



The diagram shows a particle exchange process. On the left, two incoming particles (represented by black lines) meet at a vertex. On the right, two outgoing particles meet at another vertex. A wavy line connects the two vertices, representing the exchange of a particle. The wavy line is labeled with $J^P = 2^-$ and k^μ with an arrow pointing to the right. The vertices are marked with question marks, indicating unknown particle identities.

Massive particle	
Pole residue:	$-\frac{1}{r_1} > 0$
Polarisations:	5
Square mass:	$-\frac{t_1}{2r_1} > 0$
Spin:	2
Parity:	Odd

Unitarity conditions
 $r_1 < 0 \ \&\& \ t_1 > 0$

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(No massless particles)

$$\begin{aligned}
& \text{Lagrangian density} \\
& -t_1 \omega_{\lambda'}^{\alpha'} \omega_{\kappa\alpha}^{\kappa} - \frac{1}{3} t_1 \omega_{\lambda'}^{\kappa\lambda} \omega_{\kappa\lambda}^{\lambda'} + \frac{1}{3} t_1 \omega_{\kappa\lambda}^{\lambda'} \omega_{\lambda\kappa}^{\kappa\lambda} + f^{\alpha\beta} \tau_{\alpha\beta} + \omega^{\alpha\beta\chi} \sigma_{\alpha\beta\chi} + \\
& 2 r_1 \partial_{\lambda'} \omega_{\kappa}^{\kappa\lambda} \partial' \omega_{\lambda}^{\alpha} - \frac{2}{3} r_1 \partial^{\beta} \omega_{\alpha}^{\alpha} \partial_{\theta} \omega_{\alpha\beta}^{\beta} \omega_{\kappa}^{\kappa} + \frac{2}{3} r_2 \partial^{\beta} \omega_{\alpha}^{\theta\alpha} \partial_{\theta} \omega_{\alpha\beta}^{\kappa} - \\
& \frac{2}{3} r_1 \partial_{\theta} \omega_{\alpha\beta}^{\kappa} \partial_{\kappa} \omega_{\alpha\beta}^{\alpha\beta} - \frac{1}{3} r_2 \partial_{\theta} \omega_{\alpha\beta}^{\kappa} \partial_{\kappa} \omega_{\alpha\beta}^{\alpha\beta\theta} + \frac{2}{3} r_1 \partial_{\theta} \omega_{\alpha\beta}^{\kappa} \partial_{\kappa} \omega_{\alpha\beta}^{\theta\alpha\beta} - \\
& \frac{2}{3} r_2 \partial_{\theta} \omega_{\alpha\beta}^{\kappa} \partial_{\kappa} \omega_{\alpha\beta}^{\theta\alpha\beta} + 2 r_1 \partial_{\alpha} \omega_{\lambda}^{\alpha} \partial_{\theta} \omega_{\lambda}^{\theta\kappa\lambda} - 2 r_1 \partial_{\theta} \omega_{\lambda}^{\alpha} \partial_{\kappa} \omega_{\lambda}^{\theta\kappa\lambda} + \\
& 2 r_1 \partial_{\alpha} \omega_{\lambda}^{\alpha} \partial_{\theta} \omega_{\lambda}^{\kappa\lambda\theta} - 4 r_1 \partial_{\theta} \omega_{\lambda}^{\alpha} \partial_{\kappa} \omega_{\alpha}^{\kappa\lambda\theta} - \frac{1}{3} t_1 \partial^{\alpha} f_{\theta\kappa} \partial^{\kappa} f_{\alpha}^{\theta} - \frac{2}{3} t_1 \partial^{\alpha} f_{\kappa\theta} \partial^{\kappa} f_{\alpha}^{\theta} - \\
& \frac{1}{3} t_1 \partial^{\alpha} f_{\lambda}^{\lambda} \partial^{\kappa} f_{\alpha\lambda}^{\kappa} + t_1 \omega_{\kappa\alpha}^{\alpha} \partial^{\kappa} f_{\lambda'}^{\lambda} + t_1 \omega_{\kappa\lambda}^{\lambda} \partial^{\kappa} f_{\lambda'}^{\lambda} + 2 t_1 \partial^{\alpha} f_{\kappa\alpha} \partial^{\kappa} f_{\lambda'}^{\lambda} - \\
& t_1 \partial_{\kappa} f_{\lambda}^{\lambda} \partial^{\kappa} f_{\lambda'}^{\lambda} + \frac{1}{3} t_1 \omega_{\lambda\theta\kappa} \partial^{\kappa} f_{\lambda'}^{\theta} + \frac{4}{3} t_1 \omega_{\lambda\kappa\theta} \partial^{\kappa} f_{\lambda'}^{\theta} - \frac{1}{3} t_1 \omega_{\theta\lambda\kappa} \partial^{\kappa} f_{\lambda'}^{\theta} + \\
& \frac{2}{3} t_1 \omega_{\theta\kappa\lambda} \partial^{\kappa} f_{\lambda'}^{\theta} - t_1 \omega_{\lambda'\alpha}^{\alpha} \partial^{\kappa} f_{\kappa}^{\lambda'} - t_1 \omega_{\lambda'\lambda}^{\lambda} \partial^{\kappa} f_{\kappa}^{\lambda'} + \frac{1}{3} t_1 \partial^{\alpha} f_{\kappa}^{\lambda} \partial^{\kappa} f_{\lambda\alpha}^{\lambda} + \\
& \frac{1}{3} t_1 \partial_{\kappa} f_{\theta}^{\lambda} \partial^{\kappa} f_{\lambda}^{\theta} + \frac{2}{3} t_1 \partial_{\kappa} f_{\theta}^{\lambda} \partial^{\kappa} f_{\lambda}^{\theta} - t_1 \partial^{\alpha} f_{\lambda}^{\lambda} \partial^{\kappa} f_{\lambda\kappa}^{\lambda} + \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_{\lambda'}^{\alpha\lambda} \partial_{\lambda} \omega_{\alpha\beta}^{\lambda'} - \frac{2}{3} r_2 \partial^{\beta} \omega_{\lambda'}^{\alpha\lambda} \partial_{\lambda} \omega_{\alpha\beta}^{\lambda'} - \frac{8}{3} r_1 \partial^{\beta} \omega_{\lambda'}^{\lambda\alpha} \partial_{\lambda} \omega_{\alpha\beta}^{\lambda'} + \\
& \frac{2}{3} r_2 \partial^{\beta} \omega_{\lambda'}^{\lambda\alpha} \partial_{\lambda} \omega_{\alpha\beta}^{\lambda'} - 2 r_1 \partial_{\alpha} \omega_{\lambda}^{\alpha} \partial^{\lambda} \omega_{\lambda}^{\theta\kappa} + 2 r_1 \partial_{\theta} \omega_{\lambda}^{\alpha} \partial^{\lambda} \omega_{\lambda}^{\theta\kappa}
\end{aligned}$$

	$\sigma_1^{\#1} + \alpha\beta$	$\sigma_1^{\#2} + \alpha\beta$	$\tau_1^{\#1} + \alpha\beta$	$\sigma_1^{\#1} \alpha$	$\sigma_1^{\#2} \alpha$	$\tau_1^{\#1} \alpha$	$\tau_1^{\#2} \alpha$
$\sigma_1^{\#1} + \alpha\beta$	$-\frac{6}{(3+2k^2)^2 t_1}$	$-\frac{6\sqrt{2}}{(3+2k^2)^2 t_1}$	$-\frac{6i\sqrt{2}k}{(3+2k^2)^2 t_1}$	0	0	0	0
$\sigma_1^{\#2} + \alpha\beta$	$-\frac{6\sqrt{2}}{(3+2k^2)^2 t_1}$	$-\frac{12}{(3+2k^2)^2 t_1}$	$-\frac{12ik}{(3+2k^2)^2 t_1}$	0	0	0	0
$\tau_1^{\#1} + \alpha\beta$	$-\frac{6i\sqrt{2}k}{(3+2k^2)^2 t_1}$	$-\frac{12ik}{(3+2k^2)^2 t_1}$	$-\frac{12k^2}{(3+2k^2)^2 t_1}$	0	0	0	0
$\sigma_1^{\#1} + \alpha$	0	0	0	0	$\frac{\sqrt{2}}{t_1+2k^2 t_1}$	0	$\frac{2ik}{t_1+2k^2 t_1}$
$\sigma_1^{\#2} + \alpha$	0	0	0	$\frac{\sqrt{2}}{t_1+2k^2 t_1}$	$\frac{2k^2 r_1+t_1}{(t_1+2k^2 t_1)^2}$	0	$\frac{i\sqrt{2}k(2k^2 r_1+t_1)}{(t_1+2k^2 t_1)^2}$
$\tau_1^{\#1} + \alpha$	0	0	0	0	0	0	0
$\tau_1^{\#2} + \alpha$	0	0	0	$-\frac{2ik}{t_1+2k^2 t_1}$	$-\frac{i\sqrt{2}k(2k^2 r_1+t_1)}{(t_1+2k^2 t_1)^2}$	0	$\frac{2k^2(2k^2 r_1+t_1)}{(t_1+2k^2 t_1)^2}$

$\omega_1^{#1} + \alpha\beta$	$\frac{t_1}{6}$	$-\frac{t_1}{3\sqrt{2}}$	$-\frac{t_1}{3\sqrt{2}}$	$f_1^{#1} + \alpha\beta$	$\omega_1^{#1} + \alpha\beta$	$\omega_1^{#1} - \alpha$	$\omega_1^{#2} - \alpha$	$f_1^{#1} - \alpha$	$f_1^{#2} - \alpha$
$\omega_1^{#2} + \alpha\beta$	$-\frac{t_1}{3\sqrt{2}}$	$\frac{t_1}{3}$	$\frac{t_1}{3\sqrt{2}}$	$\frac{t_1}{3}$	$\frac{t_1}{3\sqrt{2}}$	0	0	0	0
$f_1^{#1} + \alpha\beta$	$\frac{ikt_1}{3\sqrt{2}}$	$-\frac{1}{3}ikt_1$	$\frac{k^2 t_1}{3}$	0	0	0	0	0	0
$\omega_1^{#1} + \alpha$	0	0	0	0	$-k^2 r_1 - \frac{t_1}{2}$	$\frac{t_1}{\sqrt{2}}$	0	0	ikt_1
$\omega_1^{#2} + \alpha$	0	0	0	0	$\frac{t_1}{\sqrt{2}}$	0	0	0	0
$f_1^{#1} + \alpha$	0	0	0	0	0	0	0	0	0
$f_1^{#2} + \alpha$	0	0	0	0	$-ikt_1$	0	0	0	0

Source constraints	#
$\tau_0^{2+} == 0$	1
$\tau_0^{1+} - 2 \, i \, k \, \sigma_0^{1+} == 0$	1
$\tau_1^{2\alpha} + 2 \, i \, k \, \sigma_1^{2\alpha} == 0$	3
$\tau_1^{1\alpha} == 0$	3
$\tau_1^{1\alpha\beta} - 2 \, i \, k \, \sigma_1^{1\alpha\beta} == 0$	3
$2 \, \sigma_1^{1\alpha\beta} + \sigma_1^{2\alpha\beta} == 0$	3
$\tau_2^{1\alpha\beta} - 2 \, i \, k \, \sigma_2^{1\alpha\beta} == 0$	5
Total #:	19

$\sigma_0^{\#1} +$	$-\frac{1}{(1+2k^2)^2}t_1$	$\frac{i\sqrt{2}k}{(1+2k^2)^2}t_1$	$\tau_0^{\#2}$	$\sigma_0^{\#1}$
$\tau_0^{\#1} +$	$-\frac{i\sqrt{2}k}{(1+2k^2)^2}t_1$	$-\frac{2k^2}{(1+2k^2)^2}t_1$	$\tau_0^{\#2}$	0
$\tau_0^{\#2} +$	0	0	$\tau_0^{\#2}$	0
$\sigma_0^{\#1} +$	0	0	$\tau_0^{\#2}$	$\frac{1}{k^2}r_2$

$\sigma_2^{\#1} \dagger \alpha\beta$	$\frac{2}{(1+2k^2)^2 t_1}$	$-\frac{2i\sqrt{2}k}{(1+2k^2)^2 t_1}$	0	$\sigma_2^{\#1} \alpha\beta\chi$
$\tau_2^{\#1} \dagger \alpha\beta$	$\frac{2i\sqrt{2}k}{(1+2k^2)^2 t_1}$	$\frac{4k^2}{(1+2k^2)^2 t_1}$	0	
$\sigma_2^{\#1} \dagger \alpha\beta\chi$	0		$\frac{2}{2k^2 r_1 + t_1}$	

	$\omega_0^{#1}$	$f_0^{#1}$	$f_0^{#2}$	$\omega_0^{#1}$
$\omega_0^{#1} \dagger$	$-t_1$	$i \sqrt{2} k t_1$	0	0
$f_0^{#1} \dagger$	$-i \sqrt{2} k t_1$	$-2 k^2 t_1$	0	0
$f_0^{#2} \dagger$	0	0	0	0
$\omega_0^{#1} \dagger$	0	0	0	$k^2 r_2$

	$\omega_{2^+}^{\#1} \alpha \beta$	$f_{2^+}^{\#1} \alpha \beta$	$\omega_{2^-}^{\#1} \alpha \beta \chi$
$\omega_{2^+}^{\#1} \dagger \alpha \beta$	$\frac{t_1}{2}$	$-\frac{i k t_1}{\sqrt{2}}$	0
$f_{2^+}^{\#1} \dagger \alpha \beta$	$\frac{i k t_1}{\sqrt{2}}$	$k^2 t_1$	0
$\omega_{2^-}^{\#1} \dagger \alpha \beta \chi$	0	0	$k^2 r_1 + \frac{t_1}{2}$