Particle spectrograph

Wave operator and propagator

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

	$\omega_{1^+}^{\#1}{}_{\alpha\beta}$	$\omega_{1^+}^{\#2}{}_{\alpha\beta}$	$f_{1^+}^{\#1}{}_{\alpha\beta}$	$\omega_{1^-}^{\#1}{}_{\alpha}$	$\omega_{1^-}^{\#2}{}_{\alpha}$	$f_{1^-}^{\#1}{}_{\alpha}$	$f_{1^-}^{\#2}{}_{\alpha}$
$\omega_{1^+}^{\#1}{}^{\dagger\alpha\beta}$	$k^2(2r_3+r_5)+\frac{2t_2}{3}$	$\frac{\sqrt{2}t_2}{3}$	$\frac{1}{3}i\sqrt{2}kt_2$	0	0	0	0
$\omega_{1^+}^{\#2}{}^{\dagger\alpha\beta}$	$\frac{\sqrt{2}t_2}{3}$	$\frac{t_2}{3}$	$\frac{ikt_2}{3}$	0	0	0	0
$f_{1^+}^{\#1}{}^{\dagger\alpha\beta}$	$-\frac{1}{3}i\sqrt{2}kt_2$	$-\frac{1}{3}ikt_2$	$\frac{k^2t_2}{3}$	0	0	0	0
$\omega_{1^-}^{\#1}{}^{\dagger\alpha}$	0	0	0	$k^2(\frac{r_3}{2}+r_5)+\frac{2t_3}{3}$	$-\frac{\sqrt{2}t_3}{3}$	0	$-\frac{2}{3}ikt_3$
$\omega_{1^-}^{\#2}{}^{\dagger\alpha}$	0	0	0	$-\frac{\sqrt{2}t_3}{3}$	$\frac{t_3}{3}$	0	$\frac{1}{3}i\sqrt{2}kt_3$
$f_{1^-}^{\#1}{}^{\dagger\alpha}$	0	0	0	0	0	0	0
$f_{1^-}^{\#2}{}^{\dagger\alpha}$	0	0	0	$\frac{2ikt_3}{3}$	$-\frac{1}{3}i\sqrt{2}kt_3$	0	$\frac{2k^2t_3}{3}$

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

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

	$\omega_{0^+}^{\#1}$	$f_{0^+}^{\#1}$	$f_{0^+}^{\#2}$	$\omega_{0^-}^{\#1}$
$\omega_{0^+}^{\#1}{}^{\dagger}$	t_3	$-i\sqrt{2}kt_3$	0	0
$f_{0^+}^{\#1}{}^{\dagger}$	$i\sqrt{2}kt_3$	$2k^2t_3$	0	0
$f_{0^+}^{\#2}{}^{\dagger}$	0	0	0	0
$\omega_{0^-}^{\#1}{}^{\dagger}$	0	0	0	$k^2r_2+t_2$

	$\sigma_{0^+}^{\#1}{}^{\dagger}$	$\tau_{0^+}^{\#1}{}^{\dagger}$	$\tau_{0^+}^{\#2}{}^{\dagger}$	$\sigma_{0^-}^{\#1}{}^{\dagger}$
$\sigma_{0^+}^{\#1}{}^{\dagger}$	$\frac{1}{(1+2k^2)^2t_3}$	$-\frac{i\sqrt{2}k}{(1+2k^2)^2t_3}$	0	0
$\tau_{0^+}^{\#1}{}^{\dagger}$	$\frac{i\sqrt{2}k}{(1+2k^2)^2t_3}$	$\frac{2k^2}{(1+2k^2)^2t_3}$	0	0
$\tau_{0^+}^{\#2}{}^{\dagger}$	0	0	0	0
$\sigma_{0^-}^{\#1}{}^{\dagger}$	0	0	0	$\frac{1}{k^2r_2+t_2}$

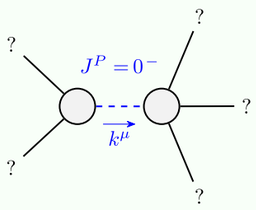
Quadratic (free) Lagrangian density

$$\frac{2}{3}t_3\,\omega_{I}^{\alpha\prime}\,\omega_{\kappa\alpha}^{\ \ \kappa}+\frac{2}{3}t_2\,\omega_{I}^{\kappa\lambda}\,\omega_{\kappa\lambda}^{\ \ \prime}+\frac{1}{3}t_2\,\omega_{\kappa\lambda}^{\ \ \prime}\,\omega^{\kappa\lambda}{}_{I}+f^{\alpha\beta}\,\tau_{\alpha\beta}+$$
$$\omega^{\alpha\beta\chi}\,\sigma_{\alpha\beta\chi}-\frac{1}{2}r_3\,\partial_{I}\omega^{\kappa\lambda}{}_{\kappa}^{\ \ \prime}\,\partial^{\prime}\omega_{\lambda\ \alpha}^{\ \ \alpha}+\frac{2}{3}r_2\,\partial^{\beta}\omega^{\theta\alpha}{}_{\kappa}^{\ \ \kappa}\,\partial_{\theta}\omega_{\alpha\beta}-$$
$$\frac{1}{3}r_2\,\partial_{\theta}\omega_{\alpha\beta}^{\ \ \ \kappa}\,\partial_{\kappa}\omega^{\alpha\beta\theta}-\frac{2}{3}r_2\,\partial_{\theta}\omega_{\alpha\beta}^{\ \ \ \kappa}\,\partial^{\theta}\omega_{\ \ \kappa}^{\alpha\beta}+\frac{1}{2}r_3\,\partial_{\alpha}\omega_{\lambda\ \theta}^{\ \ \alpha}\,\partial_{\kappa}\omega^{\theta\kappa\lambda}-$$
$$r_5\,\partial_{\alpha}\omega_{\lambda\ \theta}^{\ \ \alpha}\,\partial_{\kappa}\omega^{\theta\kappa\lambda}-\frac{1}{2}r_3\,\partial_{\theta}\omega_{\lambda\ \alpha}^{\ \ \alpha}\,\partial_{\kappa}\omega^{\kappa\lambda\theta}+$$
$$r_5\,\partial_{\alpha}\omega_{\lambda\ \theta}^{\ \ \alpha}\,\partial_{\kappa}\omega^{\kappa\lambda\theta}+r_3\,\partial_{\theta}\omega_{\lambda\ \alpha}^{\ \ \alpha}\,\partial_{\kappa}\omega^{\kappa\lambda\theta}+2r_5\,\partial_{\theta}\omega_{\lambda\ \alpha}^{\ \ \alpha}\,\partial_{\kappa}\omega^{\kappa\lambda\theta}+$$
$$\frac{1}{6}t_2\,\partial^{\alpha}f_{\theta\kappa}\,\partial^{\kappa}f_{\alpha}^{\ \ \theta}-\frac{1}{6}t_2\,\partial^{\alpha}f_{\kappa\theta}\,\partial^{\kappa}f_{\alpha}^{\ \ \theta}+\frac{1}{6}t_2\,\partial^{\alpha}f^{\lambda}{}_{\kappa}\,\partial^{\kappa}f_{\lambda\alpha}-$$
$$\frac{2}{3}t_3\,\omega_{\kappa\lambda}^{\ \ \ \lambda}\,\partial^{\kappa}f^{\prime}{}_{I}-\frac{4}{3}t_3\,\partial^{\alpha}f_{I\kappa}\,\partial^{\kappa}f^{\prime}{}_{\alpha}+\frac{2}{3}t_3\,\partial_{\kappa}f^{\lambda}{}_{\lambda}\,\partial^{\kappa}f^{\prime}{}_{I}-$$
$$\frac{2}{3}t_2\,\omega_{\iota\kappa\theta}\,\partial^{\kappa}f^{\prime\theta}-\frac{1}{3}t_2\,\omega_{\theta\iota\kappa}\,\partial^{\kappa}f^{\prime\theta}+\frac{2}{3}t_2\,\omega_{\theta\kappa\iota}\,\partial^{\kappa}f^{\prime\theta}+$$
$$\frac{2}{3}t_3\,\omega_{I\lambda}^{\ \ \ \lambda}\,\partial^{\kappa}f^{\prime}{}_{\kappa}-\frac{1}{6}t_2\,\partial^{\alpha}f^{\lambda}{}_{\kappa}\,\partial^{\kappa}f_{\lambda\alpha}-\frac{1}{6}t_2\,\partial_{\kappa}f_{\ \theta}^{\lambda}\,\partial^{\kappa}f_{\lambda}^{\ \theta}+$$
$$\frac{2}{3}t_3\,\partial^{\alpha}f_{\alpha}^{\ \lambda}\,\partial^{\kappa}f_{\lambda\kappa}+\frac{1}{3}r_2\,\partial_{\kappa}\omega^{\alpha\beta\theta}\,\partial^{\kappa}\omega_{\alpha\beta\theta}+\frac{2}{3}r_2\,\partial_{\kappa}\omega^{\theta\alpha\beta}\,\partial^{\kappa}\omega_{\alpha\beta\theta}-$$
$$\frac{2}{3}r_2\,\partial^{\beta}\omega_{I}^{\ \alpha\lambda}\,\partial_{\lambda}\omega_{\alpha\beta}^{\ \ \prime}+\frac{2}{3}r_2\,\partial^{\beta}\omega_{I}^{\lambda\alpha}\,\partial_{\lambda}\omega_{\alpha\beta}^{\ \ \prime}-4r_3\,\partial^{\beta}\omega_{I}^{\lambda\alpha}\,\partial_{\lambda}\omega_{\alpha\beta}^{\ \ \prime}-$$
$$\frac{1}{2}r_3\,\partial_{\alpha}\omega_{\lambda\ \theta}^{\ \ \alpha}\,\partial^{\lambda}\omega^{\theta\kappa}{}_{\kappa}-r_5\,\partial_{\alpha}\omega_{\lambda\ \theta}^{\ \ \alpha}\,\partial^{\lambda}\omega^{\theta\kappa}{}_{\kappa}+\frac{1}{2}r_3\,\partial_{\alpha}\omega_{\lambda\ \theta}^{\ \ \alpha}\,\partial^{\lambda}\omega^{\theta\kappa}{}_{\kappa}-r_5\,\partial_{\theta}\omega_{\lambda\ \alpha}^{\ \ \alpha}\,\partial^{\lambda}\omega^{\theta\kappa}{}_{\kappa}$$

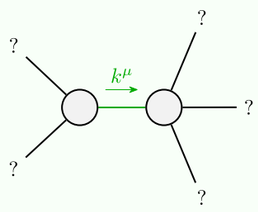
Source constraints/gauge generators

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

Massive and massless spectra



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



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

Unitarity conditions

$$r_2<0\,\&\&\,r_3<0\,\&\&\,r_5<-\frac{r_3}{2}\,\&\&\,t_2>0\,\|\,r_2<0\,\&\&\,r_3<0\,\&\&\,r_5>-2r_3\,\&\&\,t_2>0\,\|\,r_2<0\,\&\&\,r_3>0\,\&\&\,-2r_3<r_5<-\frac{r_3}{2}\,\&\&\,t_2>0$$