Particle spectrograph

Wave operator and propagator

	$\tau_{1^+}^{\#1\,\alpha\beta}$	$\sigma_{1^+}^{\#1\,\alpha}$	$\sigma_{1^+}^{\#2\,\alpha}$	$\tau_{1^-}^{\#1\,\alpha}$	$\tau_{1^-}^{\#2\,\alpha}$
$\sigma_{1^+}^{\#1\,\alpha\beta}\dagger$	$\frac{3\,i\,\sqrt{2}\,k}{(3+k^2)^2\,t_2}$	0	0	0	0
$\sigma_{1^+}^{\#2\,\alpha\beta}\dagger$	$\frac{3\,i\,k}{(3+k^2)^2\,t_2}$	0	0	0	0
$\tau_{1^+}^{\#1\,\alpha\beta}\dagger$	$\frac{3\,k^2}{(3+k^2)^2\,t_2}$	0	0	0	0
$\sigma_{1^-}^{\#1\,\alpha}\dagger$	0	$-\frac{2}{3\,k^2\,r_3}$	$-\frac{2\,\sqrt{2}}{3\,k^2\,r_3+6\,k^4\,r_3}$	0	$-\frac{4\,i}{3\,k\,r_3+6\,k^3\,r_3}$
$\sigma_{1^-}^{\#2\,\alpha}\dagger$	0	$-\frac{2\,\sqrt{2}}{3\,k^2\,r_3+6\,k^4\,r_3}$	$\frac{9\,k^2\,r_3-4\,t_3}{3\,(k+2\,k^3)^2\,r_3\,t_3}$	0	$\frac{i\,\sqrt{2}\,(9\,k^2\,r_3-4\,t_3)}{3\,k\,(1+2\,k^2)^2\,r_3\,t_3}$
$\tau_{1^-}^{\#1\,\alpha}\dagger$	0	0	0	0	0
$\tau_{1^-}^{\#2\,\alpha}\dagger$	0	$\frac{4\,i}{3\,k\,r_3+6\,k^3\,r_3}$	$-\frac{i\,\sqrt{2}\,(9\,k^2\,r_3-4\,t_3)}{3\,k\,(1+2\,k^2)^2\,r_3\,t_3}$	0	$\frac{2\,(9\,k^2\,r_3-4\,t_3)}{3\,(1+2\,k^2)^2\,r_3\,t_3}$

Quadratic (free) Lagrangian density

$$\begin{aligned}
&\tfrac{2}{3}\,t_3\,\omega_{\iota}^{\alpha\prime}\,\omega_{\kappa\alpha}^{\ \ \kappa}+\tfrac{2}{3}\,t_2\,\omega_{\iota}^{\ \kappa\lambda\prime}\,\omega_{\kappa\lambda}+f^{\alpha\beta}\,\tau_{\alpha\beta}+\omega^{\alpha\beta\chi}\,\sigma_{\alpha\beta\chi}+\\
&\tfrac{3}{2}\,r_3\,\partial_{\iota}\omega^{\kappa\lambda}{}_{\kappa}\,\partial^{\prime}\omega_{\lambda\ \alpha}^{\ \alpha}+\tfrac{2}{3}\,r_2\,\partial^{\beta}\omega^{\theta\alpha}{}_{\kappa}\,\partial_{\theta}\omega_{\alpha\beta}^{\ \ \kappa}-\\
&\tfrac{2}{3}\,r_2\,\partial_{\theta}\omega_{\alpha\beta}^{\ \ \kappa}\,\partial_{\kappa}\omega^{\theta\alpha\beta}+\tfrac{5}{2}\,r_3\,\partial_{\alpha}\omega_{\lambda\ \theta}^{\ \alpha}\,\partial_{\kappa}\omega^{\theta\kappa\lambda}+\\
&\tfrac{3}{2}\,r_3\,\partial_{\alpha}\omega_{\lambda\ \theta}^{\ \alpha}\,\partial_{\kappa}\omega^{\kappa\lambda\theta}+\tfrac{1}{6}\,t_2\,\partial^{\alpha}f_{\theta\kappa}\,\partial^{\kappa}f_{\alpha}^{\ \ \theta}-\\
&\tfrac{1}{6}\,t_2\,\partial^{\alpha}f_{\kappa\theta}\,\partial^{\kappa}f_{\alpha}^{\ \ \theta}+\tfrac{1}{6}\,t_2\,\partial^{\alpha}f^{\lambda}{}_{\kappa}\,\partial^{\kappa}f_{\lambda\ \ \alpha}^{\ \theta}-\\
&\tfrac{4}{3}\,t_3\,\partial^{\alpha}f_{\kappa\alpha}\,\partial^{\kappa}f_{\ \ \iota}^{\prime\,\theta}+\tfrac{2}{3}\,t_3\,\partial_{\kappa}f^{\lambda}{}_{\lambda}\,\partial^{\kappa}f_{\ \ \iota}^{\prime\,\theta}-\\
&\tfrac{1}{3}\,t_2\,\omega_{\theta\iota\kappa}\,\partial^{\kappa}f^{\prime\,\theta}+\tfrac{2}{3}\,t_2\,\omega_{\theta\kappa\prime}\,\partial^{\kappa}f^{\prime\,\theta}+\\
&\tfrac{1}{6}\,t_2\,\partial^{\alpha}f^{\lambda}{}_{\kappa}\,\partial^{\kappa}f_{\lambda\alpha}^{\ \ \prime}-\tfrac{1}{6}\,t_2\,\partial_{\kappa}f^{\lambda}{}_{\theta}\,\partial^{\kappa}f_{\lambda}^{\ \theta}+\\
&\tfrac{1}{3}\,r_2\,\partial_{\kappa}\omega^{\alpha\beta\theta}\,\partial^{\kappa}\omega_{\alpha\beta\theta}+\tfrac{2}{3}\,r_2\,\partial_{\kappa}\omega^{\theta\alpha\beta}\,\partial^{\kappa}\omega_{\alpha\beta\theta}-\tfrac{2}{3}\,r_2\,\partial^{\beta}\omega_{\iota}^{\ \alpha\lambda}\,\partial_{\lambda}\omega_{\alpha\beta}^{\ \ \prime}+\\
&\tfrac{2}{3}\,r_2\,\partial^{\beta}\omega_{\iota}^{\lambda\alpha}\,\partial_{\lambda}\omega_{\alpha\beta}^{\ \ \prime}-\tfrac{5}{2}\,r_3\,\partial_{\alpha}\omega_{\lambda\ \theta}^{\ \alpha}\,\partial^{\lambda}\omega^{\theta\kappa}{}_{\kappa}+\tfrac{5}{2}\,r_3\,\partial_{\theta}\omega_{\lambda\ \alpha}^{\ \alpha}\,\partial^{\lambda}\omega^{\theta\kappa}{}_{\kappa}-\\
&\tfrac{1}{2}\,r_3\,\partial_{\iota}\omega^{\kappa\lambda}{}_{\kappa}\,\partial^{\iota}\omega_{\lambda\ \alpha}^{\ \alpha}+\tfrac{1}{2}\,r_3\,\partial_{\iota}\omega^{\kappa\lambda}{}_{\lambda}\,\partial^{\iota}\omega_{\kappa\ \alpha}^{\ \alpha}+\\
&\tfrac{1}{2}\,r_3\,\partial_{\iota}\omega^{\kappa\lambda}{}_{\alpha}\,\partial^{\iota}\omega_{\kappa\lambda}^{\ \ \alpha}+\tfrac{1}{2}\,r_3\,\partial_{\iota}\omega^{\kappa\lambda}{}_{\kappa}\,\partial^{\iota}\omega_{\lambda\ \alpha}^{\ \alpha}
\end{aligned}$$

	$f_{1^+}^{\#1\,\alpha\beta}$	$\omega_{1^-}^{\#1\,\alpha}$	$\omega_{1^-}^{\#2\,\alpha}$	$f_{1^-}^{\#1\,\alpha}$	$f_{1^-}^{\#2\,\alpha}$
$\omega_{1^+}^{\#1\,\alpha\beta}\dagger$	$\frac{1}{3}\,i\,\sqrt{2}\,k\,t_2$	0	0	0	0
$\omega_{1^+}^{\#2\,\alpha\beta}\dagger$	$\frac{i\,k\,t_2}{3}$	0	0	0	0
$f_{1^+}^{\#1\,\alpha\beta}\dagger$	$\frac{k^2\,t_2}{3}$	0	0	0	0
$\omega_{1^-}^{\#1\,\alpha}\dagger$	0	$\frac{1}{6}\,(-9\,k^2\,r_3+4\,t_3)$	$-\frac{\sqrt{2}\,t_3}{3}$	0	$-\frac{2}{3}\,i\,k\,t_3$
$\omega_{1^-}^{\#2\,\alpha}\dagger$	0	$-\frac{\sqrt{2}\,t_3}{3}$	$\frac{t_3}{3}$	0	$\frac{1}{3}\,i\,\sqrt{2}\,k\,t_3$
$f_{1^-}^{\#1\,\alpha}\dagger$	0	0	0	0	0
$f_{1^-}^{\#2\,\alpha}\dagger$	0	$\frac{2\,i\,k\,t_3}{3}$	$-\frac{1}{3}\,i\,\sqrt{2}\,k\,t_3$	0	$\frac{2\,k^2\,t_3}{3}$

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

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

Source constraints/gauge generators

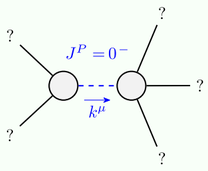
SO(3) irreps	Multiplicities
$\tau_{0^+}^{\#2} == 0$	1
$\tau_{0^+}^{\#1} - 2\,i\,k\,\sigma_{0^+}^{\#1} == 0$	1
$\tau_{1^-}^{\#2\,\alpha} + 2\,i\,k\,\sigma_{1^-}^{\#2\,\alpha} == 0$	3
$\tau_{1^-}^{\#1\,\alpha} == 0$	3
$\tau_{1^+}^{\#1\,\alpha\beta} + i\,k\,\sigma_{1^+}^{\#1\,\alpha\beta} == 0$	3
$\sigma_{1^+}^{\#1\,\alpha\beta} == \sigma_{1^+}^{\#2\,\alpha\beta}$	3
$\sigma_{2^-}^{\#1\,\alpha\beta\chi} == 0$	5
$\tau_{2^+}^{\#1\,\alpha\beta} == 0$	5
Total constraints:	24

	$\omega_{0^-}^{\#1}$
$\omega_{0^+}^{\#1}\dagger$	0
$f_{0^+}^{\#1}\dagger$	0
$f_{0^+}^{\#2}\dagger$	0
$\omega_{0^-}^{\#1}\dagger$	$k^2\,r_2+t_2$

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

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

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

(No massless particles)

Unitarity conditions

$r_2 < 0 \;\&\&\; t_2 > 0$