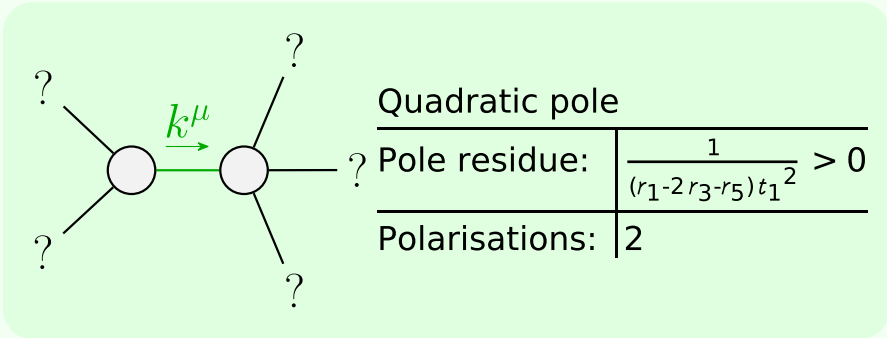


The diagram shows a particle exchange process between two vertices (pink circles). The left vertex has four external lines, and the right vertex has three external lines, all labeled with question marks. A wavy line connects the two vertices, with a blue arrow labeled k^μ pointing from left to right. Above the wavy line, the text $J^P = 2^-$ is written in blue.

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



The diagram shows a bubble diagram with two vertices (pink circles) connected by a horizontal green line labeled k^μ . Each vertex has two external lines, for a total of four external lines, all labeled with a question mark. To the right of the diagram is a table summarizing the pole analysis.

Quadratic pole	
Pole residue:	$\frac{1}{(r_1 - 2r_3 - r_5)t_1^2} > 0$
Polarisations:	2

Unitarity conditions

$$r_1 < 0 \ \&\& \ r_5 < r_1 - 2 \ r_3 \ \&\& \ t_1 > 0$$

Unitarity conditions

$$r_1 < 0 \ \&\& \ r_5 < r_1 - 2 \ r_3 \ \&\& \ t_1 > 0$$

	$\omega_{1+}^{\#1} \alpha \beta$	$\omega_{1+}^{\#2} \alpha \beta$	$f_{1+}^{\#1} \alpha \beta$	$\omega_{1-}^{\#1} \alpha$	$\omega_{1-}^{\#2} \alpha$	$f_{1-}^{\#1} \alpha$	$f_{1-}^{\#2} \alpha$
$\omega_{1+}^{\#1} \dagger^{\alpha \beta}$	$k^2 (2 r_3 + r_5) - \frac{t_1}{2}$	$-\frac{t_1}{\sqrt{2}}$	$-\frac{i k t_1}{\sqrt{2}}$	0	0	0	0
$\omega_{1+}^{\#2} \dagger^{\alpha \beta}$	$-\frac{t_1}{\sqrt{2}}$	0	0	0	0	0	0
$f_{1+}^{\#1} \dagger^{\alpha \beta}$	$\frac{i k t_1}{\sqrt{2}}$	0	0	0	0	0	0
$\omega_{1-}^{\#1} \dagger^{\alpha}$	0	0	0	$k^2 (-r_1 + 2 r_3 + r_5) + \frac{t_1}{6}$	$\frac{t_1}{3 \sqrt{2}}$	0	$\frac{i k t_1}{3}$
$\omega_{1-}^{\#2} \dagger^{\alpha}$	0	0	0	$\frac{t_1}{3 \sqrt{2}}$	$\frac{t_1}{3}$	0	$\frac{1}{3} i \sqrt{2} k t_1$
$f_{1-}^{\#1} \dagger^{\alpha}$	0	0	0	0	0	0	0
$f_{1-}^{\#2} \dagger^{\alpha}$	0	0	0	$-\frac{1}{3} i k t_1$	$-\frac{1}{3} i \sqrt{2} k t_1$	0	$\frac{2 k^2 t_1}{3}$

Lagrangian density

$$\begin{aligned}
& -\frac{1}{3}t_1 \omega_{\lambda}^{\alpha} \omega_{\kappa\alpha}^{\kappa} - t_1 \omega_{\lambda}^{\kappa\lambda} \omega_{\kappa\lambda}^{\lambda} + 2r_1 \partial_{\lambda} \omega_{\kappa}^{\kappa\lambda} \partial^{\lambda} \omega_{\lambda}^{\alpha} - 2r_3 \partial_{\lambda} \omega_{\kappa}^{\kappa\lambda} \partial^{\lambda} \omega_{\lambda}^{\alpha} - \\
& r_5 \partial_{\lambda} \omega_{\kappa}^{\kappa\lambda} \partial^{\lambda} \omega_{\lambda}^{\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^{\theta\alpha\beta} - 2r_1 \partial_{\alpha} \omega_{\lambda}^{\alpha} \partial_{\theta} \omega^{\theta\kappa\lambda} + 2r_3 \partial_{\alpha} \omega_{\lambda}^{\alpha} \partial_{\theta} \omega^{\theta\kappa\lambda} - \\
& r_5 \partial_{\alpha} \omega_{\lambda}^{\alpha} \partial_{\theta} \omega^{\theta\kappa\lambda} + 2r_1 \partial_{\theta} \omega_{\lambda}^{\alpha} \partial_{\kappa} \omega^{\theta\kappa\lambda} - 2r_3 \partial_{\theta} \omega_{\lambda}^{\alpha} \partial_{\kappa} \omega^{\theta\kappa\lambda} + \\
& r_5 \partial_{\theta} \omega_{\lambda}^{\alpha} \partial_{\kappa} \omega^{\theta\kappa\lambda} + 2r_1 \partial_{\alpha} \omega_{\lambda}^{\alpha} \partial_{\kappa} \omega^{\kappa\lambda\theta} - 2r_3 \partial_{\alpha} \omega_{\lambda}^{\alpha} \partial_{\kappa} \omega^{\kappa\lambda\theta} - \\
& r_5 \partial_{\alpha} \omega_{\lambda}^{\alpha} \partial_{\kappa} \omega^{\kappa\lambda\theta} - 4r_1 \partial_{\theta} \omega_{\lambda}^{\alpha} \partial_{\kappa} \omega^{\kappa\lambda\theta} + 4r_3 \partial_{\theta} \omega_{\lambda}^{\alpha} \partial_{\kappa} \omega^{\kappa\lambda\theta} + \\
& 2r_5 \partial_{\theta} \omega_{\lambda}^{\alpha} \partial_{\kappa} \omega^{\kappa\lambda\theta} - \frac{1}{2}t_1 \partial^{\alpha} f_{\theta\kappa} \partial^{\kappa} f_{\alpha}^{\theta} - \frac{1}{2}t_1 \partial^{\alpha} f_{\kappa\theta} \partial^{\kappa} f_{\alpha}^{\theta} - \\
& \frac{1}{2}t_1 \partial^{\alpha} f_{\kappa}^{\lambda} \partial^{\kappa} f_{\alpha\lambda} + \frac{1}{3}t_1 \omega_{\kappa\alpha}^{\alpha} \partial^{\kappa} f_{\lambda}^{\prime} + \frac{1}{3}t_1 \omega_{\kappa\lambda}^{\lambda} \partial^{\kappa} f_{\lambda}^{\prime} + \frac{2}{3}t_1 \partial^{\alpha} f_{\kappa\alpha} \partial^{\kappa} f_{\lambda}^{\prime} - \\
& \frac{1}{3}t_1 \partial_{\kappa} f_{\lambda}^{\lambda} \partial^{\kappa} f_{\lambda}^{\prime} + 2t_1 \omega_{\lambda\kappa\theta} \partial^{\kappa} f_{\lambda}^{\prime\theta} - \frac{1}{3}t_1 \omega_{\lambda\alpha}^{\alpha} \partial^{\kappa} f_{\kappa}^{\prime} - \frac{1}{3}t_1 \omega_{\lambda\lambda}^{\lambda} \partial^{\kappa} f_{\kappa}^{\prime} + \\
& \frac{1}{2}t_1 \partial^{\alpha} f_{\kappa}^{\lambda} \partial^{\kappa} f_{\lambda\alpha} + \frac{1}{2}t_1 \partial_{\kappa} f_{\theta}^{\lambda} \partial^{\kappa} f_{\lambda}^{\theta} + \frac{1}{2}t_1 \partial_{\kappa} f_{\theta}^{\lambda} \partial^{\kappa} f_{\lambda}^{\theta} - \\
& \frac{1}{3}t_1 \partial^{\alpha} f_{\lambda}^{\alpha} \partial^{\kappa} f_{\lambda\kappa} + \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_{\lambda}^{\alpha\lambda} \partial_{\lambda} \omega_{\alpha\beta}^{\prime} + \frac{4}{3}r_1 \partial^{\beta} \omega_{\lambda}^{\lambda\alpha} \partial_{\lambda} \omega_{\alpha\beta}^{\prime} - 4r_3 \partial^{\beta} \omega_{\lambda}^{\lambda\alpha} \partial_{\lambda} \omega_{\alpha\beta}^{\prime} + \\
& 2r_1 \partial_{\alpha} \omega_{\lambda}^{\alpha} \partial^{\lambda} \omega_{\kappa}^{\theta\kappa} - 2r_3 \partial_{\alpha} \omega_{\lambda}^{\alpha} \partial^{\lambda} \omega_{\kappa}^{\theta\kappa} + r_5 \partial_{\alpha} \omega_{\lambda}^{\alpha} \partial^{\lambda} \omega_{\kappa}^{\theta\kappa} - \\
& 2r_1 \partial_{\theta} \omega_{\lambda}^{\alpha} \partial^{\lambda} \omega_{\kappa}^{\theta\kappa} + 2r_3 \partial_{\theta} \omega_{\lambda}^{\alpha} \partial^{\lambda} \omega_{\kappa}^{\theta\kappa} - r_5 \partial_{\theta} \omega_{\lambda}^{\alpha} \partial^{\lambda} \omega_{\kappa}^{\theta\kappa}
\end{aligned}$$

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

	$\sigma_{0+}^{\#1}$	$\tau_{0+}^{\#1}$	$\tau_{0+}^{\#2}$	$\sigma_{0-}^{\#1}$
$\sigma_{0+}^{\#1} \vdash$	$\frac{1}{6k^2(-r_1+r_3)}$	0	0	0
$\tau_{0+}^{\#1} \vdash$	0	0	0	0
$\tau_{0+}^{\#2} \vdash$	0	0	0	0
$\sigma_{0-}^{\#1} \vdash$	0	0	0	$-\frac{1}{t_1}$

	$\omega_0^{\#1}$	$f_0^{\#1}$	$f_0^{\#2}$	$\omega_0^{\#1}$
$\omega_0^{\#1} \dagger$	$6k^2(-r_1 + r_3)$	0	0	0
$f_0^{\#1} \dagger$	0	0	0	0
$f_0^{\#2} \dagger$	0	0	0	0
$\omega_0^{\#1} \dagger$	0	0	0	$-t_1$

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

$\omega_2^{\#1} + \alpha\beta$	$\frac{t_1}{2}$	$-\frac{ikt_1}{\sqrt{2}}$	0	$\omega_2^{\#1} \omega_2 - \alpha\beta X$
$f_2^{\#1} + \alpha\beta$	$\frac{ikt_1}{\sqrt{2}}$	$k^2 t_1$	0	
$\omega_2^{\#1} + \alpha\beta X$	0	0	$k^2 r_1 + \frac{t_1}{2}$	

Source constraints	
SO(3) irreps	#
$\tau_{0+}^{\#2} == 0$	1
$\tau_{0+}^{\#1} == 0$	1
$\tau_{1-}^{\#2\alpha} + 2\,i\,k\,\sigma_{1-}^{\#2\alpha} == 0$	3
$\tau_{1-}^{\#1\alpha} == 0$	3
$\tau_{1+}^{\#1\alpha\beta} + i\,k\,\sigma_{1+}^{\#2\alpha\beta} == 0$	3
$\tau_{2+}^{\#1\alpha\beta} - 2\,i\,k\,\sigma_{2+}^{\#1\alpha\beta} == 0$	5
Total #:	16