Particle spectrograph

Wave operator and propagator

	$\tau_{1^+}^{\#1}{}_{\alpha\beta}$	$\sigma_{1^+}^{\#2}{}_{\alpha\beta}$	$\tau_{1^+}^{\#1}{}_{\alpha}$	$\sigma_{1^-}^{\#1}{}_{\alpha}$	$\sigma_{1^-}^{\#2}{}_{\alpha}$	$\tau_{1^-}^{\#1}{}_{\alpha}$	$\tau_{1^-}^{\#2}{}_{\alpha}$
$\sigma_{1^+}^{\#1}{}^{\dagger\,\alpha\beta}$	$-\frac{i\sqrt{2}\,k}{t_1+k^2 t_1}$	$-\frac{\sqrt{2}}{t_1+k^2 t_1}$	0	$\frac{1}{k^2 r_5}$	0	0	$-\frac{i}{k r_5+2k^3 r_5}$
$\sigma_{1^+}^{\#2}{}^{\dagger\,\alpha\beta}$	$-\frac{i(2k^3 r_5-k t_1)}{(1+k^2)^2 t_1^2}$	$-\frac{-2k^2 r_5+t_1}{(1+k^2)^2 t_1^2}$	0	$-\frac{1}{\sqrt{2}\,(k^2 r_5+2k^4 r_5)}$	0	0	$\frac{i(6k^2 r_5+t_1)}{\sqrt{2}\,k\,(1+2k^2)^2 r_5 t_1}$
$\tau_{1^+}^{\#1}{}^{\dagger\,\alpha\beta}$	$-\frac{-2k^4 r_5+k^2 t_1}{(1+k^2)^2 t_1^2}$	$-\frac{i(2k^3 r_5-k t_1)}{(1+k^2)^2 t_1^2}$	0	$\frac{1}{\sqrt{2}\,(k^2 r_5+2k^4 r_5)}$	0	0	$-\frac{6k^2 r_5+t_1}{(1+2k^2)^2 r_5 t_1}$
$\sigma_{1^+}^{\#1}{}^{\dagger\,\alpha\beta}$	0	$-\frac{\sqrt{2}}{t_1+k^2 t_1}$	0	$-\frac{i}{k r_5+2k^3 r_5}$	0	0	$\frac{6k^2 r_5+t_1}{(1+2k^2)^2 r_5 t_1}$
$\sigma_{1^+}^{\#2}{}^{\dagger\,\alpha\beta}$	$-\frac{\sqrt{2}}{t_1+k^2 t_1}$	$-\frac{-2k^2 r_5+t_1}{(1+k^2)^2 t_1^2}$	0	$\frac{i(6k^2 r_5+t_1)}{\sqrt{2}\,k\,(1+2k^2)^2 r_5 t_1}$	0	0	$-\frac{i(6k^2 r_5+t_1)}{\sqrt{2}\,k\,(1+2k^2)^2 r_5 t_1}$
$\tau_{1^+}^{\#1}{}^{\dagger\,\alpha\beta}$	$-\frac{i\sqrt{2}\,k}{t_1+k^2 t_1}$	$-\frac{i(2k^3 r_5-k t_1)}{(1+k^2)^2 t_1^2}$	0	$-\frac{i}{k r_5+2k^3 r_5}$	0	0	$\frac{i(6k^2 r_5+t_1)}{\sqrt{2}\,k\,(1+2k^2)^2 r_5 t_1}$
$\sigma_{1^+}^{\#1}{}^{\dagger\,\alpha}$	0	0	0	0	0	0	0
$\sigma_{1^+}^{\#2}{}^{\dagger\,\alpha}$	0	0	0	0	0	0	0
$\tau_{1^+}^{\#1}{}^{\dagger\,\alpha}$	0	0	0	0	0	0	0
$\tau_{1^+}^{\#2}{}^{\dagger\,\alpha}$	0	0	0	0	0	0	0

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

	$\omega_{2^+}^{\#1}{}_{\alpha\beta}$	$f_{2^+}^{\#1}{}_{\alpha\beta}$	$\omega_{2^-}^{\#1}{}_{\alpha\beta\chi}$
$\omega_{2^+}^{\#1}{}^{\dagger\,\alpha\beta}$	$\frac{t_1}{2}$	$-\frac{i k t_1}{\sqrt{2}}$	0
$f_{2^+}^{\#1}{}^{\dagger\,\alpha\beta}$	$\frac{i k t_1}{\sqrt{2}}$	$k^2 t_1$	0
$\omega_{2^-}^{\#1}{}^{\dagger\,\alpha\beta\chi}$	0	0	$\frac{t_1}{2}$

	$\omega_{1^+}^{\#1}{}^{\dagger\,\alpha\beta}$	$\omega_{1^+}^{\#2}{}^{\dagger\,\alpha\beta}$	$f_{1^+}^{\#1}{}^{\dagger\,\alpha\beta}$	$\omega_{1^-}^{\#1}{}^{\dagger\,\alpha}$	$\omega_{1^-}^{\#2}{}^{\dagger\,\alpha}$	$f_{1^-}^{\#1}{}^{\dagger\,\alpha}$	$f_{1^-}^{\#2}{}^{\dagger\,\alpha}$
$\omega_{1^+}^{\#1}{}^{\dagger\,\alpha\beta}$	$k^2 r_5+\frac{t_1}{6}$	$\frac{t_1}{3\sqrt{2}}$	0	$\frac{t_1}{3\sqrt{2}}$	$\frac{t_1}{3}$	0	$\frac{i k t_1}{3}$
$\omega_{1^+}^{\#2}{}^{\dagger\,\alpha\beta}$	$\frac{t_1}{3\sqrt{2}}$	0	0	0	0	0	$\frac{1}{3} i\sqrt{2}\,k t_1$
$f_{1^+}^{\#1}{}^{\dagger\,\alpha\beta}$	0	0	0	0	0	0	$\frac{2k^2 t_1}{3}$
$\omega_{1^-}^{\#1}{}^{\dagger\,\alpha}$	$-\frac{1}{3} i k t_1$	$-\frac{1}{3} i\sqrt{2}\,k t_1$	0	0	0	0	0
$\omega_{1^-}^{\#2}{}^{\dagger\,\alpha}$	0	0	0	0	0	0	0
$f_{1^-}^{\#1}{}^{\dagger\,\alpha}$	0	0	0	0	0	0	0
$f_{1^-}^{\#2}{}^{\dagger\,\alpha}$	0	0	0	0	0	0	0

Source constraints/gauge generators	Multiplicities
SO(3) irreps	
$\sigma_{0^+}^{\#1} == 0$	1
$\tau_{0^+}^{\#1} == 0$	1
$\tau_{0^+}^{\#2} == 0$	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
$\tau_{2^+}^{\#1\,\alpha\beta} - 2\,i\,k\,\sigma_{2^+}^{\#1\,\alpha\beta} == 0$	5
Total constraints:	17

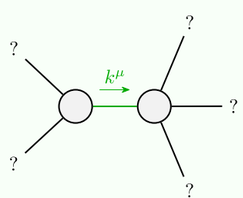
Quadratic (free) Lagrangian density

$$-\frac{1}{3} t_1\,\omega_{\prime}{}^{\alpha\prime}\,\omega_{\kappa\alpha}{}^{\kappa} - t_1\,\omega_{\prime}{}^{\kappa\lambda}\,\omega_{\kappa\lambda}{}^{\prime} + f^{\alpha\beta}\,\tau_{\alpha\beta} + \omega^{\alpha\beta\chi}\,\sigma_{\alpha\beta\chi} - r_5\,\partial_{\prime}\omega^{\kappa\lambda}{}_{\kappa}\,\partial^{\prime}\omega_{\lambda}{}^{\alpha}{}_{\alpha} -$$
$$r_5\,\partial_{\alpha}\omega_{\lambda}{}^{\alpha}{}_{\theta}\,\partial_{\kappa}\omega^{\theta\kappa\lambda} + r_5\,\partial_{\theta}\omega_{\lambda}{}^{\alpha}{}_{\alpha}\,\partial_{\kappa}\omega^{\theta\kappa\lambda} - r_5\,\partial_{\alpha}\omega_{\lambda}{}^{\alpha}{}_{\theta}\,\partial_{\kappa}\omega^{\kappa\lambda\theta} + 2\,r_5\,\partial_{\theta}\omega_{\lambda}{}^{\alpha}{}_{\alpha}\,\partial_{\kappa}\omega^{\kappa\lambda\theta} -$$
$$\frac{1}{2} t_1\,\partial^{\alpha} f_{\theta\kappa}\,\partial^{\kappa} f_{\alpha}{}^{\theta} - \frac{1}{2} t_1\,\partial^{\alpha} f_{\kappa\theta}\,\partial^{\kappa} f_{\alpha}{}^{\theta} - \frac{1}{2} t_1\,\partial^{\alpha} f^{\lambda}{}_{\kappa}\,\partial^{\kappa} f_{\alpha\lambda} + \frac{1}{3} t_1\,\omega_{\kappa\alpha}{}^{\alpha}\,\partial^{\kappa} f^{\prime}{}_{\prime} +$$
$$\frac{1}{3} t_1\,\omega_{\kappa\lambda}{}^{\lambda}\,\partial^{\kappa} f^{\prime}{}_{\prime} + \frac{2}{3} t_1\,\partial^{\alpha} f_{\kappa\alpha}\,\partial^{\kappa} f^{\prime}{}_{\prime} - \frac{1}{3} t_1\,\partial_{\kappa} f^{\lambda}{}_{\lambda}\,\partial^{\kappa} f^{\prime}{}_{\prime} + 2\,t_1\,\omega_{\prime\kappa\theta}\,\partial^{\kappa} f^{\prime\theta} -$$
$$\frac{1}{3} t_1\,\omega_{\prime\alpha}{}^{\alpha}\,\partial^{\kappa} f^{\prime}{}_{\kappa} - \frac{1}{3} t_1\,\omega_{\prime\lambda}{}^{\lambda}\,\partial^{\kappa} f^{\prime}{}_{\kappa} + \frac{1}{2} t_1\,\partial^{\alpha} f^{\lambda}{}_{\kappa}\,\partial^{\kappa} f_{\lambda\alpha} + \frac{1}{2} t_1\,\partial_{\kappa} f_{\theta}{}^{\lambda}\,\partial^{\kappa} f_{\lambda}{}^{\theta} +$$
$$\frac{1}{2} t_1\,\partial_{\kappa} f^{\lambda}{}_{\theta}\,\partial^{\kappa} f_{\lambda}{}^{\theta} - \frac{1}{3} t_1\,\partial^{\alpha} f^{\lambda}{}_{\alpha}\,\partial^{\kappa} f_{\lambda\kappa} + r_5\,\partial_{\alpha}\omega_{\lambda}{}^{\alpha}{}_{\theta}\,\partial^{\lambda}\omega^{\theta\kappa}{}_{\kappa} - r_5\,\partial_{\theta}\omega_{\lambda}{}^{\alpha}{}_{\alpha}\,\partial^{\lambda}\omega^{\theta\kappa}{}_{\kappa}$$

	$\omega_{0^+}^{\#1}$	$f_{0^+}^{\#1}$	$f_{0^+}^{\#2}$	$\omega_{0^-}^{\#1}$
$\omega_{0^+}^{\#1}{}^{\dagger}$	0	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	$-t_1$

	$\sigma_{0^+}^{\#1}$	$\tau_{0^+}^{\#1}$	$\tau_{0^+}^{\#2}$	$\sigma_{0^-}^{\#1}$
$\sigma_{0^+}^{\#1}{}^{\dagger}$	0	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	$-\frac{1}{t_1}$

Massive and massless spectra



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

(No massive particles)

Unitarity conditions

$r_5 < 0 \,\&\&\, t_1 < 0 \,||\, t_1 > 0$