

Particle spectrograph

Wave operator and propagator

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

$\sigma_{0+}^{\#1} +$	$\tau_{0+}^{\#1}$	$\tau_{0+}^{\#2}$	$\sigma_{0-}^{\#1}$
$\frac{1}{(1+2k^2)^2}t_3$	$-\frac{i\sqrt{2}k}{(1+2k^2)^2}t_3$	0	0
$\frac{i\sqrt{2}k}{(1+2k^2)^2}t_3$	$\frac{2k^2}{(1+2k^2)^2}t_3$	0	0
0	0	0	0
0	0	0	$\frac{1}{k^2r_2-t_1}$

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

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

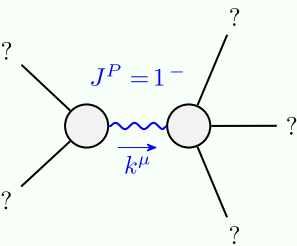
$\omega_{0+}^{\#1}$	$f_{0+}^{\#1}$	$f_{0+}^{\#2}$	$\omega_0^{\#1}$
t_3	$-i\sqrt{2}kt_3$	0	0
$i\sqrt{2}kt_3$	$2k^2t_3$	0	0
0	0	0	0
0	0	0	$k^2r_2-t_1$

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

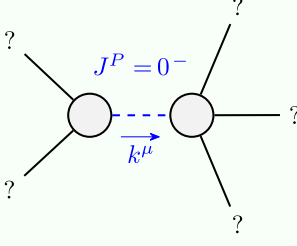
Source constraints/gauge generators	
SO(3) irreps	Multiplicities
$\tau_{0+}^{\#2} == 0$	1
$\tau_{0+}^{\#1} - 2ik\sigma_{0+}^{\#1} == 0$	1
$\tau_{1-}^{\#2\alpha} + 2ik\sigma_{1-}^{\#2\alpha} == 0$	3
$\tau_{1-}^{\#1\alpha} == 0$	3
$\tau_{1+}^{\#1\alpha\beta} + ik\sigma_{1+}^{\#2\alpha\beta} == 0$	3
$\tau_{2+}^{\#1\alpha\beta}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

Quadratic (free) action	
$S = \int \int \int (\frac{1}{6} (2 \omega^{\alpha i}_{\alpha} (t_1 \omega^{\theta}_{\theta} - 2 t_3 \omega^{\kappa}_{\kappa}) + 6 f^{\alpha\beta} \tau_{\alpha\beta} + 6 \omega^{\alpha\beta\chi} \sigma_{\alpha\beta\chi} - 4 t_1 \omega^{\theta}_{\alpha} \partial_{\theta} f^{\alpha i} + 8 t_3 \omega^{\kappa}_{\alpha} \partial_{\kappa} f^{\alpha i} + 4 t_1 \omega^{\theta}_{\theta} \partial_{\theta} f^{\alpha i} - 8 t_3 \omega^{\kappa}_{\kappa} \partial_{\kappa} f^{\alpha i} - 2 t_1 \partial_{\theta} f^{\theta}_{\theta} \partial_{\theta} f^{\alpha i} + 4 t_3 \partial_{\theta} f^{\kappa}_{\kappa} \partial_{\kappa} f^{\alpha i} - 2 t_1 \partial_{\theta} f^{\alpha i} \partial_{\theta} f^{\theta}_{\theta} + 4 t_1 \partial_{\theta} f^{\theta}_{\theta} \partial_{\theta} f^{\alpha i} - 3 t_1 \partial_{\alpha} f^{\alpha i} \partial_{\theta} f^{\alpha i} + 3 t_1 \partial_{\theta} f^{\alpha i} \partial_{\theta} f^{\alpha i} + 6 t_1 \partial_{\alpha} f^{\alpha i} \partial_{\theta} f^{\alpha i} + 6 t_1 \omega_{\alpha\theta i} (\omega^{\alpha i\theta} + 2 \partial^{\theta} f^{\alpha i}) + 8 r_2 \partial_{\beta} \omega_{\alpha i \theta} \partial^{\theta} \omega^{\alpha\beta i} - 3 t_1 \partial_{\theta} f^{\alpha i} \partial^{\theta} \omega_{\alpha\theta i} + 4 r_2 \partial_{\beta} \omega_{\alpha\theta i} \partial^{\theta} \omega^{\alpha\beta i} + 4 r_2 \partial_{\beta} \omega_{\alpha\theta i} \partial^{\theta} \omega^{\alpha\beta i} - 2 r_2 \partial_{\theta} \omega_{\alpha\theta\beta} \partial^{\theta} \omega^{\alpha\beta i} + 2 r_2 \partial_{\theta} \omega_{\alpha\beta i} \partial^{\theta} \omega^{\alpha\beta i} - 4 r_2 \partial_{\theta} \omega_{\alpha i \beta} \partial^{\theta} \omega^{\alpha\beta i} + 6 r_5 \partial_{\theta} \omega_{\kappa}^{\kappa} \partial^{\theta} \omega^{\alpha i}_{\kappa} - 6 r_5 \partial_{\theta} \omega^{\kappa}_{\kappa} \partial^{\theta} \omega^{\alpha i}_{\alpha} + \partial^{\theta} \omega^{\alpha\beta i}_{\alpha} - 4 r_2 \partial_{\theta} \omega_{\alpha i \beta} \partial^{\theta} \omega^{\alpha\beta i} + 6 r_5 \partial_{\theta} \omega_{\kappa}^{\kappa} \partial^{\theta} \omega^{\alpha i}_{\kappa} - 6 r_5 \partial_{\theta} \omega^{\kappa}_{\kappa} \partial^{\theta} \omega^{\alpha i}_{\alpha} + 4 t_3 \partial_{\theta} f^{\alpha i} \partial_{\kappa}^{\kappa} \partial_{\alpha} \partial_{\kappa} f^{\alpha i} - 8 t_3 \partial_{\theta} f^{\alpha i} \partial_{\kappa}^{\kappa} \partial_{\alpha} \partial_{\kappa} f^{\alpha i} - 6 r_5 \partial_{\alpha} \omega^{\alpha i \theta} \partial_{\kappa}^{\kappa} \partial_{\alpha} \partial_{\kappa} \omega^{\alpha i}_{\theta} + 12 r_5 \partial_{\theta} \omega^{\alpha i}_{\alpha} \partial_{\kappa}^{\kappa} \omega^{\kappa}_{\theta} + 6 r_5 \partial_{\alpha} \omega^{\alpha i \theta} \partial_{\kappa}^{\kappa} \omega^{\kappa}_{\theta} - 12 r_5 \partial_{\theta} \omega^{\alpha i}_{\alpha} \partial_{\kappa}^{\kappa} \omega^{\kappa}_{\theta})) [t, x, y, z] dz dy dx dt$	

Massive and massless spectra



Massive particle	
Pole residue:	$\frac{6t_1t_3(t_1+t_3)-3r_5(t_1^2+2t_3^2)}{2r_5(t_1+t_3)(-3t_1t_3+r_5(t_1+t_3))} > 0$
Polarisations:	3
Square mass:	$-\frac{3t_1t_3}{2r_5t_1+2r_5t_3} > 0$
Spin:	1
Parity:	Odd



Massive particle	
Pole residue:	$-\frac{1}{r_2} > 0$
Polarisations:	1
Square mass:	$\frac{t_1}{r_2} > 0$
Spin:	0
Parity:	Odd

(No massless particles)

Unitarity conditions

$r_2 < 0 \ \&\& \ r_5 < 0 \ \&\& \ t_1 < 0 \ \&\& \ 0 < t_3 < -t_1$