Particle spectrograph

Wave operator and propagator

	$\sigma^{\#1}_{1^+\,\alpha\beta}$	$\sigma^{\#2}_{1^+\,\alpha\beta}$	$\tau^{\#1}_{1^+\,\alpha\beta}$	$\sigma^{\#1}_{1^-\,\alpha}$	$\sigma^{\#2}_{1^-\,\alpha}$	$\tau^{\#1}_{1^-\,\alpha}$	$\tau^{\#2}_{1^-\,\alpha}$
$\sigma^{\#1}_{1^+}{}^{\alpha\beta}$	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
$\sigma^{\#2}_{1^+}{}^{\alpha\beta}$	$-\frac{\sqrt{2}}{t_1+k^2 t_1}$	$\frac{-2k^2(2r_3+r_5)+t_1}{(1+k^2)^2 t_1{}^2}$	$\frac{-2ik^3(2r_3+r_5)+ikt_1}{(1+k^2)^2 t_1{}^2}$	0	0	0	0
$\tau^{\#1}_{1^+}{}^{\alpha\beta}$	$\frac{i\sqrt{2}\,k}{t_1+k^2 t_1}$	$\frac{i(2k^3(2r_3+r_5)-kt_1)}{(1+k^2)^2 t_1{}^2}$	$\frac{-2k^4(2r_3+r_5)+k^2 t_1}{(1+k^2)^2 t_1{}^2}$	0	0	0	0
$\sigma^{\#1}_{1^-}{}^{\alpha}$	0	0	0	$\frac{1}{k^2(2r_3+r_5)}$	$-\frac{1}{\sqrt{2}\,(k^2+2k^4)(2r_3+r_5)}$	0	$-\frac{i}{k(1+2k^2)(2r_3+r_5)}$
$\sigma^{\#2}_{1^-}{}^{\alpha}$	0	0	0	$-\frac{1}{\sqrt{2}\,(k^2+2k^4)(2r_3+r_5)}$	$\frac{6k^2(2r_3+r_5)+t_1}{2(k+2k^3)^2(2r_3+r_5)t_1}$	0	$\frac{i(6k^2(2r_3+r_5)+t_1)}{\sqrt{2}\,k(1+2k^2)^2(2r_3+r_5)t_1}$
$\tau^{\#1}_{1^-}{}^{\alpha}$	0	0	0	0	0	0	0
$\tau^{\#2}_{1^-}{}^{\alpha}$	0	0	0	$\frac{i}{k(1+2k^2)(2r_3+r_5)}$	$-\frac{i(6k^2(2r_3+r_5)+t_1)}{\sqrt{2}\,k(1+2k^2)^2(2r_3+r_5)t_1}$	0	$\frac{6k^2(2r_3+r_5)+t_1}{(1+2k^2)^2(2r_3+r_5)t_1}$

Quadratic (free) action

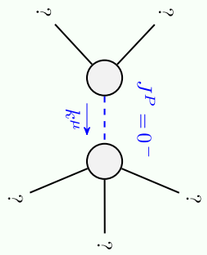
$$
\begin{aligned}
S_F == \iiiint \Big(&\tfrac{1}{6}\,(-2t_1\,\omega_{\prime}{}^{\alpha\prime}{}_{\kappa\alpha}{}^{\kappa} - 6t_1\,\omega_{\prime}{}^{\kappa\lambda}{}_{\kappa\lambda}{}^{\prime} + 6\,f^{\alpha\beta}\,\tau_{\alpha\beta} + 6\,\omega^{\alpha\beta\chi}\,\sigma_{\alpha\beta\chi} - \\
&12r_3\,\partial_{\prime}\omega^{\kappa\lambda}{}_{\kappa}\partial^{\prime}\omega_{\lambda}{}^{\alpha}{}_{\alpha} - 6r_5\,\partial_{\prime}\omega^{\kappa\lambda}{}_{\kappa}\partial^{\prime}\omega_{\lambda}{}^{\alpha}{}_{\alpha} + 4r_2\,\partial^{\beta}\omega^{\theta\alpha}{}_{\kappa}\partial_{\theta}\omega_{\alpha\beta}{}^{\kappa} - \\
&2r_2\,\partial_{\theta}\omega_{\alpha\beta}{}^{\kappa}\partial_{\kappa}\omega^{\alpha\beta\theta} - 4r_2\,\partial_{\theta}\omega_{\alpha\beta}{}^{\kappa}\partial_{\kappa}\omega^{\theta\alpha\beta} + 12r_3\,\partial_{\alpha}\omega_{\lambda}{}^{\alpha}{}_{\theta}\partial_{\kappa}\omega^{\theta\kappa\lambda} - \\
&6r_5\,\partial_{\alpha}\omega_{\lambda}{}^{\alpha}{}_{\theta}\partial_{\kappa}\omega^{\theta\kappa\lambda} - 12r_3\,\partial_{\theta}\omega_{\lambda}{}^{\alpha}{}_{\alpha}\partial_{\kappa}\omega^{\theta\kappa\lambda} + 6r_5\,\partial_{\theta}\omega_{\lambda}{}^{\alpha}{}_{\alpha}\partial_{\kappa}\omega^{\theta\kappa\lambda} - \\
&12r_3\,\partial_{\alpha}\omega_{\lambda}{}^{\alpha}{}_{\theta}\partial_{\kappa}\omega^{\kappa\lambda\theta} - 6r_5\,\partial_{\alpha}\omega_{\lambda}{}^{\alpha}{}_{\theta}\partial_{\kappa}\omega^{\kappa\lambda\theta} + 24r_3\,\partial_{\theta}\omega_{\lambda}{}^{\alpha}{}_{\alpha}\partial_{\kappa}\omega^{\kappa\lambda\theta} + \\
&12r_5\,\partial_{\theta}\omega_{\lambda}{}^{\alpha}{}_{\alpha}\partial_{\kappa}\omega^{\kappa\lambda\theta} - 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^{\lambda}{}_{\kappa}\partial^{\kappa}f_{\alpha\lambda} + \\
&2t_1\,\omega_{\kappa\alpha}{}^{\alpha}\,\partial^{\kappa}f^{\prime}{}_{\prime} + 2t_1\,\omega_{\kappa\lambda}{}^{\lambda}\,\partial^{\kappa}f^{\prime}{}_{\prime} + 4t_1\,\partial^{\alpha}f_{\kappa\alpha}\partial^{\kappa}f^{\prime}{}_{\prime} - 2t_1\,\partial_{\kappa}f^{\lambda}{}_{\lambda}\partial^{\kappa}f^{\prime}{}_{\prime} + \\
&12t_1\,\omega_{\prime\kappa\theta}\,\partial^{\kappa}f^{\prime\theta} - 2t_1\,\omega_{\prime\alpha}{}^{\alpha}\,\partial^{\kappa}f^{\prime}{}_{\kappa} - 2t_1\,\omega_{\prime\lambda}{}^{\lambda}\,\partial^{\kappa}f^{\prime}{}_{\kappa} + 3t_1\,\partial^{\alpha}f^{\lambda}{}_{\kappa}\partial^{\kappa}f_{\lambda\alpha} + \\
&3t_1\,\partial_{\kappa}f_{\theta}{}^{\lambda}\partial^{\kappa}f_{\lambda}{}^{\theta} + 3t_1\,\partial_{\kappa}f^{\lambda}{}_{\theta}\partial^{\kappa}f_{\lambda}{}^{\theta} - 2t_1\,\partial^{\alpha}f^{\lambda}{}_{\alpha}\partial^{\kappa}f_{\lambda\kappa} + 2r_2\,\partial_{\kappa}\omega^{\alpha\beta\theta}\partial^{\kappa}\omega_{\alpha\beta\theta} + \\
&4r_2\,\partial_{\kappa}\omega^{\theta\alpha\beta}\partial^{\kappa}\omega_{\alpha\beta\theta} - 4r_2\,\partial^{\beta}\omega_{\prime}{}^{\alpha\lambda}\partial_{\lambda}\omega_{\alpha\beta}{}^{\prime} + 4r_2\,\partial^{\beta}\omega_{\prime}{}^{\lambda\alpha}\partial_{\lambda}\omega_{\alpha\beta}{}^{\prime} - \\
&24r_3\,\partial^{\beta}\omega_{\prime}{}^{\lambda\alpha}\partial_{\lambda}\omega_{\alpha\beta}{}^{\prime} - 12r_3\,\partial_{\alpha}\omega_{\lambda}{}^{\alpha}{}_{\theta}\partial^{\lambda}\omega^{\theta\kappa}{}_{\kappa} + 6r_5\,\partial_{\alpha}\omega_{\lambda}{}^{\alpha}{}_{\theta}\partial^{\lambda}\omega^{\theta\kappa}{}_{\kappa} + \\
&12r_3\,\partial_{\theta}\omega_{\lambda}{}^{\alpha}{}_{\alpha}\partial^{\lambda}\omega^{\theta\kappa}{}_{\kappa} - 6r_5\,\partial_{\theta}\omega_{\lambda}{}^{\alpha}{}_{\alpha}\partial^{\lambda}\omega^{\theta\kappa}{}_{\kappa}\Big)[t, x, y, z]\,dz\,dy\,dx\,dt
\end{aligned}
$$

Source constraints/gauge generators

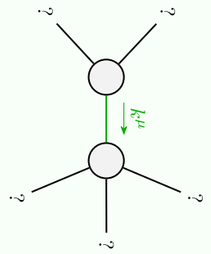
SO(3) irreps	Multiplicities
$\tau^{\#2}_{0^+} == 0$	1
$\tau^{\#1}_{0^+} == 0$	1
$\tau^{\#2\,\alpha}_{1^-} + 2i\,k\,\sigma^{\#2\,\alpha}_{1^-} == 0$	3
$\tau^{\#1\,\alpha}_{1^-} == 0$	3
$\tau^{\#1\,\alpha\beta}_{1^+} + i\,k\,\sigma^{\#2\,\alpha\beta}_{1^+} == 0$	3
$\tau^{\#1\,\alpha\beta}_{2^+} - 2i\,k\,\sigma^{\#1\,\alpha\beta}_{2^+} == 0$	5
Total constraints:	16

	$\sigma^{\#1}_{2^+\,\alpha\beta}$	$\tau^{\#1}_{2^+\,\alpha\beta}$	$\sigma^{\#1}_{2^-\,\alpha\beta\chi}$
$\sigma^{\#1}_{2^+}{}^{\alpha\beta}$	$\frac{2}{(1+2k^2)^2 t_1}$	$-\frac{2i\sqrt{2}\,k}{(1+2k^2)^2 t_1}$	0
$\tau^{\#1}_{2^+}{}^{\alpha\beta}$	$\frac{2i\sqrt{2}\,k}{(1+2k^2)^2 t_1}$	$\frac{4k^2}{(1+2k^2)^2 t_1}$	0
$\sigma^{\#1}_{2^-}{}^{\alpha\beta\chi}$	0	0	$\frac{2}{t_1}$

Massive and massless spectra



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



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

Unitarity conditions

$r_2 < 0$ && $r_5 < -2\,r_3$ && $t_1 < 0$

	$\omega^{\#1}_{1^+\,\alpha\beta}$	$\omega^{\#2}_{1^+\,\alpha\beta}$	$f^{\#1}_{1^+\,\alpha\beta}$	$\omega^{\#1}_{1^-\,\alpha}$	$\omega^{\#2}_{1^-\,\alpha}$	$f^{\#1}_{1^-\,\alpha}$	$f^{\#2}_{1^-\,\alpha}$
$\omega^{\#1}_{1^+}{}^{\alpha\beta}$	$k^2(2r_3+r_5) - \frac{t_1}{2}$	$-\frac{t_1}{\sqrt{2}}$	$-\frac{ikt_1}{\sqrt{2}}$	0	0	0	0
$\omega^{\#2}_{1^+}{}^{\alpha\beta}$	$-\frac{t_1}{\sqrt{2}}$	0	0	0	0	0	0
$f^{\#1}_{1^+}{}^{\alpha\beta}$	$\frac{ikt_1}{\sqrt{2}}$	0	0	0	0	0	0
$\omega^{\#1}_{1^-}{}^{\alpha}$	0	0	0	$k^2(2r_3+r_5) + \frac{t_1}{6}$	$\frac{t_1}{3\sqrt{2}}$	0	$\frac{ikt_1}{3}$
$\omega^{\#2}_{1^-}{}^{\alpha}$	0	0	0	$\frac{t_1}{3\sqrt{2}}$	$\frac{t_1}{3}$	0	$\frac{1}{3}i\sqrt{2}\,kt_1$
$f^{\#1}_{1^-}{}^{\alpha}$	0	0	0	0	0	0	0
$f^{\#2}_{1^-}{}^{\alpha}$	0	0	0	$-\frac{1}{3}ikt_1$	$-\frac{1}{3}i\sqrt{2}\,kt_1$	0	$\frac{2k^2t_1}{3}$

	$\sigma^{\#1}_{0^+}$	$\tau^{\#1}_{0^+}$	$\tau^{\#2}_{0^+}$	$\sigma^{\#1}_{0^-}$
$\sigma^{\#1}_{0^+}{}^{\dagger}$	$\frac{1}{6k^2 r_3}$	0	0	0
$\tau^{\#1}_{0^+}{}^{\dagger}$	0	0	0	0
$\tau^{\#2}_{0^+}{}^{\dagger}$	0	0	0	0
$\sigma^{\#1}_{0^-}{}^{\dagger}$	0	0	0	$\frac{1}{k^2 r_2 - t_1}$

	$\omega^{\#1}_{2^+\,\alpha\beta}$	$f^{\#1}_{2^+\,\alpha\beta}$	$\omega^{\#1}_{2^-\,\alpha\beta\chi}$
$\omega^{\#1}_{2^+}{}^{\alpha\beta}$	$\frac{t_1}{2}$	$-\frac{ikt_1}{\sqrt{2}}$	0
$f^{\#1}_{2^+}{}^{\alpha\beta}$	$\frac{ikt_1}{\sqrt{2}}$	$k^2 t_1$	0
$\omega^{\#1}_{2^-}{}^{\alpha\beta\chi}$	0	0	$\frac{t_1}{2}$

	$\omega^{\#1}_{0^+}{}^{\dagger}$	$f^{\#1}_{0^+}{}^{\dagger}$	$f^{\#2}_{0^+}{}^{\dagger}$	$\omega^{\#1}_{0^-}{}^{\dagger}$
$\omega^{\#1}_{0^+}$	$6k^2 r_3$	0	0	0
$f^{\#1}_{0^+}$	0	0	0	0
$f^{\#2}_{0^+}$	0	0	0	0
$\omega^{\#1}_{0^-}$	0	0	0	$k^2 r_2 - t_1$