

Particle spectrograph

Wave operator and propagator

	$\sigma_{1^+}^{\#1} \dagger^{\alpha\beta}$	$\sigma_{1^+}^{\#2} \dagger^{\alpha\beta}$	$\tau_{1^+}^{\#1} \dagger^{\alpha\beta}$	$\sigma_{1^+}^{\#1} \alpha$	$\sigma_{1^+}^{\#2} \alpha$	$\tau_{1^+}^{\#1} \alpha$	$\tau_{1^+}^{\#2} \alpha$
$\sigma_{1^+}^{\#1} \dagger^{\alpha\beta}$	$\frac{1}{k^2(2r_1+r_5)}$	0	0	0	0	0	0
$\sigma_{1^+}^{\#2} \dagger^{\alpha\beta}$	0	0	0	0	0	0	0
$\tau_{1^+}^{\#1} \dagger^{\alpha\beta}$	0	0	0	0	0	0	0
$\sigma_{1^+}^{\#1} \alpha$	0	0	0	$\frac{1}{k^2(r_1+r_5)}$	$\frac{\sqrt{2}}{k^2(1+2k^2)(r_1+r_5)}$	0	$\frac{2i}{k(1+2k^2)(r_1+r_5)}$
$\sigma_{1^+}^{\#2} \alpha$	0	0	0	$\frac{\sqrt{2}}{k^2(1+2k^2)(r_1+r_5)}$	$\frac{3k^2(r_1+r_5)+2t_3}{(k+2k^2)^2(r_1+r_5)t_3}$	0	$\frac{i\sqrt{2}(3k^2(r_1+r_5)+2t_3)}{k(1+2k^2)^2(r_1+r_5)t_3}$
$\tau_{1^+}^{\#1} \alpha$	0	0	0	0	0	0	0
$\tau_{1^+}^{\#2} \alpha$	0	0	0	$-\frac{2i}{k(1+2k^2)(r_1+r_5)}$	$-\frac{i\sqrt{2}(3k^2(r_1+r_5)+2t_3)}{k(1+2k^2)^2(r_1+r_5)t_3}$	0	$\frac{6k^2(r_1+r_5)+4t_3}{(1+2k^2)^2(r_1+r_5)t_3}$

	$\omega_{1^+}^{\#1} \dagger^{\alpha\beta}$	$\omega_{1^+}^{\#2} \dagger^{\alpha\beta}$	$f_{1^+}^{\#1} \dagger^{\alpha\beta}$	$\omega_{1^+}^{\#1} \alpha$	$\omega_{1^+}^{\#2} \alpha$	$f_{1^+}^{\#1} \alpha$	$f_{1^+}^{\#2} \alpha$
$\omega_{1^+}^{\#1} \dagger^{\alpha\beta}$	$k^2(2r_1+r_5)$	0	0	0	0	0	0
$\omega_{1^+}^{\#2} \dagger^{\alpha\beta}$	0	0	0	0	0	0	0
$f_{1^+}^{\#1} \dagger^{\alpha\beta}$	0	0	0	0	0	0	0
$\omega_{1^+}^{\#1} \alpha$	0	0	0	$k^2(r_1+r_5)+\frac{2t_3}{3}$	$-\frac{\sqrt{2}t_3}{3}$	0	$-\frac{2}{3}i k t_3$
$\omega_{1^+}^{\#2} \alpha$	0	0	0	$-\frac{\sqrt{2}t_3}{3}$	$\frac{t_3}{3}$	0	$\frac{1}{3}i\sqrt{2} k t_3$
$f_{1^+}^{\#1} \alpha$	0	0	0	0	0	0	0
$f_{1^+}^{\#2} \alpha$	0	0	0	$\frac{2i k t_3}{3}$	$-\frac{1}{3}i\sqrt{2} k t_3$	0	$\frac{2k^2t_3}{3}$

Quadratic (free) action

$$S = \iiint \Big(\frac{1}{3} (-2t_3 \omega_{\alpha}^{\alpha i} \omega_{\alpha}^{\kappa} + 3 f^{\alpha\beta} \tau_{\alpha\beta} \sigma_{\alpha\beta\chi} + 4t_3 \omega_{\alpha}^{\kappa} \partial_i f^{\alpha i} - 4t_3 \omega_{\alpha}^{\kappa} \partial^i f_{\alpha}^{\alpha} + 2t_3 \partial_i f_{\kappa}^{\kappa} \partial^i f_{\alpha}^{\alpha} - 4r_1 \partial_{\beta} \omega_{\alpha i \theta} \partial^{\theta} \omega^{\alpha\beta i} + 2r_1 \partial_{\beta} \omega_{\alpha \theta i} \partial^{\theta} \omega^{\alpha\beta i} - 8r_1 \partial_{\beta} \omega_{\alpha i \theta} \partial^{\theta} \omega^{\alpha\beta i} - 2r_1 \partial_i \omega_{\alpha\beta\theta} \partial^{\theta} \omega^{\alpha\beta i} + 2r_1 \partial_{\theta} \omega_{\alpha\beta i} \partial^{\theta} \omega^{\alpha\beta i} + 2r_1 \partial_{\theta} \omega_{\alpha i \beta} \partial^{\theta} \omega^{\alpha\beta i} + 3r_5 \partial_i \omega_{\theta}^{\kappa} \partial^{\theta} \omega_{\alpha}^{\alpha i} - 3r_5 \partial_{\theta} \omega_{\alpha}^{\kappa} \partial^{\theta} \omega_{\alpha}^{\alpha i} + 2t_3 \partial_i f^{\alpha i} \partial_{\kappa} f_{\alpha}^{\kappa} - 4t_3 \partial^i f_{\alpha}^{\alpha} \partial_{\kappa} f_{\alpha}^{\kappa} - 3r_5 \partial_{\alpha} \omega^{\alpha i \theta} \partial_{\kappa} \omega_{\alpha}^{\kappa} + 6r_5 \partial^{\theta} \omega_{\alpha}^{\alpha i} \partial_{\kappa} \omega_{\alpha}^{\kappa} + 3r_5 \partial_{\alpha} \omega^{\alpha i \theta} \partial_{\kappa} \omega_{\theta}^{\kappa} - 6r_5 \partial^{\theta} \omega_{\alpha}^{\alpha i} \partial_{\alpha} \omega_{\theta}^{\kappa}) [t, x, y, z] dz dy dx dt$$

Source constraints/gauge generators	Multiplicities
$SO(3)$ irreps	
$\sigma_0^{\#1} == 0$	1
$\tau_0^{\#2} == 0$	1
$\tau_0^{\#1} - 2i k \sigma_0^{\#1} == 0$	1
$\tau_1^{\#2\alpha} + 2i k \sigma_1^{\#2\alpha} == 0$	3
$\tau_1^{\#1\alpha} == 0$	3
$\tau_1^{\#1\alpha\beta} == 0$	3
$\sigma_1^{\#2\alpha\beta} == 0$	3
$\tau_2^{\#1\alpha\beta} == 0$	5
$\sigma_2^{\#1\alpha\beta} == 0$	5
Total constraints:	25

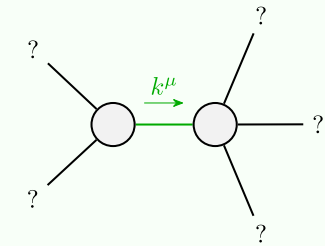
	$\sigma_{0^+}^{\#1}$	$\tau_{0^+}^{\#1}$	$\tau_{0^+}^{\#2}$	$\sigma_{0^+}^{\#1}$
$\sigma_{0^+}^{\#1} \dagger$	$\frac{1}{(1+2k^2)^2 t_3}$	$-\frac{i\sqrt{2}k}{(1+2k^2)^2 t_3}$	0	0
$\tau_{0^+}^{\#1} \dagger$	$\frac{i\sqrt{2}k}{(1+2k^2)^2 t_3}$	$\frac{2k^2}{(1+2k^2)^2 t_3}$	0	0
$\tau_{0^+}^{\#2} \dagger$	0	0	0	0
$\sigma_{0^+}^{\#1} \dagger$	0	0	0	0

	$\sigma_{2^+}^{\#1} \dagger^{\alpha\beta}$	$\tau_{2^+}^{\#1} \dagger^{\alpha\beta}$	$\sigma_{2^+}^{\#1} \alpha\beta\chi$
$\sigma_{2^+}^{\#1} \dagger^{\alpha\beta}$	0	0	0
$\tau_{2^+}^{\#1} \dagger^{\alpha\beta}$	0	0	0
$\sigma_{2^+}^{\#1} \dagger^{\alpha\beta\chi}$	0	0	$\frac{1}{k^2 r_1}$

	$\omega_{2^+}^{\#1} \dagger^{\alpha\beta}$	$f_{2^+}^{\#1} \dagger^{\alpha\beta}$	$\omega_{2^+}^{\#1} \alpha\beta\chi$
$\omega_{2^+}^{\#1} \dagger^{\alpha\beta}$	0	0	0
$f_{2^+}^{\#1} \dagger^{\alpha\beta}$	0	0	0
$\omega_{2^+}^{\#1} \dagger^{\alpha\beta\chi}$	0	0	$k^2 r_1$

	$\omega_0^{\#1}$	$f_0^{\#1}$	$f_0^{\#2}$	$\omega_0^{\#1}$
$\omega_0^{\#1} \dagger$	t_3	$-i\sqrt{2} k t_3$	0	0
$f_0^{\#1} \dagger$	$i\sqrt{2} k t_3$	$2k^2 t_3$	0	0
$f_0^{\#2} \dagger$	0	0	0	0
$\omega_0^{\#1} \dagger$	0	0	0	0

Massive and massless spectra



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

(No massive particles)

Unitarity conditions

$$r_1 < 0 \&\& (r_5 < -r_1 \parallel r_5 > -2r_1) \parallel r_1 > 0 \&\& -2r_1 < r_5 < -r_1$$