

Particle spectrograph

Wave operator and propagator

$\sigma_{1+}^{\#1} + \alpha\beta$	$\tau_{1+}^{\#1} + \alpha\beta$	$\sigma_{1+}^{\#2} \alpha$	$\tau_{1+}^{\#1} \alpha$	$\tau_{1+}^{\#2} \alpha$
$\sigma_{1+}^{\#1} + \alpha\beta$	$\frac{2(t_1+t_2)}{3t_1t_2+2k^2(2r_1+r_5)(t_1+t_2)}$	$\frac{\sqrt{2}(t_1-2t_2)}{(1+k^2)(3t_1t_2+2k^2(2r_1+r_5)(t_1+t_2))}$	0	0
$\sigma_{1+}^{\#2} + \alpha\beta$	$\frac{\sqrt{2}(t_1-2t_2)}{(1+k^2)(3t_1t_2+2k^2(2r_1+r_5)(t_1+t_2))}$	$\frac{6k^2(2r_1+r_5)+t_1+4t_2}{(1+k^2)^2(3t_1t_2+2k^2(2r_1+r_5)(t_1+t_2))}$	0	0
$\tau_{1+}^{\#1} + \alpha\beta$	$-\frac{i\sqrt{2}k(t_1-2t_2)}{(1+k^2)(3t_1t_2+2k^2(2r_1+r_5)(t_1+t_2))}$	$\frac{k^2(6k^2(2r_1+r_5)+t_1+4t_2)}{(1+k^2)^2(3t_1t_2+2k^2(2r_1+r_5)(t_1+t_2))}$	0	0
$\sigma_{1-}^{\#1} + \alpha$	0	0	$\frac{\sqrt{2}}{t_1+2k^2t_1}$	$\frac{2ik}{t_1+2k^2t_1}$
$\sigma_{1-}^{\#2} + \alpha$	0	0	$-\frac{\sqrt{2}}{t_1+2k^2t_1}$	$-\frac{i\sqrt{2}k(2k^2(r_1+r_5)+t_1)}{(t_1+2k^2t_1)^2}$
$\tau_{1-}^{\#1} + \alpha$	0	0	0	0
$\tau_{1-}^{\#2} + \alpha$	0	0	$-\frac{2ik}{t_1+2k^2t_1}$	$\frac{-4k^4(r_1+r_5)+2k^2t_1}{(t_1+2k^2t_1)^2}$

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

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

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

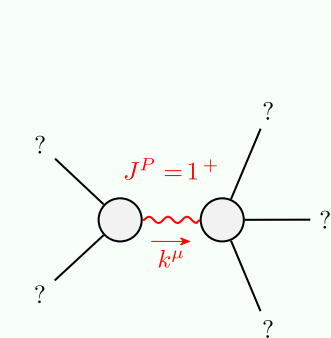
$\sigma_{0+}^{\#1} + \alpha$	$\tau_{0+}^{\#1} + \alpha$	$\tau_{0+}^{\#2} + \alpha$	$\sigma_{0-}^{\#1} + \alpha$
$\sigma_{0+}^{\#1} + \alpha$	$-\frac{1}{(1+2k^2)^2t_1}$	$\frac{i\sqrt{2}k}{(1+2k^2)^2t_1}$	0
$\tau_{0+}^{\#1} + \alpha$	$-\frac{i\sqrt{2}k}{(1+2k^2)^2t_1}$	$-\frac{2k^2}{(1+2k^2)^2t_1}$	0
$\tau_{0+}^{\#2} + \alpha$	0	0	0
$\sigma_{0-}^{\#1} + \alpha$	0	0	$\frac{1}{t_2}$

Quadratic (free) action
$S_F = \iiint \iiint (\frac{1}{6} (-6t_1 \omega_{\alpha'}^{\alpha'} \omega_{\alpha}^{\alpha} - 2(t_1 - 2t_2) \omega_{\alpha}^{\alpha} \omega_{\alpha}^{\alpha} + 2t_1 \omega_{\alpha}^{\alpha} \omega_{\alpha}^{\alpha} + 2t_2 \omega_{\alpha}^{\alpha} \omega_{\alpha}^{\alpha} + 6f^{\alpha\beta} \tau_{\alpha\beta} + 6\omega^{\alpha\beta\chi} \sigma_{\alpha\beta\chi} - 6r_5 \partial_{\alpha} \omega_{\alpha}^{\alpha} \partial^{\alpha} \omega_{\alpha}^{\alpha} - 4r_1 \partial^{\beta} \omega_{\alpha}^{\alpha} \partial_{\beta} \omega_{\alpha}^{\alpha} - 4r_1 \partial_{\beta} \omega_{\alpha}^{\alpha} \partial_{\alpha} \omega_{\alpha}^{\alpha} + 4r_1 \partial_{\beta} \omega_{\alpha}^{\alpha} \partial_{\alpha} \omega_{\alpha}^{\alpha} - 6r_5 \partial_{\alpha} \omega_{\alpha}^{\alpha} \partial_{\alpha} \omega_{\alpha}^{\alpha} + 6r_5 \partial_{\alpha} \omega_{\alpha}^{\alpha} \partial_{\alpha} \omega_{\alpha}^{\alpha} + 12r_5 \partial_{\alpha} \omega_{\alpha}^{\alpha} \partial_{\alpha} \omega_{\alpha}^{\alpha} - 2t_1 \partial^{\alpha} f_{\alpha} \partial^{\alpha} f_{\alpha}^{\alpha} + t_2 \partial^{\alpha} f_{\alpha} \partial^{\alpha} f_{\alpha}^{\alpha} - 4t_1 \partial^{\alpha} f_{\alpha} \partial^{\alpha} f_{\alpha}^{\alpha} - t_2 \partial^{\alpha} f_{\alpha} \partial^{\alpha} f_{\alpha}^{\alpha} - 2t_1 \partial^{\alpha} f_{\alpha}^{\alpha} \partial^{\alpha} f_{\alpha}^{\alpha} + t_2 \partial^{\alpha} f_{\alpha}^{\alpha} \partial^{\alpha} f_{\alpha}^{\alpha} + 6t_1 \omega_{\alpha}^{\alpha} \partial^{\alpha} f_{\alpha}^{\alpha} + 6t_1 \omega_{\alpha}^{\alpha} \partial^{\alpha} f_{\alpha}^{\alpha} + 12t_1 \partial^{\alpha} f_{\alpha} \partial^{\alpha} f_{\alpha}^{\alpha} - 6t_1 \partial_{\alpha} f_{\alpha}^{\alpha} \partial^{\alpha} f_{\alpha}^{\alpha} + 2t_1 \omega_{\alpha}^{\alpha} \partial^{\alpha} f_{\alpha}^{\alpha} + 2t_2 \omega_{\alpha}^{\alpha} \partial^{\alpha} f_{\alpha}^{\alpha} + 8t_1 \omega_{\alpha}^{\alpha} \partial^{\alpha} f_{\alpha}^{\alpha} - 4t_2 \omega_{\alpha}^{\alpha} \partial^{\alpha} f_{\alpha}^{\alpha} - 2t_1 \omega_{\alpha}^{\alpha} \partial^{\alpha} f_{\alpha}^{\alpha} - 2t_2 \omega_{\alpha}^{\alpha} \partial^{\alpha} f_{\alpha}^{\alpha} + 4t_1 \omega_{\alpha}^{\alpha} \partial^{\alpha} f_{\alpha}^{\alpha} + 4t_2 \omega_{\alpha}^{\alpha} \partial^{\alpha} f_{\alpha}^{\alpha} - 6t_1 \omega_{\alpha}^{\alpha} \partial^{\alpha} f_{\alpha}^{\alpha} - 6t_1 \omega_{\alpha}^{\alpha} \partial^{\alpha} f_{\alpha}^{\alpha} + 2t_1 \partial^{\alpha} f_{\alpha}^{\alpha} \partial^{\alpha} f_{\alpha}^{\alpha} - t_2 \partial^{\alpha} f_{\alpha}^{\alpha} \partial^{\alpha} f_{\alpha}^{\alpha} + 4t_1 \partial_{\alpha} f_{\alpha}^{\alpha} \partial^{\alpha} f_{\alpha}^{\alpha} + t_2 \partial_{\alpha} f_{\alpha}^{\alpha} \partial^{\alpha} f_{\alpha}^{\alpha} - 6t_1 \partial^{\alpha} f_{\alpha}^{\alpha} \partial^{\alpha} f_{\alpha}^{\alpha} + 4r_1 \partial_{\alpha} \omega_{\alpha}^{\alpha} \partial^{\alpha} \omega_{\alpha}^{\alpha} - 4r_1 \partial_{\alpha} \omega_{\alpha}^{\alpha} \partial^{\alpha} \omega_{\alpha}^{\alpha} + 4r_1 \partial^{\beta} \omega_{\alpha}^{\alpha} \partial_{\beta} \omega_{\alpha}^{\alpha} - 16r_1 \partial^{\beta} \omega_{\alpha}^{\alpha} \partial_{\beta} \omega_{\alpha}^{\alpha} + 6r_5 \partial_{\alpha} \omega_{\alpha}^{\alpha} \partial^{\alpha} \omega_{\alpha}^{\alpha} - 6r_5 \partial_{\alpha} \omega_{\alpha}^{\alpha} \partial^{\alpha} \omega_{\alpha}^{\alpha})) [t, x, y, z] dz dy dx dt$

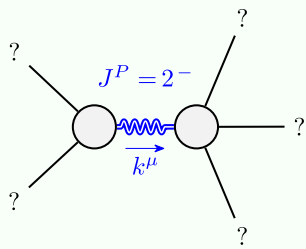
$\omega_{0+}^{\#1} + \alpha$	$f_{0+}^{\#1} + \alpha$	$f_{0+}^{\#2} + \alpha$	$\omega_{0-}^{\#1} + \alpha$
$\omega_{0+}^{\#1} + \alpha$	$-t_1$	$i\sqrt{2}kt_1$	0
$f_{0+}^{\#1} + \alpha$	$-i\sqrt{2}kt_1$	$-2k^2t_1$	0
$f_{0+}^{\#2} + \alpha$	0	0	0
$\omega_{0-}^{\#1} + \alpha$	0	0	t_2

$\omega_{1+}^{\#1} + \alpha\beta$	$\omega_{1+}^{\#2} + \alpha\beta$	$f_{1+}^{\#1} + \alpha\beta$	$\omega_{1-}^{\#1} + \alpha$	$\omega_{1-}^{\#2} + \alpha$	$f_{1-}^{\#1} + \alpha$	$f_{1-}^{\#2} + \alpha$
$\omega_{1+}^{\#1} + \alpha\beta$	$\frac{1}{6} (6k^2(2r_1+r_5)+t_1+4t_2)$	$-\frac{t_1-2t_2}{3\sqrt{2}}$	0	0	0	0
$\omega_{1+}^{\#2} + \alpha\beta$	$-\frac{t_1-2t_2}{3\sqrt{2}}$	$\frac{t_1+t_2}{3}$	0	0	0	0
$f_{1+}^{\#1} + \alpha\beta$	$\frac{ik(t_1-2t_2)}{3\sqrt{2}}$	$-\frac{1}{3} ik(t_1+t_2)$	0	0	0	0
$\omega_{1-}^{\#1} + \alpha$	0	0	$k^2(r_1+r_5) - \frac{t_1}{2}$	$\frac{t_1}{\sqrt{2}}$	$i k t_1$	0
$\omega_{1-}^{\#2} + \alpha$	0	0	0	0	0	0
$f_{1-}^{\#1} + \alpha$	0	0	0	0	0	0
$f_{1-}^{\#2} + \alpha$	0	0	$-i k t_1$	0	0	0

Massive and massless spectra



Massive particle	
Pole residue:	$\frac{-3t_1t_2(t_1+t_2)+6r_1(t_1^2+2t_2^2)+3r_5(t_1^2+2t_2^2)}{(2r_1+r_5)(t_1+t_2)-(-3t_1t_2+4r_1(t_1+t_2)+2r_5(t_1+t_2))} > 0$
Polarisations:	3
Square mass:	$-\frac{3t_1t_2}{2(2r_1+r_5)(t_1+t_2)} > 0$
Spin:	1
Parity:	Even



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

(No massless particles)

Unitarity conditions

$$r_1 < 0 \ \&\& \ r_5 > -2r_1 \ \&\& \ t_1 > 0 \ \&\& \ -t_1 < t_2 < 0$$