

Particle spectrograph

Wave operator and propagator

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

Quadratic (free) action

$$S_F = \iiint \left(\frac{1}{6} (-2t_1 \omega_{\kappa\alpha}^{\alpha'} \omega_{\kappa\alpha}^{\kappa} - 6t_1 \omega_{\kappa\lambda}^{\kappa\lambda} \omega_{\kappa\lambda}^{\lambda'} + 6f^{\alpha\beta} \tau_{\alpha\beta} + 6\omega^{\alpha\beta\chi} \sigma_{\alpha\beta\chi} - \right.$$
$$12r_3 \partial_\lambda \omega_{\kappa\lambda}^{\kappa\lambda} \partial' \omega_{\lambda\alpha}^{\alpha} - 6r_5 \partial_\lambda \omega_{\kappa\lambda}^{\kappa\lambda} \partial' \omega_{\lambda\alpha}^{\alpha} + 4r_2 \partial^\beta \omega_{\kappa\alpha}^{\theta\alpha} \partial_\beta \omega_{\alpha\beta}^{\kappa-}$$
$$2r_2 \partial_\theta \omega_{\alpha\beta}^{\kappa} \partial_\kappa \omega^{\alpha\beta\theta} - 4r_2 \partial_\theta \omega_{\alpha\beta}^{\kappa} \partial_\kappa \omega^{\theta\alpha\beta} + 12r_3 \partial_\alpha \omega_{\lambda\alpha}^{\alpha} \partial_\kappa \omega^{\theta\kappa\lambda} -$$
$$6r_5 \partial_\alpha \omega_{\lambda\alpha}^{\alpha} \partial_\kappa \omega^{\theta\kappa\lambda} - 12r_3 \partial_\theta \omega_{\lambda\alpha}^{\alpha} \partial_\kappa \omega^{\theta\kappa\lambda} + 6r_5 \partial_\theta \omega_{\lambda\alpha}^{\alpha} \partial_\kappa \omega^{\theta\kappa\lambda} -$$
$$12r_3 \partial_\alpha \omega_{\lambda\alpha}^{\alpha} \partial_\kappa \omega^{\kappa\lambda\theta} - 6r_5 \partial_\alpha \omega_{\lambda\alpha}^{\alpha} \partial_\kappa \omega^{\kappa\lambda\theta} + 24r_3 \partial_\theta \omega_{\lambda\alpha}^{\alpha} \partial_\kappa \omega^{\kappa\lambda\theta} +$$
$$12r_5 \partial_\theta \omega_{\lambda\alpha}^{\alpha} \partial_\kappa \omega^{\kappa\lambda\theta} - 3t_1 \partial^\alpha f_{\theta\kappa} \partial^\kappa f_{\alpha}^{\theta} - 3t_1 \partial^\alpha f_{\kappa\theta} \partial^\kappa f_{\alpha}^{\theta} - 3t_1 \partial^\alpha f_{\lambda}^{\theta} \partial^\kappa f_{\alpha}^{\lambda} +$$
$$2t_1 \omega_{\kappa\alpha}^{\alpha} \partial^\kappa f_{\lambda}^{\theta} + 2t_1 \omega_{\kappa\lambda}^{\lambda} \partial^\kappa f_{\lambda}^{\theta} + 4t_1 \partial^\alpha f_{\kappa\alpha} \partial^\kappa f_{\lambda}^{\theta} - 2t_1 \partial_\kappa f_{\lambda}^{\theta} \partial^\kappa f_{\lambda}^{\theta} +$$
$$12t_1 \omega_{\kappa\theta} \partial^\kappa f_{\lambda}^{\theta} - 2t_1 \omega_{\lambda\alpha}^{\alpha} \partial^\kappa f_{\kappa}^{\theta} - 2t_1 \omega_{\lambda\lambda}^{\lambda} \partial^\kappa f_{\kappa}^{\theta} + 3t_1 \partial^\alpha f_{\lambda}^{\theta} \partial^\kappa f_{\alpha}^{\lambda} +$$
$$3t_1 \partial_\kappa f_{\theta}^{\lambda} \partial^\kappa f_{\lambda}^{\theta} + 3t_1 \partial_\kappa f_{\theta}^{\lambda} \partial^\kappa f_{\lambda}^{\theta} - 2t_1 \partial^\alpha f_{\lambda}^{\theta} \partial^\kappa f_{\lambda\kappa}^{\alpha} + 2r_2 \partial_\kappa \omega^{\alpha\beta\theta} \partial^\kappa \omega_{\alpha\beta\theta} +$$
$$4r_2 \partial_\kappa \omega^{\theta\alpha\beta} \partial^\kappa \omega_{\alpha\beta\theta} - 4r_2 \partial_\theta \omega_{\lambda\alpha}^{\alpha} \partial_\lambda \omega_{\alpha\beta}^{\lambda'} + 4r_2 \partial^\beta \omega_{\alpha\beta}^{\lambda\alpha} \partial_\lambda \omega_{\alpha\beta}^{\lambda'} -$$
$$24r_3 \partial^\beta \omega_{\lambda\alpha}^{\lambda\alpha} \partial_\lambda \omega_{\alpha\beta}^{\lambda'} - 12r_3 \partial_\alpha \omega_{\lambda\alpha}^{\alpha} \partial^\lambda \omega_{\theta}^{\theta\kappa} + 6r_5 \partial_\alpha \omega_{\lambda\alpha}^{\alpha} \partial^\lambda \omega_{\theta}^{\theta\kappa} +$$
$$12r_3 \partial_\theta \omega_{\lambda\alpha}^{\alpha} \partial^\lambda \omega_{\alpha}^{\theta\kappa} - 6r_5 \partial_\theta \omega_{\lambda\alpha}^{\alpha} \partial^\lambda \omega_{\alpha}^{\theta\kappa}) [t, x, y, z] dz dy dx dt$$

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

$\sigma_{0+}^{\#1} \dagger$	$\tau_{0+}^{\#1}$	$\tau_{0+}^{\#2}$	$\sigma_{0-}^{\#1}$
$\sigma_{0+}^{\#1} \dagger$	$\frac{1}{6k^2 r_3}$	0	0
$\tau_{0+}^{\#1} \dagger$	0	0	0
$\tau_{0+}^{\#2} \dagger$	0	0	0
$\sigma_{0-}^{\#1} \dagger$	0	0	$\frac{1}{k^2 r_2 - t_1}$

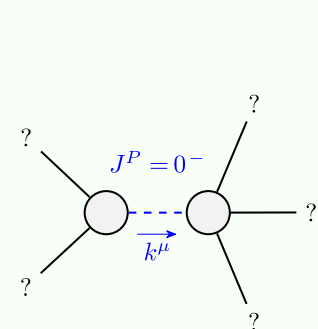
Source constraints/gauge generators	Multiplicities
SO(3) irreps	
$\tau_{0+}^{\#2} == 0$	1
$\tau_{0+}^{\#1} == 0$	1
$\tau_{1-}^{\#2\alpha} + 2ik\sigma_{1-}^{\#2\alpha} == 0$	3
$\tau_{1-}^{\#1\alpha} == 0$	3
$\tau_{1+}^{\#1\alpha\beta} + ik\sigma_{1+}^{\#2\alpha\beta} == 0$	3
$\tau_{2+}^{\#1\alpha\beta}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

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

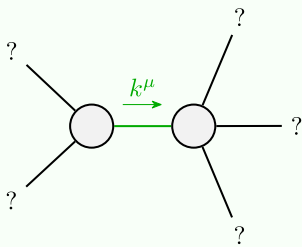
$\omega_{0+}^{\#1}$	$f_{0+}^{\#1}$	$f_{0+}^{\#2}$	$\omega_{0-}^{\#1}$
$\omega_{0+}^{\#1} \dagger$	$6k^2 r_3$	0	0
$f_{0+}^{\#1} \dagger$	0	0	0
$f_{0+}^{\#2} \dagger$	0	0	0
$\omega_{0-}^{\#1} \dagger$	0	0	$k^2 r_2 - t_1$

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

Massive and massless spectra



Massive particle	
Pole residue:	$-\frac{1}{r_2} > 0$
Polarisations:	1
Square mass:	$\frac{t_1}{r_2} > 0$
Spin:	0
Parity:	Odd



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

Unitarity conditions

$r_2 < 0 \ \&\& \ r_5 < -2r_3 \ \&\& \ t_1 < 0$