

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
$-\frac{\sqrt{2}}{t_1 + k^2} t_1$	$-\frac{2k^2 r_5 + t_1}{(1+k^2)^2} t_1^2$	$-\frac{i(2k^3 r_5 - kt_1)}{(1+k^2)^2} t_1^2$	0	0	0	0
$\frac{i\sqrt{2}k}{t_1 + k^2} t_1$	$\frac{i(2k^3 r_5 - kt_1)}{(1+k^2)^2} t_1^2$	$\frac{-2k^4 r_5 + k^2 t_1}{(1+k^2)^2} t_1^2$	0	0	0	0
0	0	0	$\frac{1}{k^2 r_5}$	$-\frac{1}{\sqrt{2}(k^2 r_5 + 2k^4 r_5)}$	0	$-\frac{i}{kr_5 + 2k^3 r_5}$
0	0	0	$-\frac{1}{\sqrt{2}(k^2 r_5 + 2k^4 r_5)}$	$\frac{6k^2 r_5 + t_1}{2(k+2k^3)^2 r_5 t_1}$	0	$\frac{i(6k^2 r_5 + t_1)}{\sqrt{2}k(1+2k^2)^2 r_5 t_1}$
0	0	0	0	0	0	0
0	0	0	$\frac{i}{kr_5 + 2k^3 r_5}$	$-\frac{i(6k^2 r_5 + t_1)}{\sqrt{2}k(1+2k^2)^2 r_5 t_1}$	0	$\frac{6k^2 r_5 + t_1}{(1+2k^2)^2 r_5 t_1}$

Quadratic (free) action

$$\begin{aligned}
 S_F = & \iiint \left(\frac{1}{6} (-2t_1 \omega_{\kappa\alpha}^{\alpha'} \omega_{\kappa\alpha}^{\kappa} - 6t_1 \omega_{\kappa\alpha}^{\kappa\lambda} \omega_{\kappa\lambda}^{\alpha'} + 6f^{\alpha\beta} \tau_{\alpha\beta} + 6\omega^{\alpha\beta\chi} \sigma_{\alpha\beta\chi} - 6r_5 \partial_{\lambda} \omega^{\kappa\lambda}_{\alpha} \right. \\
 & \partial' \omega_{\lambda}^{\alpha} - 6r_5 \partial_{\alpha} \omega_{\lambda}^{\alpha} \partial_{\kappa} \omega^{\kappa\lambda}_{\theta} + 6r_5 \partial_{\theta} \omega_{\lambda}^{\alpha} \partial_{\kappa} \omega^{\theta\kappa\lambda}_{\alpha} - 6r_5 \partial_{\alpha} \omega_{\lambda}^{\alpha} \partial_{\theta} \omega^{\kappa\lambda\theta}_{\alpha} + \\
 & 12r_5 \partial_{\theta} \omega_{\lambda}^{\alpha} \partial_{\kappa} \omega^{\kappa\lambda\theta}_{\alpha} - 3t_1 \partial^{\alpha} f_{\theta\kappa} \partial^{\kappa} f_{\alpha}^{\theta} - 3t_1 \partial^{\alpha} f_{\kappa\theta} \partial^{\kappa} f_{\alpha}^{\theta} - \\
 & 3t_1 \partial^{\alpha} f_{\kappa}^{\lambda} \partial^{\kappa} f_{\alpha\lambda} + 2t_1 \omega_{\kappa\alpha}^{\alpha} \partial^{\kappa} f_{\alpha}^{\lambda} + 2t_1 \omega_{\kappa\lambda}^{\lambda} \partial^{\kappa} f_{\alpha}^{\lambda} + 4t_1 \partial^{\alpha} f_{\kappa\alpha} \partial^{\kappa} f_{\alpha}^{\lambda} - \\
 & 2t_1 \partial_{\kappa} f_{\lambda}^{\lambda} \partial^{\kappa} f_{\alpha}^{\lambda} + 12t_1 \omega_{\kappa\theta} \partial^{\kappa} f_{\alpha}^{\theta} - 2t_1 \omega_{\alpha\lambda}^{\alpha} \partial^{\kappa} f_{\kappa}^{\lambda} - 2t_1 \omega_{\lambda\alpha}^{\lambda} \partial^{\kappa} f_{\kappa}^{\lambda} + \\
 & 3t_1 \partial^{\alpha} f_{\kappa}^{\lambda} \partial^{\kappa} f_{\lambda\alpha} + 3t_1 \partial_{\kappa} f_{\theta}^{\lambda} \partial^{\kappa} f_{\lambda}^{\theta} + 3t_1 \partial_{\kappa} f_{\theta}^{\lambda} \partial^{\kappa} f_{\lambda}^{\theta} - 2t_1 \partial^{\alpha} f_{\lambda}^{\alpha} \partial^{\kappa} f_{\alpha}^{\lambda} + \\
 & \left. 6r_5 \partial_{\alpha} \omega_{\lambda}^{\alpha} \partial^{\lambda} \omega^{\theta\kappa}_{\kappa} - 6r_5 \partial_{\theta} \omega_{\lambda}^{\alpha} \partial^{\lambda} \omega^{\theta\kappa}_{\alpha} \right) [t, x, y, z] dz dy dx dt
 \end{aligned}$$

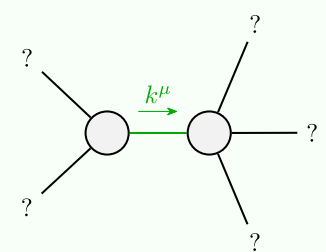
$\omega_{1+}^{\#1} + \alpha\beta$	$\omega_{1+}^{\#2} + \alpha\beta$	$f_{1+}^{\#1} + \alpha\beta$	$\omega_{1+}^{\#1} - \alpha$	$\omega_{1+}^{\#2} - \alpha$	$f_{1+}^{\#1} - \alpha$	$f_{1+}^{\#2} - \alpha$
$k^2 r_5 - \frac{t_1}{2}$	$-\frac{t_1}{\sqrt{2}}$	$-\frac{ikt_1}{\sqrt{2}}$	0	0	0	0
$-\frac{t_1}{\sqrt{2}}$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

Source constraints/gauge generators	
SO(3) irreps	Multiplicities
$\sigma_{0+}^{\#1} == 0$	1
$\tau_{0+}^{\#1} == 0$	1
$\tau_{0+}^{\#2} == 0$	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:	17

$\sigma_{0+}^{\#1} +$	$\tau_{0+}^{\#1} +$	$\tau_{0+}^{\#2} +$	$\sigma_{0-}^{\#1} +$
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	$-\frac{1}{t_1}$

$\omega_{0+}^{\#1} +$	$f_{0+}^{\#1} +$	$f_{0+}^{\#2} +$	$\omega_{0-}^{\#1} +$
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	$-t_1$

Massive and massless spectra



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

(No massive particles)

Unitarity conditions

$$r_5 < 0 \&\& t_1 < 0 || t_1 > 0$$