theta} - \\
&r_5\, \partial_{\alpha} \omega_{\lambda}{}^{\alpha}{}_{\theta}\, \partial_{\kappa} \omega^{\kappa\lambda\theta} + r_3\, \partial_{\theta} \omega_{\lambda}{}^{\alpha}{}_{\alpha}\, \partial_{\kappa} \omega^{\kappa\lambda\theta} + 2\, r_5\, \partial_{\theta} \omega_{\lambda}{}^{\alpha}{}_{\alpha}\, \partial_{\kappa} \omega^{\kappa\lambda\theta} + \\
&\tfrac{1}{6} t_2\, \partial^{\alpha} f_{\theta\kappa}\, \partial^{\kappa} f_{\alpha}{}^{\theta} - \tfrac{1}{6} t_2\, \partial^{\alpha} f_{\kappa\theta}\, \partial^{\kappa} f_{\alpha}{}^{\theta} + \tfrac{1}{6} t_2\, \partial^{\alpha} f^{\lambda}{}_{\kappa}\, \partial^{\kappa} f_{\alpha\lambda} + \\
&\tfrac{1}{3} t_2\, \omega_{I\theta\kappa}\, \partial^{\kappa} f'^{\theta} - \tfrac{2}{3} t_2\, \omega_{I\kappa\theta}\, \partial^{\kappa} f'^{\theta} - \tfrac{1}{3} t_2\, \omega_{\theta I\kappa}\, \partial^{\kappa} f'^{\theta} + \tfrac{2}{3} t_2\, \omega_{\theta\kappa I}\, \partial^{\kappa} f'^{\theta} - \\
&\tfrac{1}{6} t_2\, \partial^{\alpha} f^{\lambda}{}_{\kappa}\, \partial^{\kappa} f_{\lambda\alpha} - \tfrac{1}{6} t_2\, \partial_{\kappa} f^{\lambda}{}_{\theta}\, \partial^{\kappa} f_{\lambda}{}^{\theta} + \tfrac{1}{6} t_2\, \partial_{\kappa} f_{\theta}{}^{\lambda}\, \partial^{\kappa} f_{\lambda}{}^{\theta} + \\
&\tfrac{1}{3} r_2\, \partial_{\kappa} \omega^{\alpha\beta\theta}\, \partial^{\kappa} \omega_{\alpha\beta\theta} + \tfrac{2}{3} r_2\, \partial_{\kappa} \omega^{\theta\alpha\beta}\, \partial^{\kappa} \omega_{\alpha\beta\theta} - \tfrac{2}{3} r_2\, \partial^{\beta} \omega_{I}{}^{\alpha\lambda}\, \partial_{\lambda} \omega_{\alpha\beta}{}' + \\
&\tfrac{2}{3} r_2\, \partial^{\beta} \omega_{I}{}^{\lambda\alpha}\, \partial_{\lambda} \omega_{\alpha\beta}{}' - 4\, r_3\, \partial^{\beta} \omega_{I}{}^{\lambda\alpha}\, \partial_{\lambda} \omega_{\alpha\beta}{}' - \tfrac{1}{2} r_3\, \partial_{\alpha} \omega_{\lambda}{}^{\alpha}{}_{\theta}\, \partial^{\lambda} \omega^{\theta\kappa}{}_{\kappa} + \\
&r_5\, \partial_{\alpha} \omega_{\lambda}{}^{\alpha}{}_{\theta}\, \partial^{\lambda} \omega^{\theta\kappa}{}_{\kappa} + \tfrac{1}{2} r_3\, \partial_{\theta} \omega_{\lambda}{}^{\alpha}{}_{\alpha}\, \partial^{\lambda} \omega^{\theta\kappa}{}_{\kappa} - r_5\, \partial_{\theta} \omega_{\lambda}{}^{\alpha}{}_{\alpha}\, \partial^{\lambda} \omega^{\theta\kappa}{}_{\kappa}
\end{aligned}
$$

Added source term: $f^{\alpha\beta}\, \tau_{\alpha\beta} + \omega^{\alpha\beta\chi}\, \sigma_{\alpha\beta\chi}$

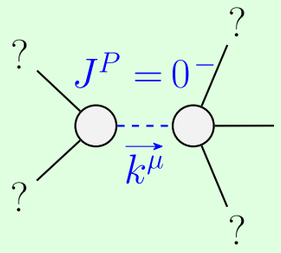
Source constraints

| # | SO(3) irreps |
|---|---|
| 1 | $\tau_{0^+}^{\#2} == 0$ |
| 1 | $\tau_{0^+}^{\#1} == 0$ |
| 1 | $\sigma_{0^+}^{\#1} == 0$ |
| 3 | $\tau_{1^+}^{\#1\,\alpha\beta} + i\, k\, \sigma_{1^+}^{\#2\,\alpha\beta} == 0$ |
| 3 | $\sigma_{1^-}^{\#2\,\alpha} == 0$ |
| 3 | $\tau_{1^-}^{\#1\,\alpha} == 0$ |
| 3 | $\tau_{1^-}^{\#2\,\alpha} == 0$ |
| 5 | $\sigma_{2^-}^{\#1\,\alpha\beta\chi} == 0$ |
| 5 | $\tau_{2^+}^{\#1\,\alpha\beta} == 0$ |
| 25 | Total #: |




Quadratic pole

| | |
|---|---|
| Pole residue: | $-\frac{1}{r_3 (2 r_3 + r_5) (r_3 + 2 r_5) p^2} > 0$ |
| Polarisations: | 2 |




Massive particle

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

Unitarity conditions

$r_2 < 0 \,\&\&\, r_3 < 0 \,\&\&\, r_5 < -\frac{r_3}{2} \,\&\&\, t_2 > 0 \,\|\|\, r_2 < 0 \,\&\&\, r_3 < 0 \,\&\&\, r_5 > -2\, r_3 \,\&\&\, t_2 > 0 \,\|\|$

$r_2 < 0 \,\&\&\, r_3 > 0 \,\&\&\, -2\, r_3 < r_5 < -\frac{r_3}{2} \,\&\&\, t_2 > 0$