Particle spectrograph

Wave operator and propagator

	$\omega_{1^+}^{\#1}{}_{\alpha\beta}$	$\omega_{1^+}^{\#2}{}_{\alpha\beta}$	$f_{1^+}^{\#1}{}_{\alpha\beta}$	$\omega_{1^-}^{\#1}{}_{\alpha}$	$\omega_{1^-}^{\#2}{}_{\alpha}$	$f_{1^-}^{\#1}{}_{\alpha}$	$f_{1^-}^{\#2}{}_{\alpha}$
$\omega_{1^+}^{\#1}{}^{\dagger\alpha\beta}$	$k^2(2r_3+r_5)-\frac{t_1}{2}$	$-\frac{t_1}{\sqrt{2}}$	$-\frac{ikt_1}{\sqrt{2}}$	0	0	0	0
$\omega_{1^+}^{\#2}{}^{\dagger\alpha\beta}$	$-\frac{t_1}{\sqrt{2}}$	0	0	0	0	0	0
$f_{1^+}^{\#1}{}^{\dagger\alpha\beta}$	$\frac{ikt_1}{\sqrt{2}}$	0	0	0	0	0	0
$\omega_{1^-}^{\#1}{}^{\dagger\alpha}$	0	0	0	$k^2(-r_1+2r_3+r_5)+\frac{t_1}{6}$	$\frac{t_1}{3\sqrt{2}}$	0	$\frac{ikt_1}{3}$
$\omega_{1^-}^{\#2}{}^{\dagger\alpha}$	0	0	0	$\frac{t_1}{3\sqrt{2}}$	$\frac{t_1}{3}$	0	$\frac{1}{3}i\sqrt{2}\,kt_1$
$f_{1^-}^{\#1}{}^{\dagger\alpha}$	0	0	0	0	0	0	0
$f_{1^-}^{\#2}{}^{\dagger\alpha}$	0	0	0	$-\frac{1}{3}ikt_1$	$-\frac{1}{3}i\sqrt{2}\,kt_1$	0	$\frac{2k^2t_1}{3}$

Left propagator table:

	$\sigma_{1^+}^{\#1}{}^{\dagger\alpha\beta}$	$\sigma_{1^+}^{\#2}{}^{\dagger\alpha\beta}$	$\tau_{1^+}^{\#1}{}^{\dagger\alpha\beta}$	$\sigma_{1^-}^{\#1}{}^{\dagger\alpha}$	$\sigma_{1^-}^{\#2}{}^{\dagger\alpha}$	$\tau_{1^-}^{\#1}{}^{\dagger\alpha}$	$\tau_{1^-}^{\#2}{}^{\dagger\alpha}$
$\tau_{1^-}^{\#2}{}_{\alpha}$	0	0	0	$\frac{i}{k(1+2k^2)(r_1-2r_3-r_5)t_1}$	$\frac{i(6k^2(r_1-2r_3-r_5)-t_1)}{\sqrt{2}k(1+2k^2)^2(r_1-2r_3-r_5)t_1}$		$\frac{\frac{1}{-r_1+2r_3+r_5}+\frac{6k^2}{t_1}}{(1+2k^2)^2}$
$\tau_{1^-}^{\#1}{}_{\alpha}$	0	0	0	0	0	0	0
$\sigma_{1^-}^{\#2}{}_{\alpha}$	0	0	0	$\frac{1}{\sqrt{2}(k^2+2k^4)(r_1-2r_3-r_5)}$	$\frac{\frac{1}{-r_1+2r_3+r_5}+\frac{6k^2}{t_1}}{2(k^2+2k^3)^2}$		$\frac{i(6k^2(r_1-2r_3-r_5)-t_1)}{\sqrt{2}k(1+2k^2)^2(r_1-2r_3-r_5)t_1}$
$\sigma_{1^-}^{\#1}{}_{\alpha}$	0	0	0	$\frac{1}{k^2(-r_1+2r_3+r_5)}$	$\frac{1}{\sqrt{2}(k^2+2k^4)(r_1-2r_3-r_5)}$	0	$\frac{i}{k(1+2k^2)(-r_1+2r_3+r_5)}$
$\tau_{1^+}^{\#1}{}_{\alpha\beta}$	$-\frac{i\sqrt{2}k}{t_1+k^2t_1}$	$-\frac{2ik^3(2r_3+r_5)+ikt_1}{(1+k^2)^2t_1^2}$	$-\frac{2k^4(2r_3+r_5)+k^2t_1}{(1+k^2)^2t_1^2}$	0	0	0	0
$\sigma_{1^+}^{\#2}{}_{\alpha\beta}$	$-\frac{\sqrt{2}}{t_1+k^2t_1}$	$-\frac{2k^2(2r_3+r_5)+t_1}{(1+k^2)^2t_1^2}$	$\frac{i(2k^3(2r_3+r_5)+kt_1)}{(1+k^2)^2t_1^2}$	0	0	0	0
$\sigma_{1^+}^{\#1}{}_{\alpha\beta}$	0	$-\frac{\sqrt{2}}{t_1+k^2t_1}$	$\frac{i\sqrt{2}k}{t_1+k^2t_1}$	0	0	0	0

$2^\pm$ sector:

	$\omega_{2^+}^{\#1}{}^{\dagger\alpha\beta}$	$f_{2^+}^{\#1}{}^{\dagger\alpha\beta}$	$\omega_{2^-}^{\#1}{}^{\dagger\alpha\beta\chi}$
$\omega_{2^-}^{\#1}{}_{\alpha\beta\chi}$	0	0	$k^2 r_1+\frac{t_1}{2}$
$f_{2^+}^{\#1}{}_{\alpha\beta}$	$-\frac{ikt_1}{\sqrt{2}}$	$k^2 t_1$	0
$\omega_{2^+}^{\#1}{}_{\alpha\beta}$	$\frac{t_1}{2}$	$\frac{ikt_1}{\sqrt{2}}$	0

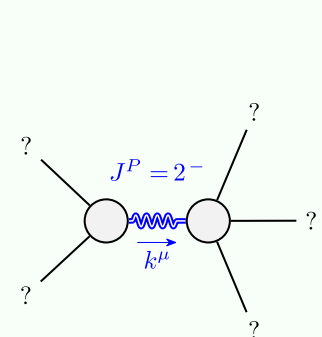|	$\sigma_{2^+}^{\#1}{}_{\alpha\beta}$	$\tau_{2^+}^{\#1}{}_{\alpha\beta}$	$\sigma_{2^-}^{\#1}{}_{\alpha\beta\chi}$
$\sigma_{2^+}^{\#1}{}^{\dagger\alpha\beta}$	$\frac{2}{(1+2k^2)^2 t_1}$	$-\frac{2i\sqrt{2}k}{(1+2k^2)^2 t_1}$	0
$\tau_{2^+}^{\#1}{}^{\dagger\alpha\beta}$	$\frac{2i\sqrt{2}k}{(1+2k^2)^2 t_1}$	$\frac{4k^2}{(1+2k^2)^2 t_1}$	0
$\sigma_{2^-}^{\#1}{}^{\dagger\alpha\beta\chi}$	0	0	$\frac{2}{2k^2 r_1+t_1}$

$0^\pm$ sector:

	$\sigma_{0^+}^{\#1}$	$\tau_{0^+}^{\#1}$	$\tau_{0^+}^{\#2}$	$\sigma_{0^-}^{\#1}$
$\sigma_{0^+}^{\#1}{}^{\dagger}$	$\frac{1}{6k^2(-r_1+r_3)}$	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	$-\frac{1}{t_1}$

	$f_{0^+}^{\#1}$	$f_{0^+}^{\#2}$	$\omega_{0^-}^{\#2}$	$\omega_{0^-}^{\#1}$
$\omega_{0^+}^{\#1}{}^{\dagger}$	0	0	0	$-t_1$
$f_{0^+}^{\#1}{}^{\dagger}$	0	0	0	0
$f_{0^+}^{\#2}{}^{\dagger}$	0	0	0	0
$\omega_{0^-}^{\#1}{}^{\dagger}$	$6k^2(-r_1+r_3)$	0	0	0

Quadratic (free) Lagrangian density

$$-\tfrac{1}{3}t_1\,\omega_i{}^{\alpha i}\,\omega_{\kappa\alpha}{}^{\kappa}-t_1\,\omega_i{}^{\kappa\lambda}\,\omega_{i\kappa\lambda}{}'+f^{\alpha\beta}\,\tau_{\alpha\beta}+\omega^{\alpha\beta\chi}\,\sigma_{\alpha\beta\chi}+2r_1\,\partial_i\omega^{\kappa\lambda}{}_\kappa\,\partial^i\omega_\lambda{}^\alpha{}_\alpha -$$
$$2r_3\,\partial_i\omega^{\kappa\lambda}{}_\kappa\,\partial^i\omega_{\lambda\alpha}{}^\alpha-r_5\,\partial_i\omega^{\kappa\lambda}{}_\kappa\,\partial'\omega_\lambda{}^\alpha{}_\alpha-\tfrac{2}{3}r_1\,\partial^\beta\partial_\theta\omega_{\lambda\alpha}{}^\alpha\,\partial_\kappa\omega^{\theta\kappa\lambda}-$$
$$\tfrac{2}{3}r_1\,\partial_\theta\omega_{\lambda\alpha}{}^\kappa\,\partial_\kappa\omega^{\theta\alpha\lambda}-2r_1\,\partial_\theta\omega_{\lambda\alpha}{}^\alpha\,\partial_\kappa\omega^{\theta\kappa\lambda}+2r_3\,\partial_\theta\omega_{\lambda\alpha}{}^\alpha\,\partial_\kappa\omega^{\theta\kappa\lambda}-$$
$$r_5\,\partial_\theta\omega_{\lambda\alpha}{}^\alpha\,\partial_\kappa\omega^{\theta\kappa\lambda}+2r_1\,\partial_\alpha\omega_{\lambda}{}^\alpha{}_\theta\,\partial_\kappa\omega^{\kappa\lambda\theta}-2r_3\,\partial_\alpha\omega_\lambda{}^\alpha{}_\theta\,\partial_\kappa\omega^{\kappa\lambda\theta}-$$
$$r_5\,\partial_\theta\omega_{\lambda\alpha}{}^\alpha\,\partial_\kappa\omega^{\kappa\lambda\theta}-4r_1\,\partial_\theta\omega_\lambda{}^\alpha{}_\alpha\,\partial_\kappa\omega^{\kappa\lambda\theta}+4r_3\,\partial_\theta\omega_\lambda{}^\alpha{}_\alpha\,\partial_\kappa\omega^{\kappa\lambda\theta}+$$
$$2r_5\,\partial_\theta\omega_\lambda{}^\alpha{}_\alpha\,\partial_\kappa\omega^{\kappa\lambda\theta}-\tfrac{1}{2}t_1\,\partial_\theta f_{\theta\kappa}\,\partial^\kappa f_\alpha{}^\theta-\tfrac{1}{2}t_1\,\partial^\alpha f^\lambda{}_\kappa\,\partial^\kappa f_{\alpha\lambda}+$$
$$\tfrac{1}{3}t_1\,\omega_{\kappa\alpha}\,\partial^\kappa f'{}_i+\tfrac{1}{3}t_1\,\omega_{i\kappa\lambda}\,\partial^\kappa f'{}_i+\tfrac{1}{2}t_1\,\partial_\kappa f_{\kappa\lambda}\,\partial^\kappa f^\lambda{}_\lambda\,\partial^\kappa f_{\lambda\alpha}+$$
$$2t_1\,\omega_{i\kappa\theta}\,\partial^\kappa f'{}_{i\alpha}{}^\alpha\partial^\kappa f'{}_\kappa-\tfrac{1}{3}t_1\,\omega_{i\lambda}{}^\alpha\,\partial^\kappa f'{}_\kappa+\tfrac{1}{2}t_1\,\partial^\alpha f'{}_\kappa+\tfrac{1}{3}t_1\,\partial^\alpha f^\lambda{}_\lambda\,\partial^\kappa f_{\lambda\kappa}+$$
$$-\tfrac{1}{2}t_1\,\partial_\kappa f^{i\theta}-\tfrac{1}{3}t_1\,\omega_{i\alpha}\,\partial^\kappa f^{\lambda}{}_\theta\,\partial^\kappa f_\lambda{}^\theta-\tfrac{1}{3}t_1\,\partial_\kappa f^\lambda{}_\theta\,\partial^\kappa f_{\lambda\kappa}+\tfrac{2}{3}r_1\,\partial_\kappa\omega^{\alpha\beta\theta}\,\partial_\kappa\omega_{\alpha\beta\theta}-$$
$$\tfrac{2}{3}r_1\,\partial_\kappa\omega^{\theta\alpha\beta}\,\partial_\theta\omega_{\alpha\beta\theta}+\tfrac{2}{3}r_1\,\partial^\beta\partial_\theta\omega_{\alpha\beta}{}^\alpha\,\partial^\kappa f_\kappa+\tfrac{4}{3}r_1\,\partial^\beta\omega_i{}^{\lambda\alpha}\partial_\lambda\omega_{\alpha\beta}{}'-$$
$$4r_3\,\partial_\alpha\omega_\lambda{}^{\lambda\alpha}\,\partial^\lambda\omega^{\theta\kappa}{}_\kappa-2r_3\,\partial_\alpha\omega_\lambda{}^\alpha{}_\theta\,\partial^\lambda\omega^{\theta\kappa}{}_\kappa+2r_3\,\partial_\theta\omega_\lambda{}^\alpha{}_\alpha\,\partial^\lambda\omega^{\theta\kappa}{}_\kappa-r_5\,\partial_\theta\omega_\lambda{}^\alpha{}_\alpha\,\partial^\lambda\omega^{\theta\kappa}{}_\kappa$$

Source constraints/gauge generators

SO(3) irreps	Multiplicities
$\tau_{0^+}^{\#2}==0$	1
$\tau_{0^+}^{\#1}==0$	1
$\tau_{1^-}^{\#2\,\alpha}+2iik\,\sigma_{1^-}^{\#2\,\alpha}==0$	3
$\tau_{1^-}^{\#1\,\alpha}==0$	3
$\tau_{1^+}^{\#1\,\alpha\beta}+ik\,\sigma_{1^+}^{\#2\,\alpha\beta}==0$	3
$\tau_{2^+}^{\#1\,\alpha\beta}-2ik\,\sigma_{2^+}^{\#1\,\alpha\beta}==0$	5
Total constraints:	16

Massive and massless spectra

Massive particle — $J^P=2^-$, k^μ

Pole residue:	$-\frac{1}{r_1}>0$
Polarisations:	5
Square mass:	$-\frac{t_1}{2r_1}>0$
Spin:	2
Parity:	Odd
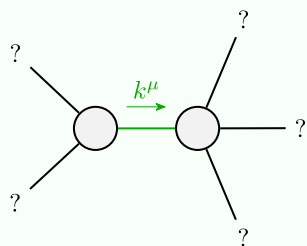
Quadratic pole — k^μ

Pole residue:	$\frac{1}{(r_1-2r_3-r_5)t_1^2}>0$
Polarisations:	2

Unitarity conditions

$r_1<0$ && $r_5<r_1-2r_3$ && $t_1>0$