Particle spectrograph

Wave operator and propagator

	$\sigma_{1^+}^{\#1}{}^{\alpha\beta}\dagger$	$\sigma_{1^+}^{\#2}{}^{\alpha\beta}\dagger$	$\tau_{1^+}^{\#1}{}^{\alpha\beta}\dagger$	$\sigma_{1^-}^{\#1}{}^{\alpha}\dagger$	$\sigma_{1^-}^{\#2}{}^{\alpha}\dagger$	$\tau_{1^-}^{\#1}{}^{\alpha}\dagger$	$\tau_{1^-}^{\#2}{}^{\alpha}\dagger$
$\tau_{1^-}^{\#2}{}_{\alpha}$	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) Lagrangian density

$$\frac{2}{3}t_2\,\omega_i{}^{\kappa\lambda}\,\omega_{\kappa\lambda}{}^i + \frac{1}{3}t_2\,\omega_{\kappa\lambda}{}^i\,\omega^{\kappa\lambda}{}_i + f^{\alpha\beta}\,\tau_{\alpha\beta} + \omega^{\alpha\beta\chi}\,\sigma_{\alpha\beta\chi} +$$
$$\frac{2}{3}r_2\,\partial^\beta\omega^{\theta\alpha}{}_\kappa\,\partial_\theta\omega_{\alpha\beta}{}^\kappa - \frac{1}{3}r_2\,\partial_\theta\omega_{\alpha\beta}{}^\kappa\,\partial_\kappa\omega^{\theta\alpha\beta} +$$
$$2r_4\,\partial_\alpha\omega_\lambda{}^\alpha{}_\theta\,\partial_\kappa\omega^{\theta\kappa\lambda} - 2r_4\,\partial_\theta\omega_\lambda{}^\alpha{}_\alpha\,\partial_\kappa\omega^{\theta\kappa\lambda} + \frac{1}{6}t_2\,\partial^\alpha f_{\theta\kappa}\,\partial^\kappa f_\alpha{}^\theta - \frac{1}{6}t_2\,\partial^\alpha f_{\kappa\theta}\,\partial^\kappa f_\alpha{}^\theta +$$
$$\frac{1}{6}t_2\,\partial^\alpha f^\lambda{}_\kappa\,\partial^\kappa f_{\alpha\lambda} + \frac{1}{3}t_2\,\omega_{\iota\theta\kappa}\,\partial^\kappa f^{\iota\theta} - \frac{2}{3}t_2\,\omega_{\iota\kappa\theta}\,\partial^\kappa f^{\iota\theta} +$$
$$\frac{2}{3}t_2\,\omega_{\theta\kappa\iota}\,\partial^\kappa f^{\iota\theta} - \frac{1}{6}t_2\,\partial^\alpha f^\lambda{}_\kappa\,\partial^\kappa f_{\lambda\alpha} - \frac{1}{6}t_2\,\partial_\kappa f^\lambda{}_\theta\,\partial^\kappa f_\lambda{}^\theta +$$
$$\frac{1}{6}t_2\,\partial_\kappa\omega^{\alpha\beta\theta}\,\partial^\kappa\omega_{\alpha\beta\theta} + \frac{2}{3}r_2\,\partial^\beta\omega^{\theta\alpha}{}_\kappa\,\partial_\theta\omega_{\alpha\beta}{}^\kappa +$$
$$\frac{2}{3}r_2\,\partial^\beta\omega^{\lambda\alpha}{}_\theta\,\partial_\lambda\omega_{\alpha\beta}{}' - 4r_3\,\partial^\beta\omega_\iota{}^{\lambda\alpha}\,\partial_\lambda\omega_{\alpha\beta}{}^\iota - 2r_4\,\partial_\alpha\omega_\lambda{}^\alpha{}_\theta\,\partial^\lambda\omega^{\theta\kappa}{}_\kappa + 2r_4\,\partial_\theta\omega_\lambda{}^\alpha{}_\alpha\,\partial^\lambda\omega^{\theta\kappa}{}_\kappa$$

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

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

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