

Particle spectrograph

Wave operator and propagator

$\sigma_1^{\#1} + \alpha\beta$	$\frac{1}{k^2(2r_1+r_5)}$	0	0	0	0	0
$\sigma_1^{\#2} + \alpha\beta$	0	0	0	0	0	0
$\tau_1^{\#1} + \alpha\beta$	0	0	0	0	0	0
$\sigma_1^{\#1} + \alpha$	0	0	0	$\frac{1}{k^2(r_1+r_5)}$	$\frac{\sqrt{2}}{k^2(1+2k^2)(r_1+r_5)}$	$\frac{2i}{k(1+2k^2)(r_1+r_5)}$
$\sigma_1^{\#2} + \alpha$	0	0	0	$\frac{\sqrt{2}}{k^2(1+2k^2)(r_1+r_5)}$	$\frac{3k^2(r_1+r_5)+2t_3}{(k+2k^3)^2(r_1+r_5)t_3}$	$\frac{i\sqrt{2}(3k^2(r_1+r_5)+2t_3)}{k(1+2k^2)^2(r_1+r_5)t_3}$
$\tau_1^{\#1} + \alpha$	0	0	0	0	0	0
$\tau_1^{\#2} + \alpha$	0	0	0	$-\frac{2i}{k(1+2k^2)(r_1+r_5)}$	$-\frac{i\sqrt{2}(3k^2(r_1+r_5)+2t_3)}{k(1+2k^2)^2(r_1+r_5)t_3}$	$\frac{6k^2(r_1+r_5)+4t_3}{(1+2k^2)^2(r_1+r_5)t_3}$

$\omega_1^{\#1} \dagger^{\alpha\beta}$	$k^2 (2 r_1 + r_5)$	0	0	0	0	0
$\omega_1^{\#2} \dagger^{\alpha\beta}$	0	0	0	0	0	0
$f_1^{\#1} \dagger^{\alpha\beta}$	0	0	0	0	0	0
$\omega_1^{\#1} \dagger^{\alpha}$	0	0	0	$k^2 (r_1 + r_5) + \frac{2t_3}{3}$	$-\frac{\sqrt{2} t_3}{3}$	$-\frac{2}{3} i k t_3$
$\omega_1^{\#2} \dagger^{\alpha}$	0	0	0	$-\frac{\sqrt{2} t_3}{3}$	$\frac{t_3}{3}$	$\frac{1}{3} i \sqrt{2} k t_3$
$f_1^{\#1} \dagger^{\alpha}$	0	0	0	0	0	0
$f_1^{\#2} \dagger^{\alpha}$	0	0	0	$\frac{2 i k t_3}{3}$	$-\frac{1}{3} i \sqrt{2} k t_3$	$\frac{2 k^2 t_3}{3}$

Quadratic (free) action

§ 11

$$\iiint (\frac{1}{3} (-2t_3 \omega_{\alpha}^{\kappa} \omega'_{\kappa} + 3 f^{\alpha\beta} \tau_{\alpha\beta} + 3 \omega^{\alpha\beta} \sigma_{\alpha\beta}) + 4 t_3 \omega_{\alpha}^{\kappa} \partial_{\kappa} f^{\alpha i} - 4 t_3 \omega'_{\kappa}$$

$$\partial' f^\alpha_\alpha + 2t_3 \partial' f^\kappa_\nu \partial' f^\alpha_\nu - 4r_1 \partial_\beta \omega_{\alpha\beta} \partial^\theta \omega^{\alpha\beta}_\theta + 2r_1 \partial_\beta \omega_{\alpha\beta} \partial^\theta \omega^{\alpha\beta}_\theta -$$

$$8r_1\partial_{\beta\alpha}\partial^\theta\omega^{\alpha\beta}-2r_1\partial_i\omega_{\alpha\beta}\partial^\theta\omega^{\alpha\beta}+2r_1\partial_\theta\omega_{\alpha\beta}\partial^\theta\omega^{\alpha\beta}+$$

$$2r_1\partial_\theta\omega_{\alpha\beta}^\theta\partial^\theta\omega^{\alpha\beta}_I+3r_5\partial_I\omega_K{}^\kappa\partial^\theta\omega^{\alpha I}_\kappa-3r_5\partial_\theta\omega_K{}^\kappa\partial^\theta\omega^{\alpha I}_\kappa+\dots$$

$$2t_3\partial_{\theta}f^{\alpha}\partial_{\kappa}f^{\kappa}-4t_3\partial^{\alpha}f^{\alpha}\partial_{\kappa}f^{\kappa}-3r_5\partial_{\alpha}f^{\alpha}\partial_{\kappa}f^{\kappa}+6r_5\partial^{\theta}f^{\theta}\partial_{\kappa}f^{\kappa}+$$

$$3r_5\partial_\alpha\omega^{\alpha i\theta}\partial_\kappa\omega^\kappa_{\theta'}-6r_5\partial^\theta\omega^{\alpha i}\partial_\kappa\omega^\kappa_{\theta'})[t,x,y,z]dzdydxdt$$

Source constraints/gauge generators	SO(3) irreps	Multiplicities
	$\sigma_0^{\#1} == 0$	1
	$\tau_{0+}^{\#2} == 0$	1
	$\tau_{0+}^{\#1} - 2 \, i \, k \, \sigma_{0+}^{\#1} == 0$	1
	$\tau_{1-}^{\#2 \alpha} + 2 \, i \, k \, \sigma_{1-}^{\#2 \alpha} == 0$	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

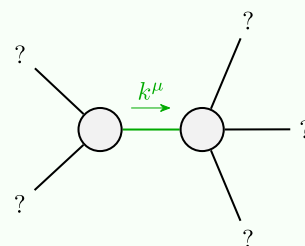
	$\sigma_{0+}^{\#1}$	$\tau_{0+}^{\#1}$	$\tau_{0+}^{\#2}$	$\sigma_{0-}^{\#1}$
$\sigma_{0+}^{\#1} \dagger$	$\frac{1}{(1+2k^2)^2 t_3}$	$-\frac{i\sqrt{2}k}{(1+2k^2)^2 t_3}$	0	0
$\tau_{0+}^{\#1} \dagger$	$\frac{i\sqrt{2}k}{(1+2k^2)^2 t_3}$	$\frac{2k^2}{(1+2k^2)^2 t_3}$	0	0
$\tau_{0+}^{\#2} \dagger$	0	0	0	0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

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

$\omega_2^{#1} + \alpha\beta$	$\omega_2^{#1} + \alpha\beta$	$\omega_2^{#1} + \alpha\beta$	$\omega_2^{#1} + \alpha\beta$
$\omega_2^{#1} + \alpha\beta$	$\omega_2^{#1} + \alpha\beta$	$\omega_2^{#1} + \alpha\beta$	$\omega_2^{#1} + \alpha\beta$
$\omega_2^{#1} + \alpha\beta$	$\omega_2^{#1} + \alpha\beta$	$\omega_2^{#1} + \alpha\beta$	$\omega_2^{#1} + \alpha\beta$

$\omega_0^{\#1+}$	t_3	$-i\sqrt{2}kt_3$	$f_0^{\#2+}$	$f_0^{\#1+}$	$\omega_0^{\#1+}$
$\omega_0^{\#1+}$	$i\sqrt{2}kt_3$	$2k^2t_3$	$f_0^{\#2+}$	$f_0^{\#1+}$	$\omega_0^{\#1+}$
$\omega_0^{\#2+}$	0	0	$f_0^{\#2+}$	$f_0^{\#1+}$	$\omega_0^{\#2+}$
$\omega_0^{\#1+}$	0	0	$f_0^{\#2+}$	$f_0^{\#1+}$	$\omega_0^{\#1+}$

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

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