

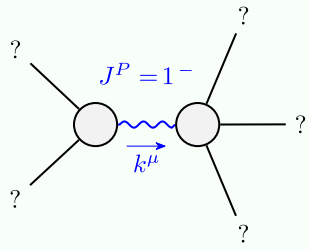
Particle spectrograph

Wave operator and propagator

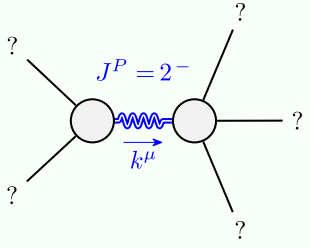
Massive and massless spectra

Unitarity conditions

$r_1 < 0 \&\& r_5 < -r_1 \&\& t_1 > 0 \&\& t_3 < -t_1 || t_3 > 0$



Massive particle	
Pole residue:	$-\frac{3(-2t_1t_3(t_1+t_3)+r_1(t_1^2+2t_3^2))+r_5(t_1^2+2t_3^2))}{2(r_1+r_5)(t_1+t_3)(-3t_1t_3+r_1(t_1+t_3)+r_5(t_1+t_3))} > 0$
Polarisations:	3
Square mass:	$-\frac{3t_1t_3}{2(r_1+r_5)(t_1+t_3)} > 0$
Spin:	1
Parity:	Odd



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

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$\sigma_{1+}^{\#1} \dagger \alpha\beta$	$\sigma_{1+}^{\#2} \alpha\beta$	$\tau_{1+}^{\#1} \alpha\beta$	$\sigma_{1-}^{\#1} \alpha$	$\sigma_{1-}^{\#2} \alpha$	$\tau_{1-}^{\#1} \alpha$	$\tau_{1-}^{\#2} \alpha$
$\sigma_{1+}^{\#1} \dagger \alpha\beta$	0	$-\frac{\sqrt{2}}{t_1+k^2t_1}$	$-\frac{i\sqrt{2}k}{t_1+k^2t_1}$	0	0	0
$\sigma_{1+}^{\#2} \dagger \alpha\beta$	$-\frac{\sqrt{2}}{t_1+k^2t_1}$	$\frac{-2ik^2(2r_1+r_5)+t_1}{(1+k^2)^2t_1}$	$\frac{-2ik^3(2r_1+r_5)+ikt_1}{(1+k^2)^2t_1}$	0	0	0
$\tau_{1+}^{\#1} \dagger \alpha\beta$	$\frac{i\sqrt{2}k}{t_1+k^2t_1}$	$\frac{i(2k^3(2r_1+r_5)-kt_1)}{(1+k^2)^2t_1}$	$\frac{-2k^4(2r_1+r_5)+k^2t_1}{(1+k^2)^2t_1}$	0	0	0
$\sigma_{1-}^{\#1} \dagger \alpha$	0	0	$\frac{2(t_1+t_3)}{3t_1t_3+2k^2(r_1+r_5)(t_1+t_3)}$	$-\frac{\sqrt{2}(t_1-2t_3)}{(1+2k^2)(3t_1t_3+2k^2(r_1+r_5)(t_1+t_3))}$	0	$-\frac{2ik(t_1-2t_3)}{(1+2k^2)(3t_1t_3+2k^2(r_1+r_5)(t_1+t_3))}$
$\sigma_{1-}^{\#2} \dagger \alpha$	0	0	$-\frac{\sqrt{2}(t_1-2t_3)}{(1+2k^2)(3t_1t_3+2k^2(r_1+r_5)(t_1+t_3))}$	$\frac{6k^2(r_1+r_5)+t_1+4t_3}{(1+2k^2)^2(3t_1t_3+2k^2(r_1+r_5)(t_1+t_3))}$	0	$\frac{i\sqrt{2}k(6k^2(r_1+r_5)+t_1+4t_3)}{(1+2k^2)^2(3t_1t_3+2k^2(r_1+r_5)(t_1+t_3))}$
$\tau_{1-}^{\#1} \dagger \alpha$	0	0	0	0	0	0
$\tau_{1-}^{\#2} \dagger \alpha$	0	0	$-\frac{2ik(t_1-2t_3)}{(1+2k^2)(3t_1t_3+2k^2(r_1+r_5)(t_1+t_3))}$	$-\frac{i\sqrt{2}k(6k^2(r_1+r_5)+t_1+4t_3)}{(1+2k^2)^2(3t_1t_3+2k^2(r_1+r_5)(t_1+t_3))}$	0	$\frac{2k^2(6k^2(r_1+r_5)+t_1+4t_3)}{(1+2k^2)^2(3t_1t_3+2k^2(r_1+r_5)(t_1+t_3))}$

Source constraints/gauge generators	
SO(3) irreps	Multiplicities
$\tau_{0+}^{\#2} == 0$	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
$\tau_{1+}^{\#1\alpha\beta} + ik\sigma_{1+}^{\#2\alpha\beta} == 0$	3
$\tau_{2+}^{\#1\alpha\beta} - 2ik\sigma_{2+}^{\#1\alpha\beta} == 0$	5
Total constraints:	16

$\omega_{1+}^{\#1} \alpha\beta$	$\omega_{1+}^{\#2} \alpha\beta$	$f_{1+}^{\#1} \alpha\beta$	$\omega_{1-}^{\#1} \alpha$	$\omega_{1-}^{\#2} \alpha$	$f_{1-}^{\#1} \alpha$	$f_{1-}^{\#2} \alpha$
$\omega_{1+}^{\#1} \dagger \alpha\beta$	$k^2(2r_1+r_5) - \frac{t_1}{2}$	$-\frac{t_1}{\sqrt{2}}$	0	0	0	0
$\omega_{1+}^{\#2} \dagger \alpha\beta$	$-\frac{t_1}{\sqrt{2}}$	0	0	0	0	0
$f_{1+}^{\#1} \dagger \alpha\beta$	$\frac{ikt_1}{\sqrt{2}}$	0	0	0	0	0
$\omega_{1-}^{\#1} \dagger \alpha$	0	0	$\frac{1}{6}(6k^2(r_1+r_5)+t_1+4t_3)$	$\frac{t_1-2t_3}{3\sqrt{2}}$	0	$\frac{1}{3}ik(t_1-2t_3)$
$\omega_{1-}^{\#2} \dagger \alpha$	0	0	$\frac{t_1-2t_3}{3\sqrt{2}}$	$\frac{t_1+t_3}{3}$	0	$\frac{1}{3}i\sqrt{2}k(t_1+t_3)$
$f_{1-}^{\#1} \dagger \alpha$	0	0	0	0	0	0
$f_{1-}^{\#2} \dagger \alpha$	0	0	$-\frac{1}{3}ik(t_1-2t_3)$	$-\frac{1}{3}i\sqrt{2}k(t_1+t_3)$	0	$\frac{2}{3}k^2(t_1+t_3)$

Quadratic (free) action

$$S = \iiint (\frac{1}{6} (2\omega_{\alpha}^{\alpha i} (t_1\omega_{,\theta}^{\theta}-2t_3\omega_{,\kappa}^{\kappa}) + 6f^{\alpha\beta}\tau_{\alpha\beta} + 6\omega^{\alpha\beta\chi}\sigma_{\alpha\beta\chi} - 4t_1\omega_{\alpha}^{\theta}\partial_{,\theta}f^{\alpha i} + 8t_3\omega_{\alpha}^{\kappa}\partial_{,\kappa}f^{\alpha i} + 4t_1\omega_{,\theta}^{\theta}\partial'f_{\alpha}^{\alpha} - 8t_3\omega_{,\kappa}^{\kappa}\partial'f_{\alpha}^{\alpha} - 2t_1\partial_{,\theta}f_{\theta}^{\theta}\partial'f_{\alpha}^{\alpha} + 4t_3\partial_{,\kappa}f_{\kappa}^{\kappa}\partial'f_{\alpha}^{\alpha} - 2t_1\partial_{,\theta}f_{\alpha}^{\alpha i}\partial_{\theta}f_{\alpha}^{\theta} + 4t_1\partial'f_{\alpha}^{\alpha}\partial_{\theta}f_{\alpha}^{\theta} - 6t_1\partial_{\alpha}f_{,\theta}\partial^{\theta}f^{\alpha i} - 3t_1\partial_{\alpha}f_{\theta i}\partial^{\theta}f^{\alpha i} + 3t_1\partial_{,\theta}f_{\alpha\theta}\partial^{\theta}f^{\alpha i} + 3t_1\partial_{\theta}f_{\alpha i}\partial^{\theta}f^{\alpha i} + 3t_1\partial_{\theta}f_{,\alpha}\partial^{\theta}f^{\alpha i} + 6t_1\omega_{\alpha\theta i}(\omega^{\alpha i\theta} + 2\partial^{\theta}f^{\alpha i}) - 8r_1\partial_{\beta}\omega_{\alpha i\theta}\partial^{\theta}\omega^{\alpha\beta i} + 4r_1\partial_{\beta}\omega_{\alpha\theta i}\partial^{\theta}\omega^{\alpha\beta i} - 16r_1\partial_{\beta}\omega_{,\theta\alpha}\partial^{\theta}\omega_{,\theta\alpha}^{\alpha\beta i} - 4r_1\partial_{,\theta}\omega_{\alpha\beta\theta}\partial^{\theta}\omega^{\alpha\beta i} + 4r_1\partial_{\theta}\omega_{\alpha\beta i}\partial^{\theta}\omega^{\alpha\beta i} + 4r_1\partial_{\theta}\omega_{\alpha i\beta}\partial^{\theta}\omega^{\alpha\beta i} + 6r_5\partial_{,\theta}\omega_{\theta\kappa}^{\kappa}\partial^{\theta}\omega_{,\kappa}^{\kappa} - 6r_5\partial_{\theta}\omega_{,\kappa}^{\kappa}\partial^{\theta}\omega_{\alpha}^{\alpha i} + 4t_3\partial_{,\theta}f^{\alpha i}\partial_{\kappa}f_{\alpha}^{\kappa} - 8t_3\partial'f_{\alpha}^{\alpha}\partial_{\kappa}f_{,\kappa}^{\kappa} - 6r_5\partial_{\alpha}\omega^{\alpha i\theta}\partial_{\kappa}\omega_{,\theta}^{\kappa} + 12r_5\partial^{\theta}\omega_{\alpha}^{\alpha i}\partial_{\kappa}\omega_{,\theta}^{\kappa} + 6r_5\partial_{\alpha}\omega^{\alpha i\theta}\partial_{\kappa}\omega_{\theta}^{\kappa} - 12r_5\partial^{\theta}\omega_{\alpha}^{\alpha i}\partial_{\kappa}\omega_{\theta}^{\kappa}))[t,x,y,z]dzdydxdt$$

$\sigma_{0+}^{\#1} \dagger$	$\tau_{0+}^{\#1}$	$\tau_{0+}^{\#2}$	$\sigma_{0-}^{\#1}$
$\sigma_{0+}^{\#1} \dagger$	$-\frac{1}{(1+2k^2)^2t_3}$	$-\frac{i\sqrt{2}k}{(1+2k^2)^2t_3}$	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	$-\frac{1}{t_1}$

	$\omega_{2+}^{\#1} \dagger \alpha\beta$	$f_{2+}^{\#1} \dagger \alpha\beta$	$\omega_{2-}^{\#1} \alpha\beta\chi$
$\omega_{2+}^{\#1} \dagger \alpha\beta$	$\frac{t_1}{2}$	$-\frac{ikt_1}{\sqrt{2}}$	0
$f_{2+}^{\#1} \dagger \alpha\beta$	$\frac{ikt_1}{\sqrt{2}}$	$k^2 t_1$	0
$\omega_{2-}^{\#1} \dagger \alpha\beta\chi$	0	0	$k^2 r_1 + \frac{t_1}{2}$

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

$\omega_{0+}^{\#1} \dagger$	$f_{0+}^{\#2} \dagger$	$\omega_{0-}^{\#1}$
$\omega_{0+}^{\#1} \dagger$	0	0
$f_{0+}^{\#2} \dagger$	$-i\sqrt{2}kt_3$	0
$f_{0+}^{\#1} \dagger$	$i\sqrt{2}kt_3$	0
$f_{0+}^{\#2} \dagger$	0	0
$\omega_{0-}^{\#1} \dagger$	0	$-t_1$