Particle spectrograph

Wave operator and propagator

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

Quadratic (free) action

$$S_F == \int\int\int\Big(\tfrac{1}{6}(-2 t_1\, \omega_l^{\alpha\prime}\, \omega_{\kappa\alpha}{}^{\kappa} - 6 t_1\, \omega_l^{\kappa}\, \omega_{\lambda}{}^{\alpha\prime} + 6\, \omega^{\alpha\beta\chi}\, \sigma_{\alpha\beta\chi} + 12 r_1 \partial_l \omega^{\kappa\lambda}{}_{\kappa} \partial^{\prime} \omega_{\lambda}{}^{\alpha} - 4 r_1 \partial^{\beta} \omega^{\theta\alpha}{}_{\kappa} \partial_{\theta} \omega_{\alpha\beta}{}^{\kappa} - 12 r_3 \partial_l \omega^{\kappa\lambda}{}_{\kappa} \partial^{\prime} \omega_{\lambda}{}^{\alpha} - 6 r_5 \partial_l \omega_{\lambda}{}^{\alpha}{}_{\theta} \partial_{\kappa} \omega^{\theta\kappa\lambda} + 4 r_1 \partial_{\theta} \omega_{\alpha\beta}{}^{\kappa} \partial_{\kappa} \omega^{\theta\alpha\beta} - 12 r_1 \partial_{\theta} \omega_{\lambda}{}^{\alpha}{}_{\kappa} \partial_{\alpha} \omega^{\theta\kappa\lambda} + 12 r_3 \partial_{\theta} \omega_{\lambda}{}^{\alpha}{}_{\kappa} \partial_{\alpha} \omega^{\theta\kappa\lambda} - 6 r_5 \partial_{\theta} \omega_{\lambda}{}^{\alpha}{}_{\alpha} \partial_{\kappa} \omega^{\theta\kappa\lambda} + 12 r_1 \partial_{\alpha} \omega_{\lambda}{}^{\alpha}{}_{\theta} \partial_{\kappa} \omega^{\theta\kappa\lambda} - 12 r_3 \partial_{\alpha} \omega_{\lambda}{}^{\alpha}{}_{\theta} \partial_{\kappa} \omega^{\theta\kappa\lambda} + 6 r_5 \partial_{\alpha} \omega_{\lambda}{}^{\alpha}{}_{\theta} \partial_{\kappa} \omega^{\theta\kappa\lambda} - 12 r_1 \partial_{\theta} \omega_{\lambda}{}^{\alpha}{}_{\alpha} \partial_{\kappa} \omega^{\kappa\lambda\theta} + 12 r_3 \partial_{\theta} \omega_{\lambda}{}^{\alpha}{}_{\alpha} \partial_{\kappa} \omega^{\kappa\lambda\theta} - 6 r_5 \partial_{\theta} \omega_{\lambda}{}^{\alpha}{}_{\alpha} \partial_{\kappa} \omega^{\kappa\lambda\theta} + 24 r_3 \partial_{\theta} \omega_{\lambda}{}^{\alpha}{}_{\alpha} \partial_{\kappa} \omega^{\kappa\lambda\theta} - 3 t_1 \partial^{\alpha} f_{\kappa\lambda}{}^{\prime} \partial^{\kappa} f_{\alpha}{}^{\lambda\prime} + 2 t_1 \partial^{\alpha} f_{\kappa\alpha}{}^{\prime} \partial^{\kappa} f_{\lambda}{}^{\lambda\prime} + 2 t_1 \partial_{\kappa} f^{\lambda}{}_{\lambda}{}^{\prime} \partial^{\kappa} f_{l}{}^{\prime} + 12 t_1\, \omega_{l\kappa\theta}\, \partial^{\kappa} f^{\prime\theta} - 2 t_1\, \omega_{l\alpha}{}^{\alpha}\, \partial^{\kappa} f^{\prime}{}_{\kappa} - 2 t_1\, \omega_{l\lambda}{}^{\lambda}\, \partial^{\kappa} f^{\prime}{}_{\kappa} + 3 t_1 \partial^{\alpha} f^{\lambda}{}_{\kappa}\, \partial^{\kappa} f_{\lambda\alpha} + 3 t_1 \partial_{\kappa} f^{\lambda}{}_{\theta}\, \partial^{\kappa} f_{\lambda}{}^{\theta} - 2 t_1 \partial^{\alpha} f^{\lambda}{}_{\alpha}\, \partial^{\kappa} f_{\lambda\kappa} + 4 r_1 \partial_{\kappa} \omega^{\alpha\beta\theta}\, \partial^{\kappa} \omega_{\alpha\beta\theta} - 4 r_1 \partial_{\kappa} \omega^{\theta\alpha\beta}\, \partial^{\kappa} \omega_{\alpha\beta\theta} + 8 r_1 \partial^{\beta} \omega_{l}{}^{\lambda\alpha}\, \partial_{\lambda} \omega_{\alpha\beta}{}^{\prime} - 24 r_3 \partial^{\beta} \omega_{l}{}^{\lambda\alpha}\, \partial_{\lambda} \omega_{\alpha\beta}{}^{\prime} + 12 r_1 \partial_{\alpha} \omega_{\lambda}{}^{\alpha}{}_{\theta}\, \partial^{\lambda} \omega^{\theta\kappa}{}_{\kappa} - 12 r_3 \partial_{\alpha} \omega_{\lambda}{}^{\alpha}{}_{\theta}\, \partial^{\lambda} \omega^{\theta\kappa}{}_{\kappa} + 6 r_5 \partial_{\alpha} \omega_{\lambda}{}^{\alpha}{}_{\theta}\, \partial^{\lambda} \omega^{\theta\kappa}{}_{\kappa} + 12 r_3 \partial_{\theta} \omega_{\lambda}{}^{\alpha}{}_{\alpha}\, \partial^{\lambda} \omega^{\theta\kappa}{}_{\kappa} - 6 r_5 \partial_{\theta} \omega_{\lambda}{}^{\alpha}{}_{\alpha}\, \partial^{\lambda} \omega^{\theta\kappa}{}_{\kappa}))[t, x, y, z]\, d\!\!\!/ z\, d\!\!\!/ y\, d\!\!\!/ x\, d\!\!\!/ t$$

	$\sigma^{\#1}_{1^+}{}^{\alpha\beta}$	$\sigma^{\#2}_{1^+}{}^{\alpha\beta}$	$\tau^{\#1}_{1^+}{}^{\alpha\beta}$	$\sigma^{\#1}_{1^-}{}^{\alpha}$	$\sigma^{\#2}_{1^-}{}^{\alpha}$	$\tau^{\#1}_{1^-}{}^{\alpha}$	$\tau^{\#2}_{1^-}{}^{\alpha}$
$\sigma^{\#1}_{1^+}{}^{\dagger\alpha\beta}$	0	$-\frac{\sqrt{2}}{t_1 + k^2 t_1}$	$-\frac{i\sqrt{2}\,k}{t_1 + k^2 t_1}$	0	0	0	0
$\sigma^{\#2}_{1^+}{}^{\dagger\alpha\beta}$	$-\frac{\sqrt{2}}{t_1 + k^2 t_1}$	$\frac{-2 k^2 (2 r_3 + r_5) + t_1}{(1 + k^2)^2 t_1^2}$	$\frac{-2 i k^3 (2 r_3 + r_5) + i k t_1}{(1 + k^2)^2 t_1^2}$	0	0	0	0
$\tau^{\#1}_{1^+}{}^{\dagger\alpha\beta}$	$\frac{i\sqrt{2}\,k}{t_1 + k^2 t_1}$	$\frac{i (2 k^3 (2 r_3 + r_5) - k t_1)}{(1 + k^2)^2 t_1^2}$	$\frac{-2 k^4 (2 r_3 + r_5) + k^2 t_1}{(1 + k^2)^2 t_1^2}$	0	0	0	0
$\sigma^{\#1}_{1^-}{}^{\dagger\alpha}$	0	0	0	$\frac{1}{k^2 (-r_1 + 2 r_3 + r_5)}$	$\frac{1}{\sqrt{2}\,(k^2 + 2 k^4)(r_1 - 2 r_3 - r_5)}$	$\frac{i}{k (1 + 2 k^2)(-r_1 + 2 r_3 + r_5)}$	$\frac{i}{k (1 + 2 k^2)(r_1 - 2 r_3 - r_5)}$
$\sigma^{\#2}_{1^-}{}^{\dagger\alpha}$	0	0	0	$\frac{1}{\sqrt{2}\,(k^2 + 2 k^4)(r_1 - 2 r_3 - r_5)}$	$\frac{1}{2 (k + 2 k^3)^2} \frac{-r_1 + 2 r_3 + r_5}{t_1} + \frac{6 k^2}{t_1}$	0	$-\frac{i (6 k^2 (r_1 - 2 r_3 - r_5) - t_1)}{\sqrt{2}\,k (1 + 2 k^2)^2 (r_1 - 2 r_3 - r_5) t_1}$
$\tau^{\#1}_{1^-}{}^{\dagger\alpha}$	0	0	0	0	0	0	0
$\tau^{\#2}_{1^-}{}^{\dagger\alpha}$	0	0	0	$\frac{i}{k (1 + 2 k^2)(r_1 - 2 r_3 - r_5)}$	$\frac{i (6 k^2 (r_1 - 2 r_3 - r_5) - t_1)}{\sqrt{2}\,k (1 + 2 k^2)^2 (r_1 - 2 r_3 - r_5) t_1}$	0	$\frac{1}{\frac{-r_1 + 2 r_3 + r_5}{t_1} + \frac{6 k^2}{t_1}} \frac{1}{(1 + 2 k^2)^2}$

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

	$\omega^{\#1}_{2^+}{}_{\alpha\beta}$	$f^{\#1}_{2^+}{}_{\alpha\beta}$	$\omega^{\#1}_{2^-}{}_{\alpha\beta\chi}$
$\omega^{\#1}_{2^+}{}^{\dagger\alpha\beta}$	$\frac{t_1}{2}$	$-\frac{i k t_1}{\sqrt{2}}$	0
$f^{\#1}_{2^+}{}^{\dagger\alpha\beta}$	$\frac{i k t_1}{\sqrt{2}}$	$k^2 t_1$	0
$\omega^{\#1}_{2^-}{}^{\dagger\alpha\beta\chi}$	0	0	$k^2 r_1 + \frac{t_1}{2}$

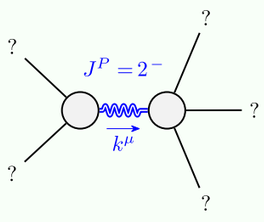
	$\omega^{\#1}_{0^+}$	$f^{\#1}_{0^+}$	$f^{\#2}_{0^+}$	$\omega^{\#1}_{0^-}$
$\omega^{\#1}_{0^+}{}^{\dagger}$	$6 k^2 (-r_1 + r_3)$	0	0	0
$f^{\#1}_{0^+}{}^{\dagger}$	0	0	0	0
$f^{\#2}_{0^+}{}^{\dagger}$	0	0	0	0
$\omega^{\#1}_{0^-}{}^{\dagger}$	0	0	0	$-t_1$

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

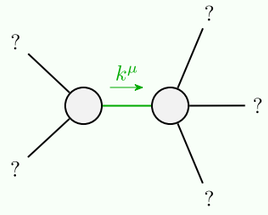
Source constraints/gauge generators

SO(3) irreps	Multiplicities
$\tau^{\#2}_{0^+} == 0$	1
$\tau^{\#1}_{0^+} == 0$	1
$\tau^{\#2\alpha}_{1^-} + 2 i k\, \sigma^{\#2\alpha}_{1^-} == 0$	3
$\tau^{\#1\alpha}_{1^-} == 0$	3
$\tau^{\#1\alpha\beta}_{1^+} + i k\, \sigma^{\#2\alpha\beta}_{1^+} == 0$	3
$\tau^{\#1\alpha\beta}_{2^+} - 2 i k\, \sigma^{\#1\alpha\beta}_{2^+} == 0$	5
Total constraints:	16

Massive and massless spectra



Massive particle	
Pole residue:	$-\frac{1}{r_1} > 0$
Polarisations:	5
Square mass:	$-\frac{t_1}{2 r_1} > 0$
Spin:	2
Parity:	Odd



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

Unitarity conditions

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