



Quadratic pole

Pole residue:

$$-\frac{1}{r_1(r_1+r_5)(2r_1+r_5)p^2} > 0$$

Polarisations:

2

(No massive particles)

$r_1 < 0 \&\& (r_5 < -r_1 \parallel r_5 > -2r_1) \parallel r_1 > 0 \&\& -2r_1 < r_5 < -r_1$

| $\sigma_{1^+}^{\#1} \dagger \alpha \beta$ | $\sigma_{1^+}^{\#2} \dagger \alpha \beta$ | $\tau_{1^+}^{\#1} \dagger \alpha \beta$ | $\sigma_{1^-}^{\#1} \dagger \alpha$ | $\sigma_{1^-}^{\#2} \dagger \alpha$ | $\tau_{1^-}^{\#1} \dagger \alpha$ | $\tau_{1^-}^{\#2} \dagger \alpha$ |
|-------------------------------------------|-------------------------------------------|-----------------------------------------|-----------------------------------------|------------------------------------------------------------------|-----------------------------------|-----------------------------------------------------------------|
| $\sigma_{1^+}^{\#1} \dagger \alpha \beta$ | $\frac{1}{k^2(2r_1+r_5)}$ | 0 | 0 | 0 | 0 | 0 |
| $\sigma_{1^+}^{\#2} \dagger \alpha \beta$ | 0 | 0 | 0 | 0 | 0 | 0 |
| $\tau_{1^+}^{\#1} \dagger \alpha \beta$ | 0 | 0 | 0 | 0 | 0 | 0 |
| $\sigma_{1^-}^{\#1} \dagger \alpha$ | 0 | 0 | $\frac{1}{k^2(r_1+r_5)}$ | $\frac{\sqrt{2}}{k^2(1+2k^2)(r_1+r_5)}$ | 0 | $\frac{2i}{k(1+2k^2)(r_1+r_5)}$ |
| $\sigma_{1^-}^{\#2} \dagger \alpha$ | 0 | 0 | $\frac{\sqrt{2}}{k^2(1+2k^2)(r_1+r_5)}$ | $\frac{3k^2(r_1+r_5)+2t_3}{(k+2k^2)^2(r_1+r_5)t_3}$ | 0 | $\frac{i\sqrt{2}(3k^2(r_1+r_5)+2t_3)}{k(1+2k^2)^2(r_1+r_5)t_3}$ |
| $\tau_{1^-}^{\#1} \dagger \alpha$ | 0 | 0 | 0 | 0 | 0 | 0 |
| $\tau_{1^-}^{\#2} \dagger \alpha$ | 0 | 0 | $-\frac{2i}{k(1+2k^2)(r_1+r_5)}$ | $-\frac{i\sqrt{2}(3k^2(r_1+r_5)+2t_3)}{k(1+2k^2)^2(r_1+r_5)t_3}$ | 0 | $\frac{6k^2(r_1+r_5)+4t_3}{(1+2k^2)^2(r_1+r_5)t_3}$ |

| $\omega_{1^+}^{\#1} \dagger \alpha \beta$ | $\omega_{1^+}^{\#2} \dagger \alpha \beta$ | $f_{1^+}^{\#1} \dagger \alpha \beta$ | $\omega_{1^-}^{\#1} \dagger \alpha$ | $\omega_{1^-}^{\#2} \dagger \alpha$ | $f_{1^-}^{\#1} \dagger \alpha$ | $f_{1^-}^{\#2} \dagger \alpha$ |
|-------------------------------------------|-------------------------------------------|--------------------------------------|-------------------------------------|-------------------------------------|--------------------------------|--------------------------------|
| $\omega_{1^+}^{\#1} \dagger \alpha \beta$ | $k^2(2r_1+r_5)$ | 0 | 0 | 0 | 0 | 0 |
| $\omega_{1^+}^{\#2} \dagger \alpha \beta$ | 0 | 0 | 0 | 0 | 0 | 0 |
| $f_{1^+}^{\#1} \dagger \alpha \beta$ | 0 | 0 | 0 | 0 | 0 | 0 |
| $\omega_{1^-}^{\#1} \dagger \alpha$ | 0 | 0 | $k^2(r_1+r_5)+\frac{2t_3}{3}$ | $-\frac{\sqrt{2}t_3}{3}$ | 0 | $-\frac{2}{3}i kt_3$ |
| $\omega_{1^-}^{\#2} \dagger \alpha$ | 0 | 0 | $-\frac{\sqrt{2}t_3}{3}$ | $\frac{t_3}{3}$ | 0 | $\frac{1}{3}i\sqrt{2} kt_3$ |
| $f_{1^-}^{\#1} \dagger \alpha$ | 0 | 0 | 0 | 0 | 0 | 0 |
| $f_{1^-}^{\#2} \dagger \alpha$ | 0 | 0 | $\frac{2ikt_3}{3}$ | $-\frac{1}{3}i\sqrt{2} kt_3$ | 0 | $\frac{2k^2t_3}{3}$ |

Lagrangian density

$$\frac{2}{3}t_3\omega_{\prime}^{\alpha\prime}\omega_{\kappa\alpha}^{\kappa}+f^{\alpha\beta}\tau_{\alpha\beta}+\omega^{\alpha\beta\chi}\sigma_{\alpha\beta\chi}{}^{-}r_5\partial_1\omega_{\prime}^{\kappa\lambda}\partial_{\prime}\omega_{\lambda}^{\alpha}{}_{\alpha}{}^{-}\frac{2}{3}r_1\partial^{\beta}\omega_{\kappa}^{\theta\alpha}\partial_{\theta}\omega_{\alpha\beta}^{\kappa}{}^{-}$$

$$\frac{2}{3}r_1\partial_{\theta}\omega_{\alpha\beta}^{\kappa}\partial_{\kappa}\omega_{\alpha\beta}^{\theta}+\frac{2}{3}r_1\partial_{\theta}\omega_{\alpha\beta}^{\kappa}\partial_{\kappa}\omega_{\alpha\beta}^{\theta}-r_5\partial_{\alpha}\omega_{\lambda}^{\alpha}\partial_{\theta}\omega_{\lambda}^{\alpha}{}_{\theta}{}^{\kappa\lambda}+\frac{2}{3}r_1\partial_{\theta}\omega_{\lambda}^{\alpha}\partial_{\kappa}\omega_{\lambda}^{\alpha}{}_{\theta}{}^{\kappa\lambda}-r_5\partial_{\alpha}\omega_{\lambda}^{\alpha}\partial_{\theta}\omega_{\lambda}^{\alpha}{}_{\theta}{}^{\kappa\lambda}+2r_5\partial_{\theta}\omega_{\lambda}^{\alpha}\partial_{\kappa}\omega_{\lambda}^{\alpha}{}_{\theta}{}^{\kappa\lambda}-\frac{2}{3}t_3\omega_{\kappa\alpha}^{\alpha}\partial^{\kappa}f_{\prime}^{\prime}{}_{\prime}{}^{-}$$

$$\frac{2}{3}t_3\omega_{\kappa\lambda}^{\lambda}\partial^{\kappa}f_{\prime}^{\prime}{}_{\prime}{}^{-}\frac{4}{3}t_3\partial^{\alpha}f_{\kappa\alpha}\partial^{\kappa}f_{\prime}^{\prime}{}_{\prime}{}^{-}+\frac{2}{3}t_3\partial_{\kappa}f_{\lambda}^{\lambda}\partial^{\kappa}f_{\prime}^{\prime}{}_{\prime}{}^{-}+\frac{2}{3}t_3\omega_{\prime\lambda}^{\lambda}\partial^{\kappa}f_{\kappa}^{\prime}{}_{\prime}{}^{-}+\frac{2}{3}t_3\partial^{\alpha}f_{\alpha}^{\lambda}\partial^{\kappa}f_{\lambda\kappa}^{\prime}{}_{\prime}{}^{-}+\frac{2}{3}r_1\partial_{\kappa}\omega^{\alpha\beta\theta}\partial^{\kappa}\omega_{\alpha\beta\theta}{}^{-}\frac{2}{3}r_1\partial_{\kappa}\omega^{\theta\alpha\beta}\partial^{\kappa}\omega_{\alpha\beta\theta}{}^{+}$$

$$\frac{2}{3}r_1\partial^{\beta}\omega_{\prime}^{\alpha\lambda}\partial_{\lambda}\omega_{\alpha\beta}^{\prime}{}_{\beta}{}^{-}\frac{8}{3}r_1\partial^{\beta}r_1\partial^{\beta}\omega_{\prime}^{\lambda\alpha}\partial_{\lambda}\omega_{\alpha\beta}^{\prime}{}_{\beta}{}^{-}+r_5\partial_{\alpha}\omega_{\lambda}^{\alpha}{}_{\theta}{}^{\lambda\alpha}\partial^{\lambda}\omega_{\lambda}^{\theta\kappa}{}_{\kappa}{}^{-}r_5\partial_{\theta}\omega_{\lambda}^{\alpha}\partial_{\alpha}\omega_{\lambda}^{\theta\kappa}{}_{\kappa}{}^{-}$$

Source constraints

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

| $\sigma_{2^+}^{\#1} \dagger \alpha \beta$ | $\tau_{2^+}^{\#1} \dagger \alpha \beta$ | $\sigma_{2^+}^{\#1} \dagger \alpha \beta \chi$ |
|------------------------------------------------|-----------------------------------------|------------------------------------------------|
| $\sigma_{2^+}^{\#1} \dagger \alpha \beta$ | 0 | 0 |
| $\tau_{2^+}^{\#1} \dagger \alpha \beta$ | 0 | 0 |
| $\sigma_{2^+}^{\#1} \dagger \alpha \beta \chi$ | 0 | $\frac{1}{k^2r_1}$ |

| $\omega_{0^+}^{\#1} \dagger$ | $f_{0^+}^{\#1} \dagger$ | $f_{0^+}^{\#2} \dagger$ | $\omega_{0^-}^{\#1} \dagger$ |
|------------------------------|-------------------------|-------------------------|------------------------------|
| $\omega_{0^+}^{\#1} \dagger$ | t_3 | $-i\sqrt{2} kt_3$ | 0 |
| $f_{0^+}^{\#1} \dagger$ | $i\sqrt{2} kt_3$ | $2k^2t_3$ | 0 |
| $f_{0^+}^{\#2} \dagger$ | 0 | 0 | 0 |
| $\omega_{0^-}^{\#1} \dagger$ | 0 | 0 | 0 |

| $\omega_{2^+}^{\#1} \dagger \alpha \beta$ | $f_{2^+}^{\#1} \dagger \alpha \beta$ | $\omega_{2^+}^{\#1} \dagger \alpha \beta \chi$ |
|------------------------------------------------|--------------------------------------|------------------------------------------------|
| $\omega_{2^+}^{\#1} \dagger \alpha \beta$ | 0 | 0 |
| $f_{2^+}^{\#1} \dagger \alpha \beta$ | 0 | 0 |
| $\omega_{2^+}^{\#1} \dagger \alpha \beta \chi$ | 0 | k^2r_1 |

| $\sigma_{0^+}^{\#1} \dagger$ | $\tau_{0^+}^{\#1} \dagger$ | $\tau_{0^+}^{\#2} \dagger$ | $\sigma_{0^-}^{\#1} \dagger$ |
|------------------------------|------------------------------------|-------------------------------------|------------------------------|
| $\sigma_{0^+}^{\#1} \dagger$ | $\frac{1}{(1+2k^2)^2t_3}$ | $-\frac{i\sqrt{2}k}{(1+2k^2)^2t_3}$ | 0 |
| $\tau_{0^+}^{\#1} \dagger$ | $\frac{i\sqrt{2}k}{(1+2k^2)^2t_3}$ | $\frac{2k^2}{(1+2k^2)^2t_3}$ | 0 |
| $\tau_{0^+}^{\#2} \dagger$ | 0 | 0 | 0 |
| $\sigma_{0^-}^{\#1} \dagger$ | 0 | 0 | 0 |