Particle spectrograph

Wave operator and propagator

	$\sigma_{1^+}^{\#1}\dagger^{\alpha\beta}$	$\sigma_{1^+}^{\#2}\dagger^{\alpha\beta}$	$\tau_{1^+}^{\#1}\dagger^{\alpha\beta}$	$\sigma_{1^-}^{\#1}\dagger^{\alpha}$	$\sigma_{1^-}^{\#2}\dagger^{\alpha}$	$\tau_{1^-}^{\#1}\dagger^{\alpha}$	$\tau_{1^-}^{\#2}\dagger^{\alpha}$
$\tau_{1^-}^{\#2}{}_{\alpha}$	0	0	0	0	0	0	0
$\tau_{1^-}^{\#1}{}_{\alpha}$	0	0	0	0	0	0	0
$\sigma_{1^-}^{\#2}{}_{\alpha}$	0	0	0	0	0	0	0
$\sigma_{1^-}^{\#1}{}_{\alpha}$	0	0	0	0	0	0	0
$\tau_{1^+}^{\#1}{}_{\alpha\beta}$	$-\dfrac{i\sqrt{2}}{k(1+k^2)(2r_3-r_4)}$	$\dfrac{i(k^2(6r_3-3r_4)+2t_2)}{k(1+k^2)^2(2r_3-r_4)t_2}$	$\dfrac{1}{r_3-\frac{r_4}{2}}-\dfrac{\frac{3k^2}{2}+t_2}{(1+k^2)^2}$	0	0	0	0
$\sigma_{1^+}^{\#2}{}_{\alpha\beta}$	$\dfrac{\sqrt{2}}{-k^2(1+k^2)(2r_3-r_4)}$	$\dfrac{k^2(6r_3-3r_4)+2t_2}{(k+k^3)^2(2r_3-r_4)t_2}$	$-\dfrac{i(k^2(6r_3-3r_4)+2t_2)}{k(1+k^2)^2(2r_3-r_4)t_2}$	0	0	0	0
$\sigma_{1^+}^{\#1}{}_{\alpha\beta}$	$\dfrac{1}{k^2(2r_3-r_4)}$	$-\dfrac{\sqrt{2}}{k^2(1+k^2)(2r_3-r_4)}$	$\dfrac{i\sqrt{2}}{k(1+k^2)(2r_3-r_4)}$	0	0	0	0

Quadratic (free) action

$$
\begin{aligned}
S_F ==\iiint\Big[\tfrac{1}{6}\big(&4t_2\,\omega_i{}^{\kappa\lambda}\,\omega_{\kappa\lambda}{}^i+2t_2\,\omega_{\kappa\lambda}{}^i\,\omega_i{}^{\kappa\lambda}+\\
&6f^{\alpha\beta}\,\tau_{\alpha\beta}+6\,\omega^{\alpha\beta\chi}\,\sigma_{\alpha\beta\chi}+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\kappa\lambda}+12r_4\,\partial_\alpha\omega_\lambda{}^\alpha{}_\theta\,\partial_\kappa\omega^{\theta\kappa\lambda}-12r_4\,\partial_\theta\omega_\lambda{}^\alpha{}_\alpha\,\partial_\kappa\omega^{\theta\kappa\lambda}+\\
&t_2\,\partial^\alpha f_{\theta\kappa}\,\partial^\kappa f_\alpha{}^\theta-t_2\,\partial^\alpha f_{\kappa\theta}\,\partial^\kappa f_{\alpha}{}^\lambda+t_2\,\partial^\alpha f^\lambda{}_\kappa\,\partial^\kappa f_{\alpha\lambda}+2t_2\,\omega_{1\theta\kappa}\,\partial^\kappa f^{1\theta}-\\
&4t_2\,\omega_{1\kappa\theta}\,\partial^\kappa f^{1\theta}-2t_2\,\omega_{\theta1\kappa}\,\partial^\kappa f^{1\theta}+4t_2\,\omega_{\theta\kappa1}\,\partial^\kappa f^{1\theta}-\\
&t_2\,\partial_\kappa f_\theta{}^\lambda\,\partial^\kappa f_\lambda{}^\theta+t_2\,\partial_\kappa f^{\lambda}{}_\theta\,\partial^\kappa f_\lambda{}^\theta+2r_2\,\partial_\kappa\omega^{\alpha\beta\theta}\,\partial_\theta\omega_{\alpha\beta}{}^\kappa+4r_2\,\partial_\kappa\omega^{\theta\alpha\beta}\,\partial^\kappa\omega_{\alpha\beta\theta}-\\
&4r_2\,\partial^\beta\omega_i{}^{\alpha\lambda}{}_\beta\,\partial_\lambda\omega_{\alpha\beta}{}^i+4r_2\,\partial^\beta\omega_i{}^{\lambda\alpha}\,\partial_\lambda\omega_{\alpha\beta}{}^i-24r_3\,\partial^\beta\omega_i{}^{\lambda\alpha}\,\partial_\lambda\omega_{\alpha\beta}{}^i-\\
&12r_4\,\partial_\alpha\omega_\lambda{}^\alpha{}_\theta\,\partial^\lambda\omega^{\theta\kappa}{}_\kappa+12r_4\,\partial_\theta\omega_\lambda{}^\alpha{}_\alpha\,\partial^\lambda\omega^{\theta\kappa}{}_\kappa\big)\Big][t,x,y,z]\,dz\,dy\,dx\,dt
\end{aligned}
$$

	$\omega_{1^+}^{\#1}\dagger^{\alpha\beta}$	$\omega_{1^+}^{\#2}\dagger^{\alpha\beta}$	$f_{1^+}^{\#1}\dagger^{\alpha\beta}$	$\omega_{1^-}^{\#1}\dagger^{\alpha}$	$\omega_{1^-}^{\#2}\dagger^{\alpha}$	$f_{1^-}^{\#1}\dagger^{\alpha}$	$f_{1^-}^{\#2}\dagger^{\alpha}$
$f_{1^-}^{\#2}{}_{\alpha}$	0	0	0	0	0	0	0
$f_{1^-}^{\#1}{}_{\alpha}$	0	0	0	0	0	0	0
$\omega_{1^-}^{\#2}{}_{\alpha}$	0	0	0	0	0	0	0
$\omega_{1^-}^{\#1}{}_{\alpha}$	0	0	0	0	0	0	0
$f_{1^+}^{\#1}{}_{\alpha\beta}$	$\frac{1}{3}i\sqrt{2}\,kt_2$	$\frac{ikt_2}{3}$	$\frac{k^2 t_2}{3}$	0	0	0	0
$\omega_{1^+}^{\#2}{}_{\alpha\beta}$	$\frac{\sqrt{2}t_2}{3}$	$\frac{t_2}{3}$	$-\frac{1}{3}ikt_2$	0	0	0	0
$\omega_{1^+}^{\#1}{}_{\alpha\beta}$	$k^2(2r_3-r_4)+\frac{2t_2}{3}$	$\frac{\sqrt{2}t_2}{3}$	$-\frac{1}{3}i\sqrt{2}\,kt_2$	0	0	0	0

	$\sigma_{0^+}^{\#1}$	$\tau_{0^+}^{\#1}$	$\tau_{0^+}^{\#2}$	$\sigma_{0^-}^{\#1}$
$\sigma_{0^+}^{\#1}\dagger$	$\frac{1}{-2k^2 r_3+4k^2 r_4}$	0	0	0
$\tau_{0^+}^{\#1}\dagger$	0	0	0	0
$\tau_{0^+}^{\#2}\dagger$	0	0	0	0
$\sigma_{0^-}^{\#1}\dagger$	0	0	0	$\frac{1}{k^2 r_2+t_2}$

	$\omega_{0^+}^{\#1}$	$f_{0^+}^{\#1}$	$f_{0^+}^{\#2}$	$\omega_{0^-}^{\#1}$
$\omega_{0^+}^{\#1}\dagger$	$-2k^2(r_3-2r_4)$	0	0	0
$f_{0^+}^{\#1}\dagger$	0	0	0	0
$f_{0^+}^{\#2}\dagger$	0	0	0	0
$\omega_{0^-}^{\#1}\dagger$	0	0	0	$k^2 r_2+t_2$
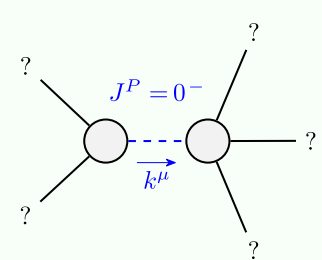
Source constraints/gauge generators

SO(3) irreps	Multiplicities
$\tau_{0^+}^{\#2}==0$	1
$\tau_{0^+}^{\#1}==0$	1
$\tau_{1^-}^{\#2\,\alpha}==0$	3
$\tau_{1^-}^{\#1\,\alpha}==0$	3
$\sigma_{1^-}^{\#2\,\alpha}==0$	3
$\sigma_{1^-}^{\#1\,\alpha}==0$	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:	27

	$\sigma_{2^+}^{\#1}{}_{\alpha\beta}$	$\tau_{2^+}^{\#1}{}_{\alpha\beta}$	$\sigma_{2^-}^{\#1}{}_{\alpha\beta\chi}$
$\sigma_{2^+}^{\#1}\dagger^{\alpha\beta}$	$\frac{1}{k^2(-2r_3+r_4)}$	0	0
$\tau_{2^+}^{\#1}\dagger^{\alpha\beta}$	0	0	0
$\sigma_{2^-}^{\#1}\dagger^{\alpha\beta\chi}$	0	0	0

	$\omega_{2^+}^{\#1}{}_{\alpha\beta}$	$f_{2^+}^{\#1}{}_{\alpha\beta}$	$\omega_{2^-}^{\#1}{}_{\alpha\beta\chi}$
$\omega_{2^+}^{\#1}\dagger^{\alpha\beta}$	$k^2(-2r_3+r_4)$	0	0
$f_{2^+}^{\#1}\dagger^{\alpha\beta}$	0	0	0
$\omega_{2^-}^{\#1}\dagger^{\alpha\beta\chi}$	0	0	0

Massive and massless spectra

$J^P = 0^-$, k^μ

Massive particle	
Pole residue:	$-\frac{1}{r_2} > 0$
Polarisations:	1
Square mass:	$-\frac{t_2}{r_2} > 0$
Spin:	0
Parity:	Odd

(No massless particles)

Unitarity conditions

$r_2 < 0$ && $t_2 > 0$