Particle spectrograph

Wave operator and propagator

	$\sigma_{1^+}^{\#2}{}_{\alpha\beta}$	$\tau_{1^+}^{\#1}{}_{\alpha\beta}$	$\sigma_{1^-}^{\#1}{}_{\alpha}$	$\tau_{1^-}^{\#1}{}_{\alpha}$	$\tau_{1^-}^{\#2}{}_{\alpha}$
$\sigma_{1^+}^{\#1}{}_{\alpha\beta}\,\dagger$	$-\frac{\sqrt{2}}{k^2\,(1+k^2)\,(2\,r_3+r_5)}$	$-\frac{i\,\sqrt{2}}{k\,(1+k^2)\,(2\,r_3+r_5)}$	$\frac{4\,i}{k\,(1+2\,k^2)\,(r_3+2\,r_5)}$	0	0
$\sigma_{1^+}^{\#2}{}_{\alpha\beta}\,\dagger$	$\frac{3\,k^2\,(r_3+2\,r_5)+4\,t_3}{(k+k^3)^2\,(2\,r_3+r_5)\,t_3}$	$\frac{i\,(3\,k^2\,(2\,r_3+r_5)+2\,t_2)}{k\,(1+k^2)^2\,(2\,r_3+r_5)\,t_2}$	$\frac{2\,\sqrt{2}}{k^2\,(1+2\,k^2)\,(r_3+2\,r_5)}$	0	0
$\tau_{1^+}^{\#1}{}_{\alpha\beta}\,\dagger$	0	$\frac{3\,k^2\,(2\,r_3+r_5)+2\,t_2}{(1+k^2)^2\,(2\,r_3+r_5)\,t_2}$	0	0	0
$\sigma_{1^-}^{\#1}{}_{\alpha}\,\dagger$	$-\frac{i\,\sqrt{2}\,(3\,k^2\,(r_3+2\,r_5)+4\,t_3)}{k\,(1+2\,k^2)^2\,(r_3+2\,r_5)\,t_3}$	0	$-\frac{4\,i}{k\,(1+2\,k^2)\,(r_3+2\,r_5)}$	$\frac{6\,k^2\,(r_3+2\,r_5)+8\,t_3}{(1+2\,k^2)^2\,(r_3+2\,r_5)\,t_3}$	0
$\sigma_{1^-}^{\#2}{}_{\alpha}\,\dagger$	0	0	0	0	$\frac{1}{t_2}$

	$\sigma_{0^+}^{\#1}$	$\tau_{0^+}^{\#1}$	$\tau_{0^+}^{\#2}$	$\sigma_{0^-}^{\#1}$
$\sigma_{0^+}^{\#1}\,\dagger$	$\frac{1}{(1+2\,k^2)^2\,t_3}$	$-\frac{i\,\sqrt{2}\,k}{(1+2\,k^2)^2\,t_3}$	0	0
$\tau_{0^+}^{\#1}\,\dagger$	$\frac{i\,\sqrt{2}\,k}{(1+2\,k^2)^2\,t_3}$	$\frac{2\,k^2}{(1+2\,k^2)^2\,t_3}$	0	0
$\tau_{0^+}^{\#2}\,\dagger$	0	0	0	0
$\sigma_{0^-}^{\#1}\,\dagger$	0	0	0	$\frac{1}{t_2}$

	$\omega_{0^+}^{\#1}$	$f_{0^+}^{\#1}$	$f_{0^+}^{\#2}$	$\omega_{0^-}^{\#1}$
$\omega_{0^+}^{\#1}\,\dagger$	t_3	$-i\,\sqrt{2}\,k\,t_3$	0	0
$f_{0^+}^{\#1}\,\dagger$	$i\,\sqrt{2}\,k\,t_3$	$2\,k^2\,t_3$	0	0
$f_{0^+}^{\#2}\,\dagger$	0	0	0	0
$\omega_{0^-}^{\#1}\,\dagger$	0	0	0	t_2

	$f_{1^-}^{\#2}{}_{\alpha}$	$f_{1^-}^{\#1}{}_{\alpha}$	$\omega_{1^-}^{\#2}{}_{\alpha}$	$\omega_{1^-}^{\#1}{}_{\alpha}$	$f_{1^+}^{\#1}{}_{\alpha\beta}$	$\omega_{1^+}^{\#2}{}_{\alpha\beta}$	$\omega_{1^+}^{\#1}{}_{\alpha\beta}$
$f_{1^-}^{\#2}{}_{\alpha}\,\dagger$	0	$-\frac{2}{3}\,i\,k\,t_3$	0	$k^2\,(\frac{r_3}{2}+r_5)+\frac{2\,t_3}{3}$	$\frac{1}{3}\,i\,\sqrt{2}\,k\,t_2$	$\frac{\sqrt{2}\,t_2}{3}$	$k^2\,(2\,r_3+r_5)+\frac{2\,t_2}{3}$
$f_{1^-}^{\#1}{}_{\alpha}\,\dagger$	$\frac{1}{3}\,i\,\sqrt{2}\,k\,t_3$	0	$-\frac{\sqrt{2}\,t_3}{3}$	$\frac{\sqrt{2}\,t_2}{3}$	$\frac{i\,k\,t_2}{3}$	$\frac{t_2}{3}$	$\frac{\sqrt{2}\,t_2}{3}$
$\omega_{1^-}^{\#2}{}_{\alpha}\,\dagger$	0	$\frac{t_3}{3}$	0	0	$\frac{k^2\,t_2}{3}$	$-\frac{1}{3}\,i\,k\,t_2$	$-\frac{\sqrt{2}\,t_2}{3}$
$\omega_{1^-}^{\#1}{}_{\alpha}\,\dagger$	$-\frac{2}{3}\,i\,k\,t_3$	$\frac{1}{3}\,i\,\sqrt{2}\,k\,t_3$	0	$\frac{2\,i\,k\,t_3}{3}$	0	0	0
$f_{1^+}^{\#1}{}_{\alpha\beta}\,\dagger$	0	0	0	0	0	0	0
$\omega_{1^+}^{\#2}{}_{\alpha\beta}\,\dagger$	0	0	0	0	0	0	0
$\omega_{1^+}^{\#1}{}_{\alpha\beta}\,\dagger$	$k^2\,(\frac{r_3}{2}+r_5)+\frac{2\,t_3}{3}$	$-\frac{\sqrt{2}\,t_3}{3}$	$\frac{t_3}{3}$	$-\frac{1}{3}\,i\,\sqrt{2}\,k\,t_3$	0	0	0

	$\sigma_{2^+}^{\#1}{}_{\alpha\beta}$	$\tau_{2^+}^{\#1}{}_{\alpha\beta}$	$\sigma_{2^-}^{\#1}{}_{\alpha\beta\chi}$
$\sigma_{2^+}^{\#1}\,\dagger^{\alpha\beta}$	$-\frac{2}{3\,k^2\,r_3}$	0	0
$\tau_{2^+}^{\#1}\,\dagger^{\alpha\beta}$	0	0	0
$\sigma_{2^-}^{\#1}\,\dagger^{\alpha\beta\chi}$	0	0	0

	$\omega_{2^+}^{\#1}{}_{\alpha\beta}$	$f_{2^+}^{\#1}{}_{\alpha\beta}$	$\omega_{2^-}^{\#1}{}_{\alpha\beta\chi}$
$\omega_{2^+}^{\#1}\,\dagger^{\alpha\beta}$	$-\frac{3\,k^2\,r_3}{2}$	0	0
$f_{2^+}^{\#1}\,\dagger^{\alpha\beta}$	0	0	0
$\omega_{2^-}^{\#1}\,\dagger^{\alpha\beta\chi}$	0	0	0

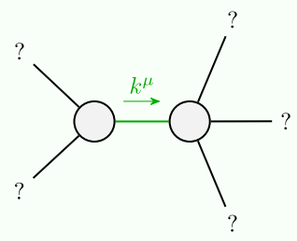
Source constraints/gauge generators

SO(3) irreps	Multiplicities
$\tau_{0^+}^{\#2} == 0$	1
$\tau_{0^+}^{\#1} - 2\,i\,k\,\sigma_{0^+}^{\#1} == 0$	1
$\tau_{1^-}^{\#2\,\alpha} + 2\,i\,k\,\sigma_{1^-}^{\#2\,\alpha} == 0$	3
$\tau_{1^-}^{\#1\,\alpha} == 0$	3
$\tau_{1^+}^{\#1\,\alpha\beta} + i\,k\,\sigma_{1^+}^{\#2\,\alpha\beta} == 0$	3
$\sigma_{2^-}^{\#1\,\alpha\beta\chi} == 0$	5
$\tau_{2^+}^{\#1\,\alpha\beta} == 0$	5
Total constraints:	21

Quadratic (free) action

$$
\begin{aligned}
S == \int\int\int (&\tfrac{1}{6}\,(-4\,t_3\,\omega^{\alpha\prime}{}_{\alpha}\,\omega_{\prime}{}^{\kappa}{}_{\kappa} + 6\,f^{\alpha\beta}\,\tau_{\alpha\beta} + 6\,\omega^{\alpha\beta\chi}\,\sigma_{\alpha\beta\chi} + 8\,t_3\,\omega_{\alpha}{}^{\kappa}{}_{\kappa}\,\partial_{\prime}f^{\alpha\prime} - 8\,t_3\,\omega_{\prime}{}^{\kappa}{}_{\kappa} \\
&\partial^{\prime}f^{\alpha}{}_{\alpha} + 4\,t_3\,\partial_{\prime}f^{\kappa}{}_{\kappa}\,\partial^{\prime}f^{\alpha}{}_{\alpha} - 3\,r_3\,\partial_{\prime}\omega_{\beta}{}^{\theta}{}_{\theta}\,\partial^{\prime}\omega^{\alpha\beta}{}_{\alpha} - 3\,r_3\,\partial_{\alpha}\omega^{\alpha\beta\prime} \\
&\partial_{\theta}\omega_{\beta}{}^{\theta}{}_{\prime} - 3\,r_3\,\partial_{\alpha}\omega^{\alpha\beta\prime}\,\partial_{\theta}\omega_{\prime}{}^{\theta}{}_{\beta} + 6\,r_3\,\partial^{\prime}\omega^{\alpha\beta}{}_{\alpha}\,\partial_{\theta}\omega_{\prime}{}^{\theta}{}_{\beta} + 4\,t_2 \\
&\omega_{\prime\theta\alpha}\,\partial^{\theta}f^{\alpha\prime} + 2\,t_2\,\partial_{\alpha}f_{\prime\theta}\,\partial^{\theta}f^{\alpha\prime} - 4\,t_2\,\omega_{\alpha\theta\prime} \\
&t_2\,\partial_{\theta}f_{\prime\alpha}\,\partial^{\theta}f^{\alpha\prime} - t_2\,\partial_{\prime}f_{\alpha\theta}\,\partial^{\theta}f^{\alpha\prime} + t_2\,\partial_{\theta}f_{\alpha\prime}\,\partial^{\theta}f^{\alpha\prime} - \\
&24\,r_3\,\partial_{\beta}\omega_{\prime\theta\alpha}\,\partial^{\theta}\omega^{\alpha\beta\prime} + 6\,r_5\,(\omega^{\alpha\prime\theta} + \partial^{\theta}f^{\alpha\prime}) + 2\,t_2\,\omega_{\alpha\prime\theta}\,(\omega^{\alpha\prime\theta} + 2\,\partial^{\theta}f^{\alpha\prime}) - \\
&4\,t_3\,\partial_{\prime}f^{\alpha\prime}\,\partial_{\kappa}f_{\alpha}{}^{\kappa} - 8\,t_3\,\partial^{\prime}f^{\alpha}{}_{\alpha} + 6\,r_5\,\partial_{\prime}\omega_{\theta}{}^{\kappa}{}_{\kappa}\,\partial^{\theta}\omega^{\alpha\prime}{}_{\alpha} + \\
&6\,r_5\,\partial_{\alpha}\omega^{\alpha\prime\theta}\,\partial_{\kappa}\omega_{\theta}{}^{\kappa}{}_{\prime} - 12\,r_5\,\partial^{\theta}\omega^{\alpha\prime}{}_{\alpha}\,\partial_{\kappa}\omega_{\prime}{}^{\kappa}{}_{\theta} + \\
&6\,r_5\,\partial_{\alpha}\omega^{\alpha\prime\theta}\,\partial_{\kappa}\omega_{\theta}{}^{\kappa}{}_{\prime}))[t,\,x,\,y,\,z]\,dz\,dy\,dx\,dt
\end{aligned}
$$

Massive and massless spectra



Quadratic pole

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

(No massive particles)

Unitarity conditions

$$r_3 < 0\;\&\&\;(r_5 < -\tfrac{r_3}{2}\;||\;r_5 > -2\,r_3)\;||\;r_3 > 0\;\&\&\;-2\,r_3 < r_5 < -\tfrac{r_3}{2}$$